MALDIVES DIGITAL HEALTH BLUEPRINT 2026 - 2030

A FRAMEWORK AND AN ACTION PLAN TO TRANSFORM THE HEALTH ECOSYSTEM

An initiative of
Maldives 2.0: Digital First Nation

Republic of Maldives

Maldives Digital Health Blueprint
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ADT:	Admission, Discharge, Transfer
AES:	Advanced Encryption Standard
AHIMA:	American Health Information Management Association
ANC:	Antenatal Care
API:	Application Programming Interface
CapEx :	Capital Expenditure
CBB:	Core Building Block
CD:	Communicable Disease
CDS/CDSS:	Advanced Encryption Standard
CEO:	Chief Executive Officer
CKO:	Chief Knowledge Officer
COO:	Chief Operating Officer
CoW :	Computer On Wheels
CRVS:	Civil Registration And Vital Statistics
CSF:	Cyber Security Framework
CTO:	Chief Technology Officer
DB/DBA:	Database (Administrator)
DC/DRC:	Data Centre/Disaster Recovery Centre
DH:	Digital Health
DHE:	Digital Health Enterprise
DHIS2:	District Health Information System
DIIG:	Digital Infrastructure Investment Guide
DNR:	Department Of National Registration
DPG:	Digital Public Goods
EHR:	Electronic Health Record
EMR:	Electronic Medical Record
FA:	Federated Architecture
FHIR:	Fast Healthcare Interoperability Resources
FHR:	Federated Health Record
SC:	Governing Council
GDP:	Gross Domestic Product
HFID:	Health Facility ID
HIE:	Health Information Exchange
HIS:	Hospital Information System
HMIS:	Health Management Information System
HL7:	Health Level 7 (Standard)
HPID:	Health Professional ID
HSPA:	Health Service Provider Application
HWID:	Health Worker ID
ICD 10/11:	International Classification Of Diseases
IDSP:	Integrated Disease Surveillance Program
IEC:	Information, Education, Communication
IGMH:	Indira Gandhi Memorial Hospital, Male
IHE:	Integrating Health Enterprise
IMR:	Infant Mortality Rate
IP:	In-Patient
FA:	ISO/TC:
ISO/TC:	International Organization For Standards (ISO)/Technical Committee
ISO/TS:	ISO Technical Specifications
IT/ICT	Information Technology/ Information And Communication Technologies
ISMS:	Information Security Management System
ISP:	Internet Service Provider
Km:	Kilometer
LIS :	Laboratory Information System
KMS:	Knowledge Management System
LOINC:	Logical Observation Identifiers Names And Codes
MDHEA:	Maldives Digital Health Ecosystem Architecture
MMR:	Measles, Mumps And Rubella
MDHB	Maldives Digital Health Blueprint
MRI:	Magnetic Resonance Imaging
MoHFW:	Ministry Of Health, Family And Welfare, Maldives

M&E:	Monitoring & Evaluation
MFDA:	Maldives Food And Drug Authority
NCD:	Non-Communicable Diseases
MDS:	Maldives Digital Service
NDHID	National Digital Health And Innovation Department
NHDMP:	National Health Data Management Policy
NIST:	National Institute Of Standards And Technology, USA
NRHF:	National Registry Of Health Facilities
NRHP:	National Registry Of Health Professionals
OP:	Out-Patient
OTP:	One-Time Password
OpEx:	Operational Expenditure
PHC:	Primary Health Center (Care)
PHR:	Personal Health Record
PPP:	Public-Private Partnership
RHIS:	Routine Health Information System
RMNCAH:	Reproductive, Maternal, Newborn, Child And Adolescent Health
SDG:	Sustainable Development Goals
SEARO:	South-East Asia Regional Office (WHO)
SLA:	Service Level Agreement
SOC:	Security Operations Centre
SNOMED-CT/GPS:	Systematized Medical Nomenclature For Medicine – Clinical Terminology/ Global Patient Set
SHA:	Secure Hash Algorithm
TAT:	Turnaround Time
TPA:	Third-Party Agency
TWD:	Technical Working Group On Digital Health
UHC:	Universal Health Coverage
UI/UX:	User Interface/User Experience
VPN:	Virtual Private Network
vCPU:	Virtual Central Processing Unit
VM:	Virtual Machine
WHO:	World Health Organization
ISMS:	Information Security Management System
ISP:	Internet Service Provider

Acknowledgement

The Maldives Digital Health Blueprint serves as a strategic roadmap developed by the Ministry of Health,Family and Welfare (MoHFW) to guide the digital transformation of the national health system. The primary objective of this Blueprint is to inform evidence-based policy-making, planning, and investment in digital health across the Maldives. It presents a comprehensive overview of the current landscape and future direction of digital health in the country.

We extend our heartfelt gratitude to WHO consultant Mr. Jeedigunta Satyanarayana for his pivotal role in conceptualizing and formulating the Blueprint. His leadership in drafting the document, thoughtfully integrating insights and comments from multiple stakeholders, has been instrumental in shaping the final version of this Blueprint.

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Executive Summary

The relevance of the proverb 'health is wealth' cannot be overemphasized in this fast age. Health is critical to the well-being of individuals as much as to the economy of any nation. The importance given to Universal Health Coverage and health-related SDGs is a testimony to the special attention that the health sector deserves.

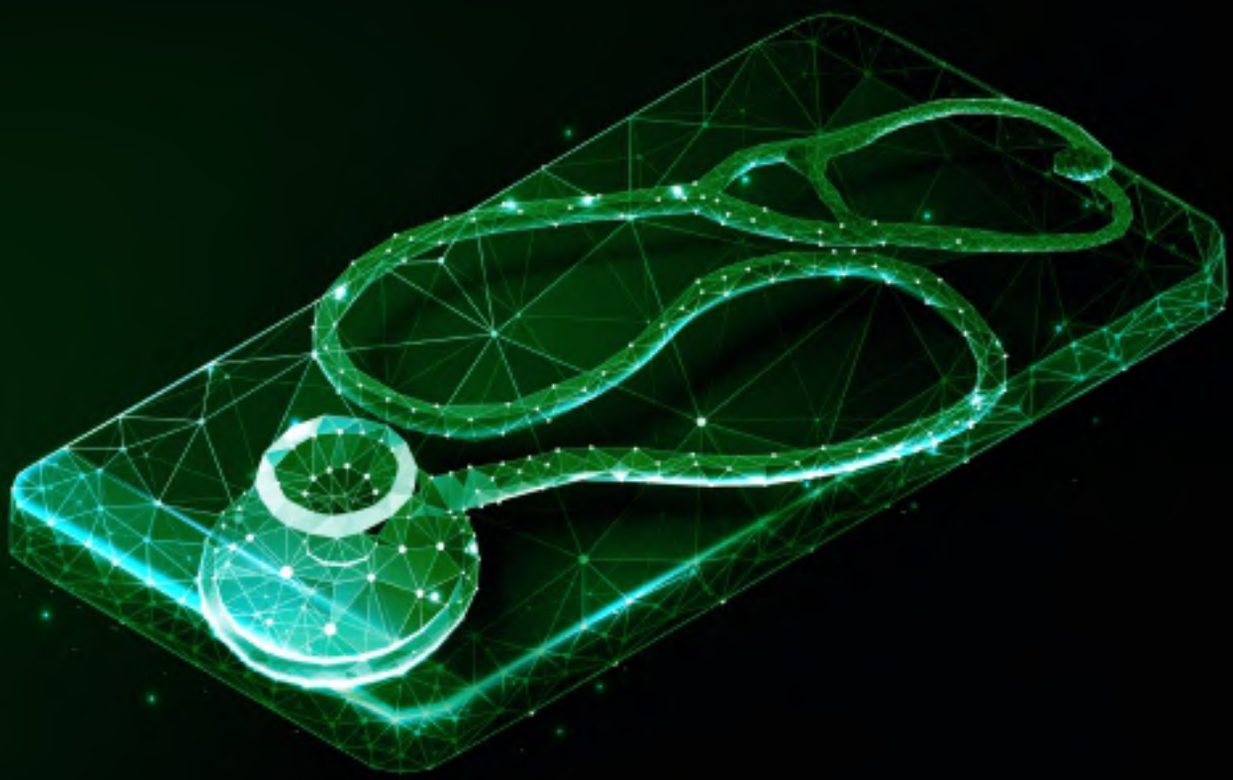
The health sector suffers from several challenges including shortage of resources, human, financial, managerial, and organizational. These challenges are more serious and complex in developing countries, especially in the Small Island Developing Countries. We need to do more with less and rapidly. The systematic and holistic deployment of digital technologies is an effective strategy demonstrated by several countries. WHO has been laying increasing emphasis on the adoption of digital technologies by the member states.

The government of Maldives intends to leverage digital technologies to enhance the health and well- being of its citizens. It intends to develop a digital health ecosystem that addresses most of the challenges that the citizens, residents and other stakeholders face. To this end, the government has embarked on designing a comprehensive blueprint for the design, development and deployment of digital health named Maldives Digital Health Blueprint (MDHB). The initiative is taken up in association with WHO (South-East Asia Regional Office).

The blueprint is a combination of several aspects critical to success. It comprises of a set of objectives and health outcomes, an ecosystem architecture, description of enablers like ICT infrastructure, legislation and capacity building. It contains a costed action plan that propels rapid progress in the journey of digital health.

The architecture recommended in this blueprint is modular, based on a set of reusable building blocks, and open standards. Federated architecture is preferred considering the need to ensure that the health services provided by the public, private and NGO sectors are interoperable and form a continuum of healthcare. Establishing an organization or unit dedicated to digital health is critical to success, considering the humongous effort involved in the design of the building blocks and coordination between the multiple organizations that the ecosystem contains.

The blueprint is a result of a consultative process. More importantly, it is proposed to be shaped as a living document, updated at regular intervals to subsume and leverage future knowledge and technologies. Effective leadership is the most critical determinant of the impact of digital health on the population scale.



CHAPTER 1

Digital Health Transformation

1.1

The context

The health sector is crucial for the well-being of any society. But its importance is magnified in developing countries where the population often faces significant health challenges. High burdens of disease, maternal and child mortality, and malnutrition are prevalent, and these create gigantic challenges for the population and the economy.

Digital health plays a transformative role in enhancing healthcare delivery, accessibility, and efficiency. Applications like mobile health (mHealth), telemedicine, and the use of personal health records (PHRs) improve the efficiency of health systems and quality of care. Additionally, the implementation of health information systems (HIS) helps in efficient management of health resources and planning of public health initiatives.

Seizing the opportunity to leverage technology for accelerating global progress on Universal Health Coverage (UHC) and the health-related Sustainable Development Goals, WHO has been making consistent efforts to advance digital health, for instance, by publishing the Global Strategy on Digital Health 2025 and the Digital Infrastructure Investment guide.

As per WHO, 'Digital health is the systematic application of information communication and technologies, computer science, and data to support informed decision-making by individuals, the health workforce, and health systems to strengthen the resilience to disease and improve health and wellness.'

A.

Benefits to the stakeholders

Enhancement of efficiency and effectiveness of the health systems.

Better access of health services by people residing in remote islands (for example, through telemedicine).

Enabling the health professionals and frontline workers to continuously update their domain knowledge and skills.

Propelling the Government to move towards evidence-based policy-making, monitoring and evaluation.

Empowerment of people through Personal Health Records controlled by them and shared with health professionals as per need.

Given the distinct benefits that it brings, the government of the Maldives intends to leverage the methods and techniques of digital health to transform the access and quality of health services. Therefore, the government of the Maldives has designed this digital health blueprint in close association with WHO (South-East Asia Regional Office) to trigger action on multiple fronts to transform the health systems rapidly.

1.2

Landscape Analysis

A.

Demography and Economy

The Maldives is an island nation in the Indian Ocean, situated southwest of Sri Lanka and India. It comprises 1,192 coral islands forming a chain 82 km long and 130 km wide, within a territorial area of 859,000 sq km. The islands are small and low-lying, averaging 1.6 meters above sea level, surrounded by clear lagoons and coral reefs. The country has a unified society with one language, culture, and religion. Dhivehi is the official language, while English is widely used in education, business, and commerce (Maldives Bureau of Statistics, 2022).

The Maldives is the smallest country in Asia as well as one of the world's most geographically dispersed sovereign states, with a population of 515,132 (Maldives Bureau of Statistics, 2022). Its peculiar geographic distribution poses several challenges in accessing services and the logistics of service delivery.

Maldives has a unitary presidential form of government. It comprises 21 administrative units, comprising 17 atolls (groups of closely located islands) and 4 cities. These units are administered by elected atoll councils and city councils, respectively. The cities are Malé (capital of Maldives), Addu, Fuvahmulah, and Kulhudhuffishi (Decentralization Act Article No. 56-1 & Maldives Land Survey Authority).

Maldives is classified by the World Bank as an Upper Middle-Income Country (UMIC), with a GDP per capita of US$11,786 (Maldives Bureau of Statistics, 2021), compared to the South Asia average of US$2,273.7 (World Bank, 2021).

Maldives ranks 'high' on the UN Human Development Index, ranking 87 out of 193 countries. It reports a life expectancy at birth of 80.8 (world average of 72.0), expected years of schooling of 12.2 (world average of 13.0), and mean years of schooling of 7.8 (world average of 8.7) (Human Development Report 2023/2024).

B.

Health Profile

Table 1.1 shows the health profile of the Maldives in terms of the WHO IMPACT Indicators.

Health Outcomes

Indicator	Value	Year	Data source
Maternal Mortality Ratio per 100,000 live births	51	2021	Maldives Health Statistics 2021
Neonatal Mortality Rate per 1000 live births	6	2021	Maldives Health Statistics 2021
Infant mortality rate per 1000 live births	10	2021	Maldives Health Statistics 2021
Mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease (%)	10	2021	Maldives Health Statistics 2021
Death rate due to road traffic injuries per 100,000 population	0.9	2021	Maldives Health Statistics 2021

Health Service Coverage And Health Care Access

Indicator	Value	Year	Data source
Proportion of births attended by skilled health personnel (%)	99	2021	Maldives Health Statistics 2021
% of currently married women aged 15-49 years with an unmet need for family planning.	31	2016 -2017	Maldives Demographic Health Survey 2016 - 2017
Adolescent fertility rate (15-19) per 1,000 women in that age group	18.5	2021	Maldives Health Statistics 2021

Health Service Coverage And Health Care Access

Indicator	Value	Year	Data source
UHC Service coverage index (%)	61	2021	Global health observatory, WHO
RMNCH Service coverage index (%)	67	2021	Maldives RMNCAH Factsheet December 2020, WHO
Proportion of the target population covered by all vaccines included in their national programme	76.4	2016-2017	Maldives Demographic Health Survey 2016-2017

Health Determinants And Risk Factors

Indicator	Value	Year	Data source
Prevalence of wasting among children under 5 years of age	9.1	2016-2017	Maldives Demographic Health Survey 2016-2017
Prevalence of stunting among children under 5 years of age	15.3	2016-2017	Maldives Demographic Health Survey 2016-2017
Prevalence of anaemia in women aged 15 to 49 years (%)	63.4	2016-2017	Maldives Demographic Health Survey 2016-2017
Number of new HIV infections per 1,000 uninfected population (by age, sex, and key populations) HIV incidence rate	40	2022	HPA Maldives https://hpa.gov.mv/health-topics/hiv-aids/
Age-standardized prevalence of current tobacco use among persons aged 15 years and older	22.5	2016-2017	Maldives Demographic Health Survey 2016-2017
Percentage of the population using safely managed drinking water services	76	2022	Census 2022, Maldives Bureau of statistics

Health Financing

Indicator	Value	Year	Data source
Government Health expenditure as a percentage of current expenditure (%)	73	2016	National Health Accounts 2015-2017
Government health expenditure as a percentage of GDP	8	2016	National Health Accounts 2015-2017
Out-of-pocket expenditure as percentage of health expenditure	19	2016	National Health Accounts 2015-2017

Health Workforce

Indicator	Value	Year	Data source
Skilled health professionals density (per 10,000 population)	231	2023	Maldives Health Statistics 2023, Human resource data
Medical doctors (per 10,000 population)	28.1	2023	Maldives Health Statistics 2023, Human resource data
Nurses (per 10,000 population)	72.1	2023	Maldives Health Statistics 2023, Human resource data
Public Health workers per 10,000 population	4.2	2023	Maldives Health Statistics 2023, Human resource data

Table 1.1: Performance of the Maldives on WHO IMPACT indicator

C.

Existing digital health landscape

Before embarking on the ambitious initiative of developing the Maldives' Digital Health Ecosystem Architecture, it is essential to undertake visiting major health facilities at the primary, secondary, and tertiary levels, and meeting a synoptic view of the major IT systems currently in use. An assessment of the existing digital systems developed independently by various organizations during the last few years. A WHO mission toured the country in July 2023, visited major health facilities at the primary, secondary, and tertiary levels, and met the key organizations and experts dealing with the subject. The following subsections present synoptic views and provide a comprehensive overview of the major IT systems currently in use.

1. Aasandha / Vinavi

Owner	Strengths	Areas requiring improvement	Number of location
Aasandha	▸ Simple UI. ▸ Established country-wide footprint. ▸ Focused on activities that have financial implications. ▸ Uses ICD-10. ▸ The entire workforce is conversant with the platform. ▸ JSON API integrated with other HMIS used in major hospitals and clinics. ▸ Hosted on a primary site located in a TIER IV data center. Services can be brought up online in off-site secondary location in event of primary site failure (estimated time for recovery: 2-3 hours).	▸ Not FHIR-compliant. ▸ No pre-authorization module. ▸ No validation (uniqueness check) of each registration and 'claim'.	Country-wide (730 sites)

2. HINAI

Owner	Strengths	Areas requiring improvement	Number of location
Male' City group of Hospitals (MCGH)	▸ Handles 75% of the OP/IP load of the entire country. ▸ Has an entire range of modules for HIS, mainly operates OP, IP, OT, lab and radiology modules. ▸ Compliant with FHIR. ▸ Locally hosted with 2 external backup facilities. ▸ Medical records are sent to patients by email, on request (This is an existing practice, not recommended to be continued in the future).	▸ Does not interoperate with HMIS, resulting in duplicative and tedious data entry. ▸ Quality of data is not assured, especially with respect to the use of correct ICD Codes. ▸ Analytics can be improved. ▸ Heavy vendor-dependency and lock-in. ▸ HR and finance modules not implemented.	2 Locations

3.VESALIUS

Owner	Strengths	Areas requiring improvement	Number of location
Tree Top Hospital	▸ Clinical operations are substantially digital, with very limited paper-based records. ▸ Use of Computer-on-Wheels (COWS) for capturing in-patient data in the wards. ▸ FHIR-compliant. ▸ Hosted in the DC of an ISP (Dhiraagu). ▸ Integrated with Aasandha. ▸ TTH Patient portal provide access to medical records. ▸ Interoperability with other hospitals/health systems. ▸ Non-Clinical modules are implemented (HR/Finance etc..).	▸ Quality assurance to be improved. ▸ Proprietary systems, vendor lock-in is a concern.	2 Locations

4. HMIS/RHIS

Owner	Strengths	Areas requiring improvement	Number of location
Ministry of Health, Family and Welfare Maldives	▸ Based on DHIS2 platform. ▸ Compliant with FHIR (through DHIS2). ▸ Compliant with ICD-10. ▸ Captures aggregated data on select indicators (OP, Observation, IP, gynecology and obstetrics, Surgeries, Procedures, Lab data, Emergency Management, Public Health). ▸ Providing the basis for the StatBook prepared annually by MoHFW (latest report released on 2021 but starting from 2022 chapter wise publication was initiated with infographics.	▸ Data Quality is a big concern. ▸ Incomplete reporting by health facilities. ▸ Timeliness of reporting to be improved. ▸ Need to build capacity in areas such as data analytics and use for supporting operational and policy decisions. ▸ Lacks performance management module. ▸ Base data of Routine Health Information System (RHIS) may be used to develop core registries (described in Chapter 3).	Country-wide (189 locations)

5. DHIS2/ Tracker

Owner	Strengths	Areas requiring improvement	Number of location
Ministry of Health, Family and Welfare Maldives	▸ Immunization module is operational at all public health facilities. ▸ PHC module, piloted and data collection started in 10 Atolls. ▸ Nationwide rollout of the Growth Monitoring and Developmental Milestones module. ▸ Pilot of the Maternal Health module completed. ▸ Cancer registry rollout in Male' area tertiary hospitals. ▸ Built on DHIS2 Platform, which is a DPG. ▸ Conforms to ICD-10 and can migrate to ICD-11. ▸ Can conform to FHIR, if DHIS2 platform adopts FHIR.	▸ A layer of analytics needs to be added at all levels- national, atoll and island levels to support evidence-based decisions. ▸ Features may be incorporated to support the fine-tuning of health programs, better supervision, and provide access to policymakers.	Country-wide

6. GEMEN

Owner	Strengths	Areas requiring improvement	Number of location
Local Government Authority	▸ Enables real-time census by recording all births and deaths. ▸ Triggers action to create/ update national IDs. ▸ Compliant with data standards. ▸ Hosted in the national data centre operated by MDS.	▸ Does not interoperate with CRVS.	At all councils and health facilities

7. NARES (National Registration System)

Owner	Strengths	Areas requiring improvement	Number of location
DNR	▸ Well-established system for assigning each citizen a unique identifying number. ▸ Established a system for recording births and deaths. ▸ 100% of events registered. ▸ Already integrated by API with GEMEN, e-council, vaccine portal and MFDA dhirithi portal. ▸ The system is presently undergoing an improvement phase and will undergo multiple enhancements.	▸ Vital registration metadata improvements. ▸ Developing KYC update module (which incorporates information such as current address). ▸ Does not interoperate with GEMEN or the HIS in health facilities. ▸ Requires manual porting of GEMEN data to CRVS.	Deployed in 88% of local council

8. EFAAS

Owner	Strengths	Areas requiring improvement	Number of location
MDS	▸ State-of-the-art digital ID system for the citizens of Maldives. ▸ About 46.5% of the population has been issued with a digital national ID so far. ▸ Can support consent-based, citizen-controlled access to personal records.	▸ Possible improvements in the regulatory aspects. ▸ Needs to be integrated with Aasandha and other health systems.	N/A

D.

Digital Health Development Index

Maldives has made satisfactory progress in implementing several digital health initiatives during the last 10 years. As per the results of the surveys conducted recently (as briefly mentioned below), there are several areas in which Maldives can improve in digital health.

1. Dip-stick survey of digital health conducted by WHO SEARO:

Maldives scored 50.5% in the dip-stick survey of digital health (2023). As per this, while Maldives has most of the components of digital health in place, they need to be pieced together and implemented holistically through appropriate architecture, policies, and capacity building.

2. The Global Digital Health Index (GDHI):

Assesses the status of implementation of digital health in a country in terms of the 7 indicators identified by WHO in their Global Digital Health Strategy 2020–2025. Maldives scores low on GDHI (phase 2 on a scale of 1 to 5). It is particularly less developed in policy, standards, interoperability, and infrastructure, as depicted in Figure 1.1. Clearly, the immediate focus should be on developing and implementing the Digital Health Blueprint, which will ensure progress evenly along all 7 dimensions of GDHI and helps advance Maldives to phase 4 or 5 in a short span.

Indicator	Singapore	Mauritius	Sri Lanka	Maldives
Overall	5	4	3	2
Leadership & Governance	5	4	3	3
Strategy & Investment	N/A	N/A	2	2
Workforce	N/A	N/A	3	2
Legislation, Policy & Compliance	5	4	3	1
Standards & Interoperability	N/A	N/A	3	1
Infrastructure	5	4	3	1
Services & Applications	N/A	N/A	3	2

Figure 1.1: Comparative picture of DH Index of Small Island countries

1.3

Challenges of health systems and of Small Island Developing States (SIDS)

Challenges are problems that slow down the implementation of digital health initiatives. The challenges to digital health lie in multiple dimensions and are broadly categorized under the four heads described below. These challenges have been identified through a structured survey of the digital health landscape of Maldives, besides the interactions with the experts and practitioners during the WHO SEARO Mission undertaken during 9-13 July 2023. Besides this, the unique challenges faced by SIDS have been identified through secondary research.

The digital health blueprint attempts to address these challenges by proposing appropriate architecture, digital health interventions, and solutions.

A.

Governance-related challenges

Lack of a central organization dedicated to digital health

Lack of dedicated organization for digital health leads to fragmented systems, duplicated efforts, and poor interoperability among the involved sectors. A dedicated digital health organization is needed to oversee the entire process from concept to deployment, ensuring standardization, integration, and efficient implementation.

Lack of laws, regulations and policies

The absence of clear data management policies hampers data sharing, affecting healthcare efficiency and convenience. Hence, it is important to establish guardrails for managing sensitive health data. Fast-tracking the Digital Health Act and Data Protection Act is essential to creating a secure and enabling environment.

Lack of a framework for cross-border exchange of health information

A lot of Maldivians get referred to tertiary hospitals in other countries where advanced facilities are available, notably in India and Sri Lanka, but the absence of a cross-border health data policy causes treatment delays, redundant tests, and insurance claim issues.

Figure 1.2: Governance-related challenges

B.

People-related challenges

Absence of a medium. and long-term plan for workforce development

Maldives faces challenges with skilled manpower in most sectors. There is a significant dependence on expatriates for providing skilled services, and more so, expert services. There is a dire need to develop a medium and long-term plan for workforce development in the health sector, especially for the development of a cadre of specialists in digital health.

Inadequate local infrastructure for education and training

The existing infrastructure for education and training in health sector is inadequate to meet the demand for health services. This applies across all the faculties, namely, medical education, nursing education, public health, lab technician training, pharmacy, IT and HealthTech.

Human Resource Management System (HRMS)

A comprehensive HRMS has been established in Maldives. It is currently being scaled up. The system is in line with WHO-NHWA (National Health Workforce Accounts). It may have to be aligned to comply with the interoperability requirements of Maldives Digital Health Ecosystem Architecture (MDHEA) recommended in this document.

Figure 1.3: People-related challenges

C.

Innovation Challenge

Island nation challenges

Maldives' unique geography presents challenges in transport, logistics, and climate adaptation that require innovative solutions. A global challenge can invite startups to develop cutting-edge technologies tailored to island nations. The solutions pioneered here can benefit other SIDS worldwide.

Figure 1.4: Innovation-related challenges

D.

Technology-relatedchallenges

Multiple legacy applications developed in isolation

Several applications were developed in isolation, leading to inefficiencies and duplicate data entry. Table 1.2 provides a quick assessment of the major applications. The key challenge is deciding whether to retain, consolidate, integrate, or rebuild them to meet global standards.

Absence of certified data center(s)

The public sector's main data center, managed by MDS, lacks certification (e.g., Uptime Institute Standards) due to the absence of a disaster recovery facility and dual power sources, reflecting broader infrastructure challenges. This leads to occasional operational disruptions.

Lack of adherence to terminology and coding standards

Most systems comply with ICD-10, but migration to ICD-11 has not begun. Most systems, apart from Vesalius and HINAI, have not adopted FHIR terminology, posing challenges to interoperability. The same applies to SNOMED-CT and LOINC adoption.

Lack of interoperability

The lack of common data standards and models has resulted in poor interoperability and a systemic inability to develop integrated services, especially for EMR, EHR, and PHR.

Stand-alone systems of HIS in PHCs

MoHFW developed a hospital information system for primary care. However, it is not updated due to a lack of support. The system runs locally in PHCs, causing version control issues and poor local management. Additionally, data aggregation and analytics at higher levels are inefficient.

Lack of unifying architecture

The lack of a unifying architecture is the root cause of current challenges, including fragmented IT investments, gaps in care of continuity, difficulty developing PHR systems, and slow adaptation to emerging technologies.

Lack of well-designed data analytics solutions

As a result, data is used solely for statistics rather than supporting evidence-based decision-making or policy planning.

Figure 1.5: Technology-related challenges

E.

Process and system-related challenges

Standardization and Interoperability of IT Systems

While IT systems exist for creating national IDs, registries, and master data, they need standardization and interoperability. The Health Information Exchange must be built from scratch.

Supply Chain Management Solution

Currently, two major systems are used for supply chain management: e-LMIS, developed with WHO support, and the Supply Chain Management (SCM) system, developed by State Trading Corporation (STO).

Lack of tools for visualization & planning

This gap leads to ineffectiveness in planning and supervision.

Low health-seeking behavior

The lack of focus on health awareness and lifestyle changes may contribute to low health-seeking behavior. As a result, many health facilities, especially at primary and secondary levels, are significantly underutilized.

Tertiary care is substantially paper based

Most of the tertiary care is provided by Indira Gandhi Memorial Hospital, Male'. A large portion of patient records is maintained manually and later scanned. Although the HINAI platform supports paperless case management, it is not effectively utilized, limiting the range and scope of digital health services that could be introduced.

Figure 1.6: Process and systems-related challenges

F.

Challenges of SIDS:

SIDS are a distinct group of countries that face unique social, economic, and environmental challenges on account of their special geography and small size. Factors like small population size, remoteness from international markets, high transportation costs, vulnerability to exogenous economic shocks, and fragile land and marine ecosystems make SIDS particularly vulnerable to biodiversity loss and climate change because they lack economic alternatives.

Figure 1.7 brings out the consequences of the unique challenges of SIDS on health outcomes. Implementing digital health processes requires significantly higher effort in SIDS.

Vulnerability to natural calamities

- Health systems often thrown out of gear.
- Preparedness and response are limited, causing damage to life and population health.

Dispersed geography

- Logistical challenges and inefficiencies in the supply of medicines and consumables.

Remoteness Of geography

- Difficulties in sustaining the supply, recruitment, and retention of HR for health.
- Heavy dependence on foreigners for expertise.

Inadequate health infrastructure

- Outward health tourism causes a loss of economy. opportunities for the country and impose a financial burden on citizens.

Lack of expert medical educational institutions

- Dependence on immigrant professionals leading to high turnover.

Small size of the economy

- The market is not attractive for reputable suppliers.
- Government does not have economies of scale.
- Competition is low, driving up costs and pushing down quality.

Figure 1.7: Challenges of SIDS

Unique challenges require unique solutions and approaches in designing the digital health blueprint and architecture.

This blueprint endeavors to address all the challenges through appropriate architectural approaches and application design considerations to maximize the impact of the digital health program.

1.4

Transformative power of digital health

Maldives has an opportunity to leapfrog towards a health systems transformation, adopting a person-centered approach and architecture. The country has basic versions of most of the core building blocks of digital health architecture. We need to chisel these rudimentary building blocks to the defined standards and piece them together to create a big picture. These include the opportunities to create a continuum of care, to promote telemedicine extensively in a geographically challenged terrain like in Maldives, and to adopt the once only principle in capturing data.

In addition to the opportunities that digital health enterprise provides, Maldives has the unique potential to pursue the following aspirational goals that enhance the quality of life in Maldives and make a difference in other countries.

The DHIS2-based trackers developed in Maldives can be shaped as a comprehensive global Digital Public Good (DPG). The significant work done by Maldives in shaping the DHIS2-based trackers that are being developed places Maldives in a unique position. As these have been designed to conform to the global standards of clinical classification and terminology, they can be shaped as digital public goods with marginal efforts. These modules comprise immunization, PHC, nutrition & growth monitoring, ANC/PNC, communicable disease surveillance, and cancer registry.

1.5

Initial list of digital health services

The services targeted by the digital health program should be aligned with the local context to address the challenges identified earlier. Annexure 1 provides an indicative list of prioritized digital health services. The list needs to be fine-tuned through stakeholder consultation and engagement. The architecture and building blocks are designed to meet the requirements of these services.

1.6

WHAT and WHY of Digital Health Blueprint

A Digital Health Blueprint is a document that combines the Digital Health Strategy with a costed, time-bound Action Plan to transform the health systems through a holistic digital health enterprise architecture to achieve UHC and the health-related SDGs.

The singular benefit of the blueprint is that it seeks to identify all the challenges, desired outcomes and aspirations at one time (rather than in a piecemeal fashion) and recommends a holistic approach to addressing the challenges and to achieving the desired outcomes in a phased manner.

The investment of effort and resources in developing the blueprint is justified on the following counts:

- The blueprint meets the specific needs and addresses the specific challenges of Maldives. It accelerates progress towards UHC and SDGs.
- The blueprint contains a high-level but actionable implementation plan.
- It creates a shared vision and builds public awareness and opinion in favor of this nationally important socio-digital infrastructure.
- The blueprint enables engagement and involvement of the citizens, civic groups, and civil society organizations in a positive debate, the outcome of which would eventually enhance the design of the digital health program.
- Above all, the blueprint acts as a strong mechanism for creating a sense of ownership among the stakeholders, which is essential for successful implementation.

1.7

Structure, methodology and intended audience

A.

Structure of the blueprint

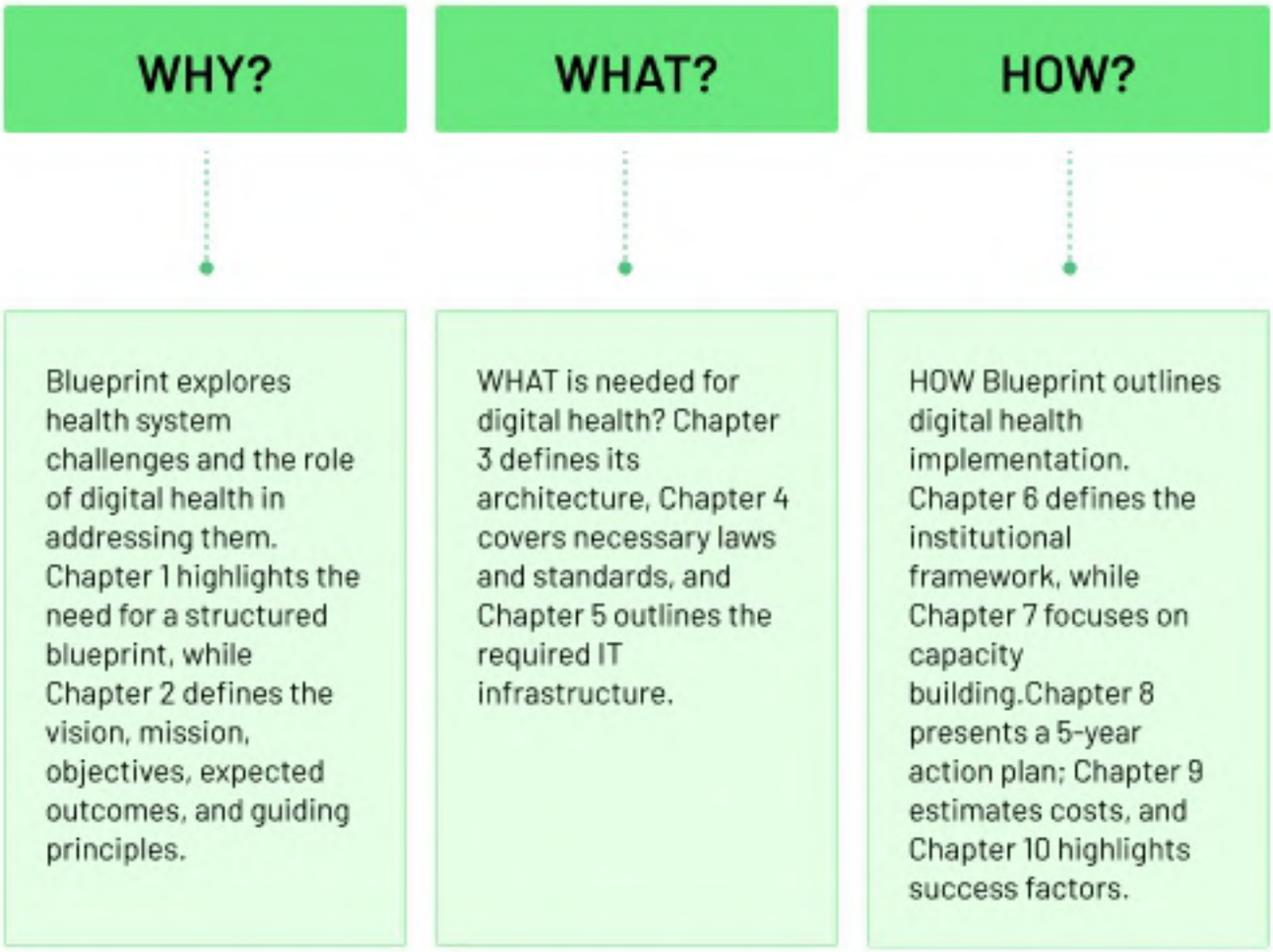


Figure 1.8: Three fundamental questions building the structure of the blueprint

B.

Intended Audience

Policy-makers

To sensitize them (i) to formulate appropriate legislation, policies, and regulations that enable, facilitate, or regulate the various actions and transactions in providing digital health services; (ii) to provide for adequate budgets; (iii) to allocate qualified experts and professionals to the program; and, above all (iv) to provide the leadership that such a program demands.

Health administrators

To execute the action plan suggested in the blueprint in time and be responsible for the outcomes expected of the program.

Healthcare professionals

To get them on board to cope with the huge change caused by the digital ways of clinical management. They can enhance their efficiency and effectiveness through the use of digital tools and techniques recommended in this blueprint.

HealthTech companies

To pursue the opportunities opened by the blueprint and align their platforms, products, and applications to meet the specific needs and standards highlighted by the blueprint.

Architects, developers

To leverage and hone their capabilities to design the architecture and develop the applications envisaged by the blueprint.

Civil society

To evaluate the propositions of the blueprint critically from the point of citizens' rights, especially the right to privacy and security of their health data, and advocate the appropriate policies to safeguard the individual interests.

Prospective donor agencies and multilateral agencies

To explore the right opportunities and initiatives of the digital health program to invest in with the assurance of seeing the maximum impact.

Citizens, expats and international tourists

To give feedback on the user perspective and citizen-centricity, which are critical for the right designs.

C.

Methodology used to design the blueprint

A structured methodology has been adopted to develop the Blueprint. It consists of 3 broad stages, as shown in Figure 1.9. The first phase (ASSESS) involves field visits and interviews with stakeholders, besides benchmarking with other countries. The second phase (DESIGN) sees the evolution of a series of draft blueprint iterated to incorporate the comments of SEARO, WCO, and other experts. The third phase (FINALIZE) involves seeking comments from a multistakeholder community in a workshop format, incorporating these comments to the blueprint, seeking the comments of the Ministry of Health, Family and Welfare, incorporating the same, and finalizing the blueprint document.

Figure 1.9: Methodology used to develop the blueprint

A multi-stakeholder convergence workshop was conducted by MoHFW in association with SEARO, WHO, during 24-25 September 2024 at Male' City. About 50 participants from different organizations and health facilities attended the workshop. In addition, experts from Singapore and Sri Lanka participated in person, and representatives of Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia, and Asia eHealth Information Network (AEHIN) participated virtually.

The overarching feedback of the participants is that

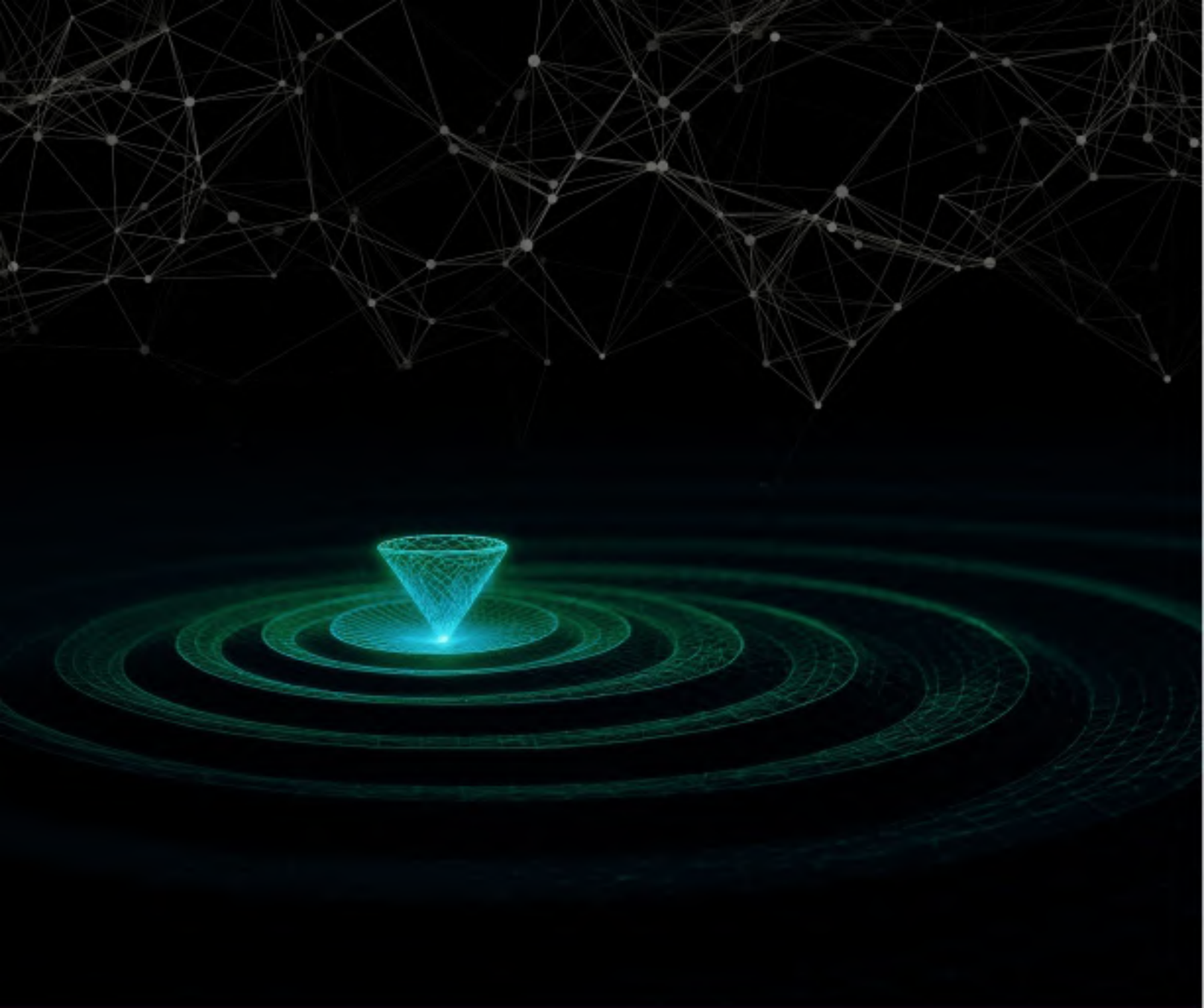
- The Digital Health Blueprint is quite useful, essential, and timely.
- The stakeholder engagement process is useful and should continue at all stages.
- The need for person-controlled health records is widely acknowledged.
- The role of leadership & governance is of paramount importance.

D.

What is NOT within the scope of the blueprint

The blueprint is NOT

- A detailed functional requirements specification document, but only a listing of the challenges and possible approaches to the solutions.
- Detailed architecture specification that prescribes how software is developed.
- Platform or tool that transforms the health systems.
- An RFP that can be published inviting responses.



CHAPTER 2

Vision, Objective And Principles

2.1

Aspirational goals of a few countries

The hallmark of good leadership and governance (Pillar 1 of the WHO Strategy) is the ability to develop a shared vision and to establish a set of SMART Objectives to drive any large initiative. While the specific goals of digital health in various countries may be different, the direction appears to be the same.

The following subsections present the digital health aspirations of the countries selected for benchmarking.

A.

Australia

Nature of the document	Year
Digital Health Blueprint	2023-2033

Main objectives	▸ To create a more connected, person-centered, and sustainable health system for all Australians through the effective use of digital technologies.
Key goals	▸ Enhance access and convenience: Offer multiple healthcare options, including in-person. virtual, and digital channels, for easier access and choice. ▸ Connected care: build a system centered on the consumer, giving them access to vital health data and information. ▸ Transparency and accountability: ensure transparency in data usage, service access, and healthcare costs to strengthen the system. ▸ Seamless team care: enable safe, collaborative care by sharing patient data among providers, reducing the need for repetition, and giving individuals control over their data. ▸ Privacy and security: strengthen privacy, security, and consent practices to protect personal health data. ▸ Inclusivity and equity: Design the system to be inclusive, equitable, and accessible to all Australians, ensuring no one is left behind.

B.

Canada

Nature of the document

Canadian Digital Healthcare Strategies

Main objectives	▸ Enhance healthcare digital transformation. ▸ Increase inter-provincial collaboration. ▸ Identify common themes, barriers, and enablers. ▸ Improve healthcare delivery and patient outcomes. ▸ Develop a systemic framework for digital health interoperability.
Key goals	▸ Enhancing patient engagement and education to improve healthcare outcomes. ▸ Addressing health disparities and promoting equity across the healthcare system. ▸ Strengthening integration among hospitals, community providers, and clinical systems. ▸ Leveraging data-driven insights to inform healthcare decisions and trends. ▸ Upgrading digital health Infrastructure for greater efficiency and effectiveness. ▸ Establishing clear policies for data management and interoperability. ▸ Collaborating with the private sector to drive innovation and digital health advancements. ▸ Tackling major roadblocks that hinder digital health implementation. ▸ Utilizing artificial intelligence and modern tech solutions to improve healthcare operations. ▸ Ensuring that digital health advancements are implemented in a structured and coordinated manner.

C.

Estonia

Nature of the document	Year
Estonian eHealth Strategy	2020

Main objectives	▸ To enhance the quality and efficiency of healthcare services through the development and implementation of digital solutions.
Key goals	▸ 'Better information – more health!' ▸ High-quality health information and an infrastructure of health data. ▸ Focus on persons and personal medicine. ▸ Comprehensive case management and cooperation of organizations ▸ Effectiveness of health services and capacity for analysis. ▸ Development of remote services.

D.

Indonesia

Nature of the document	Year
Blueprint of Digital Health Transformation Strategy	2024

Main objectives	▸ Digital health transformation to address data fragmentation, inefficiencies, and inadequate health service integration. ▸ Improve healthcare quality and policy-making using accurate, standardized, and integrated data.
Key goals	▸ Achieve a healthy Indonesia through data-driven and digital health services. ▸ Develop the Indonesia Health Services (IHS) platform for data integration and health application collaboration. ▸ Increase access to telemedicine, enhance biotechnology research, and optimize health financing and human resource management.

E.

Mauritius

Nature of the document
He@lth 2015 Seamless Continuity of Care

Main objectives	▸ To exploit ICT to extend seamless continuity of care through affordable, high-quality, user-centric service to all healthcare stakeholders in Mauritius and to promote knowledge networking among them.
Key goals	▸ Improve clinical outcomes through better client-centric service delivery & high levels of internal efficiency and effectiveness. ▸ Enhance competency levels of health care staff at all levels and across organization types towards ICT to deliver better healthcare. ▸ Improve levels of collaboration between the sector stakeholders with interoperability, standardization, and cooperative knowledge exchange.

F.

Singapore

Nature of the document	**Year**
Healthier SG	2023

Main objectives	▸ Healthier SG aims to nurture an ecosystem that supports better health by leveraging the primary healthcare system and community partners.
Key goals	▸ Healthy 365 app to promote healthier lifestyle choices. ▸ GP clinic management systems (CMSs) that integrate with the National Electronic Health Records system. ▸ Health Hub app, for citizens to be more informed and responsible for their health.

G.

Sri Lanka

Nature of the document	**Year**
Sri Lanka Digital Health Blueprint	2023

Main objectives	▸ To support the secure and confidential digital health future within Sri Lanka as envisioned within the National Policy on Health.
Key goals	▸ Digitization of clinical workflows and connecting the health solutions to the digital health ecosystem. ▸ Sharing the health information via open APIs.

2.2

Vision and Mission of Maldives Digital Health Blueprint (MDHB)

The vision of the Ministry of Health, Family and Welfare is "Together as a nation for excellence in health." Digital initiatives would play a transformative role in achieving this vision. The vision envisages leapfrogging by the adoption of the latest concepts like PHC-oriented and person-centered health systems and cutting-edge technologies. It also requires the design and development of solutions that can overcome the challenges posed by the country's epidemiology, demography, and unique geography.

The mission statement of the Ministry of Health, Family and Welfare is "to ensure nation's participation in attaining excellence in quality health services in an affordable, equitable and accessible manner". Derived from the foregoing, the mission of the digital health blueprint is

MISSION

Architect and design the digital health ecosystem for efficiency, interoperability, accessibility, and affordability to suit the epidemiology, demography, and unique geography of the Maldives, duly protecting security, privacy, and confidentiality of health information.

VISION

"To transform health systems by leveraging digital technologies to accelerate Universal Health Coverage and continuity of care through affordable, high-quality, user-centric services provided in a person-controlled way."

2.3

Objectives

1. To enhance the availability, efficiency, quality and accessibility of the core healthcare services, with special focus on UHC and PHC, leveraging the transformational power of digital health.

2. To establish state-of-the-art digital health systems for managing the core digital health data and the infrastructure required for its seamless exchange.

3. To ensure continuum of care across the health ecosystem.

4. To create and/ or enhance the communication networks to ensure access to health services by the residents of remote islands.

5. To promote the adoption of open standards by all the actors in the digital health ecosystem.

6. To create a citizen-controlled Personal Health Record system, ensuring confidentiality, security, and accessibility for both citizens and healthcare providers with consent-based access.

7. To ensure that the healthcare institutions, professionals, and health partners operating in both the public and private domains participate actively in the building of the digital ecosystem.

8. To enable cross-border exchange of health data as needed by formulating appropriate policies and building the required technological capabilities.

9. To improve the efficiency and governance at all levels through evidence-based decision-making, real-time monitoring of health programs, and Clinical Decision Support Systems (CDSS).

2.4

Expected outcomes

An outcome-focused approach is best suited to architect the digital health ecosystem. Health indicators and technology indicators define the outcomes.

Health Outcomes

Indicator	Baseline	Baseline year	Target outcome	Target Year
Maternal Mortality Ratio per 100,000 livebirths	51	2021	Maintain below 50	2030
Neonatal Mortality Rate per 1000 livebirths	6	2021	Maintain below 6	2030
Infant mortality rate per 1000 livebirths	10	2021	Maintain below 9	2030
Mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease (%)	10	2021	Reduce by 1/3rd	2030
Death rate due to road traffic injuries per 100,000 population	0.9	2021	Maintain below 1 per 100,000 population	2030

Health Service Coverage And Health Care Access

Indicator	Baseline	Baseline year	Target outcome	Target Year
Proportion of births attended by skilled health personnel (%)	99	2021	Maintain above 95%	2030
Antenatal care coverage at least four visits (%)	82	2016 -2017	Increase to 90% and maintain	2030
% of currently married women aged 15-49 years with an unmet need for family planning	31	2016 -2017	Reduce to 25% and maintain below 25%	2030
Adolescent fertility rate (15-19) per 1,000 women in that age group	18.5	2021	Decrease to 13 and maintain	2030
UHC Service coverage index (%)	61	2021	To reach to 80%	2030
Proportion of the target population covered by all vaccines included in their national program	76.4	2016 - 2017	Increase to 95% and maintain above 95%	2030

Health Determinants And Risk Factors

Indicator	Baseline	Baseline year	Target outcome	Target Year
Prevalence of stunting among children under 5 years of age (%)	15.3	2016-2017	Reduce by 1/3rd and maintain	2030
Prevalence of anaemia in women aged 15 to 49 years (%)	63.4	2016-2017	Reduce by 20.5%	2030
Number of new HIV infections per 1,000 uninfected population (by age, sex, and key populations)	0.01	2022	Maintain below 0.05	2030
Age-standardized prevalence of current tobacco use among persons aged 15 years and older (%)	23.1	2016-2017	Reduce by 25%	2030
Percentage of the population using safely managed drinking water services	76	2022	Increase to above 95%	2030

Health Financing

Indicator	Baseline	Baseline year	Target outcome	Target Year
General Government Health Expenditure(GGHE) as % of Total Expenditure on Health (THE)	71.5	2016	Maintain above 70%	2030
Government health expenditure as a percentage of GDP	8	2016	Maintain at 8%	2030
Out-of-Pocket Spending on Health (OOPS) as % of Total Expenditure on Health (THE)	20.6	2016	Reduce by 25%	2030

Health Workforce

Indicator	Baseline	Baseline year	Target outcome	Target Year
Skilled health professionals' density (per 10,000 population)	231	2023	Increase by 50% and maintain	2030
Medical doctors (per 10,000 population)	28.1	2023	Maintain above 20	2030
Nurses (per 10,000 population)	72.1	2023	Maintain above 50	2030
Public Health workers (per 10,000 population)	4.2	2023	Increase to 20 and maintain above 20	2030

Technology Outcomes

Indicator	Baseline	Baseline year	Target outcome	Target Year
Global Digital Health Index (overall rating)	2		5	2030
Core registries established	3		100%	2030
Hospital Automation System	4.2		Increase to 20 and maintain above 20	2030
Health Information Exchange established	N/A		100%	2030
Health Information Exchange implemented	N/A		80%	2030
Interoperability established among public institutions	N/A		Increase to 50% reach to 100%	2030
FHIR standard adopted (% of applications adopting)	N/A		80%	2030
PHR adopted by population (%)	N/A		>80%	2030

Table 2.2: Indicative list of outcomes expected of Digital Health Program

2.5

Principles to guide Maldives Digital Health Blueprint

The evolution of the digital health program is proposed to be guided by a set of principles that are adopted by the stakeholders through consensus.

The principles of digital health are categorized under Health Domain, Technology and Implementation. The success of the digital health program depends on the universal adoption of these principles:

A.

Domain Principles

1 PHC-Centricity

Reorient the health systems to primary healthcare, prevention and wellness. The primary healthcare record should be the foundation of continuum of care.

2 Person-controlled PHRs

Build the digital ecosystem based on person-controlled PHRs.

3 Inclusivity

Health and wellness services shall be available uniformly to citizens, residents and tourists, and to people who are disadvantaged economically and by remoteness.

4 Portability

Health records and services has to be accessible irrespective of travel/ relocation within the country and travel abroad.

5 Once-only

Data entered ONCE should be reused wherever required, subject to the applicable consent requirements.

B.

Technology Principles

1 Federated Architecture

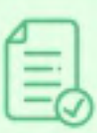
Adopt a Federated Architecture, as it promotes well established applications to be standardized/enhanced and retained, provides for interoperability of distinct systems within public sector and across public-private-NGO sectors, and strengthens privacy and security.

2 Building Block Approach

Design a modular architecture made up of building blocks.

3 Open, Open, Open

Adopt open standards, open source, and open API specifications to enhance transparency, security and cost-effectiveness.



4 Standards

Adapt and adopt global standards for representing and exchanging data to support interoperability, representing clinical and diagnostic terminology, ensuring security and privacy of health information and assuring safety of patients.

5 Interoperability

Aim at interoperability-by-design at syntactic and semantic levels.

6 Security- and Privacy-by-Design

Adopt the global principles and best practices of security and privacy 'by design'.

7 Minimalist design

All designs (architectures, data models, interfaces, reports etc) shall be minimalist.

C.

Implementation Principles

1 Establish a dedicated Institution

Establish a funded institution dedicated to the design, development, implementation and promotion of digital health under the overall guidance of the Ministry of Health, Family and Welfare.

2 Build capacities

Design and implement a multi-level plan for capacity building on digital health to ensure that the DH systems are properly designed, deployed, used and leveraged.

3 Extend policy support

Enact/notify appropriate legislation or policy on data protection, digital health, health data management and sharing.

CHAPTER 3

Maldives Digital Health Ecosystem Architecture

3.1

Approach to designing the Maldives Digital Health Ecosystem Architecture

The discussion in the earlier chapters established that the digital health program is required to address multiple, widely divergent issues related to technology, governance, people, and processes. Interestingly, several of the problems related to governance, people, and processes need solutions that are rooted in technology. The net result is that the Maldives digital health blueprint (MDHB) needs to be developed on the foundation of a robust and holistic architecture.

It must provide guidance on what types of infrastructure, applications, and capabilities should exist and how they interrelate and interoperate to provide a wide range of digital services to the stakeholders. The Digital Health Enterprise Architecture (such as Open HIE), Integrating Health Enterprise (IHE), DHIS2 and the models of architecture designed in some of the bench-marked countries provide guidance on the design of MDHEA.

The approach to designing MDHEA is proposed to be guided by the following considerations. These considerations are elaborated, to the extent required, in the subsequent sections.

1. MDHEA is modular and is composed of a set of building blocks that are reusable and thereby lend significant flexibility and agility to the evolution of the digital ecosystem.
2. The core building blocks form the heart of MDHEA. The Common Building Blocks and all other applications derive certain basic services from the Core.
3. The architecture shall support deployment at 3 levels: central level, atoll/city level, and island level.
4. The architecture shall support the preventive and curative services offered by the public, private, and NGO sectors, besides international organizations and multilateral agencies.
5. Person-controlled personal health records (PHRs) must be the most compelling feature of MDHEA in order for it to be widely and quickly adopted by the patients and the health workforce. PHR empowers people, promotes a PHC-centric approach, enhances service delivery, protects privacy, and above all, democratizes digital health.

6 The functional scope of architecture shall extend to the wide range of functionality of the health ecosystem, which is divided into the following four segments for ease of design, development, and deployment:

- Public Health
- Healthcare and Wellness
- Health workforce
- Health Information Management

7 The architecture shall meet the requirements of interoperability between the 3 deployment levels (at 3), 3 types of entities (at 4), and 4 segments of the ecosystem (at 6), ALL AT THE SAME TIME.

8 The complexity of the consideration (at 7) is best addressed by adopting a Federated Architecture Model. While the adoption of federated architecture may seem challenging due to limitations in local digital capacities, it is beneficial in the medium and long term by safeguarding public interests such as security and privacy. Additionally, it supports the rapid evolution of multiple systems that adhere to the same principles and standards.

9 The architecture must be designed to overcome the unique challenges of a Small Island Developing State (SIDS) country like the Maldives, as outlined in Section 1.3(f).

10 MDHEA should cater to the varying needs of the mixed demographic, consisting of citizens, residents with foreign nationalities, and tourists. Such a variety of impacts, for instance, the process of identification of persons, the clinical differentiators that factor ethnicity, the user interface, linguistic needs, and the processes for payments, insurance, and reimbursement.

11 MDHEA should factor into the legacy systems, some of which have a nationwide footprint, as mentioned in Chapter 1. It is essential to critically evaluate these and identify the modifications needed to make them compatible with the requirements of the MDHEA. An application should be retired only if it is built on a technology that is outmoded and cannot easily be made to interoperate or scale.

3.2

Functionality to be supported by Maldives Digital Health Ecosystem Architecture

The functionalities to be supported by the health ecosystem are diverse and wide. Based on the landscape survey and interactions with the experts and practitioners, the major functionalities are organized under the 4 broad themes mentioned in section 3.1(6). Figure 3.1 provides a schematic view of the same.

Functional Representation Of Maldives Digital Health Ecosystem Architecture (MDHEA)

Healthcare & Wellness

- PHC
- Secondary and tertiary care
- Health facility management
- Lab & diagnostics
- Geriatric care
- Mental health and wellness
- Emergency response
- Emergency medical care
- Remote healthcare
- Health Insurance
- Healthcare quality assurance

Health Information Management

- Health management information
- Health analytics
- Health administration

Health Workforce

- Human resource management
- Professional development
- Performance management

Public Health

- Civil registrations
- Environmental health and climate change impacts
- Disease surveillance
- Communicable disease prevention and control
- NCD prevention and control
- Women's health/maternal health
- Sexual and reproductive health
- Newborn, child, and adolescent health

Figure 3.1: Major functions of health system requiring transformation

There is immense scope for transforming the above functions through digitalization

3.3

Scope of major functional modules

A detailed description of the functional requirements is not within the purview of this blueprint. It will be done during the design phase that follows the approval of the blueprint.

Table 3.1 provides a brief description of the scope of the major functional components at the high level. It also describes the status of digitization of these functions.

Public Health Management

Module/Sub-module	Functionality	Illustrative Digital Services	Current status
CRVS: Civil Registration and Vital Statistics	▸ To register births, deaths, marriages, and divorces. ▸ To generate basic reports on demographics.	▸ Digital registration of life events. ▸ Digital certificates of birth, death, marriage, and divorce.	▸ Digital registration of life events. ▸ Digital certificates of birth, death, marriage, and divorce.
Public Health Program Management System	▸ To monitor the disease-specific and other population health programs run by the Ministry of Health, Family and Welfare. ▸ To enable capture of data at source at the field level.	▸ Personalized and targeted digital health services. ▸ Health alerts and notifications. ▸ Evidence-based decision-making. ▸ Prediction-based planning to prevent outbreaks or spread of communicable diseases.	▸ The trackers (DHIS2-based) being implemented/ designed are well-poised to deliver the services effectively. ▸ New enhancements and programs are in the pipeline.

Health Information

Module/Sub-module	Functionality	Illustrative Digital Services	Current status
HMIS – Health Management Information System	▸ To monitor the performance of health facilities. ▸ To monitor the progress towards the SDGs and UHC. ▸ To support evidence-based decision-making by identifying priority areas and health outcome indicators needing special attention.	▸ Real-time performance reports on health indicators. ▸ Analytical reports with insights for action/ interventions. ▸ AI-based insights and prediction services.	▸ The current HMIS is statistically oriented and is based on partial reporting periodically. ▸ The aim is to establish a real-time, automated reporting system.
Supply Chain Management	▸ To introduce efficiencies and transparency in the procurement, distribution, and accounting of medicines, supplies, and consumables. ▸ To avoid stock out of essential medicines. ▸ To optimize the logistics in distribution. ▸ Inventory and asset management of general and medical supplies. ▸ Reduce wastage.	▸ Real-time monitoring of stocks and reorder levels. ▸ Optimization of procurement decisions. ▸ Alerts and notifications. ▸ Public information on the availability of medicines.	▸ Currently two major solutions are operational: e-LMIS and the Supply Chain Management (SCM) solution of STO. ▸ The existing solutions need to be made interoperable as per this blueprint.

Healthcare and Wellness Management

Module/Sub-module	Functionality	Illustrative Digital Services	Current status
EMR/ Admission, Discharge and transfer	▸ To introduce efficiencies in admission, discharge, and transfer. ▸ To eliminate/ reduce queues and waiting time at the OPs, especially in the tertiary hospitals. ▸ To reduce paperwork and promote electronic medical records. ▸ To link island facility referrals to tertiary facilities through a PHC-based system.	▸ EMR, EHR, and PHR services. ▸ E-Prescription. ▸ E-registration and appointments. ▸ "Q to QR." ▸ Electronic discharge summary.	▸ Hospital management systems are not linked/ interoperable. ▸ Hence, there are challenges in ensuring continuity of care, including seamless utilization of referrals between different facilities. (e.g., even if a patient is referred by a doctor/health center to a tertiary hospital, the patient has to do additional work to obtain a consultation/ appointment from a tertiary hospital.)
Diagnostics & Lab reports	▸ To introduce automated systems of generating diagnostic reports and lab reports. ▸ To integrate diagnostics and lab systems to HIS. ▸ To set controls for unnecessary testing/duplication of similar reports in a short time frame.	▸ Diagnostic and lab reports were communicated electronically to the patients. ▸ Diagnostics and lab reports form part of the EMR/EHR of the patient automatically, through application integration.	▸ Currently, major health facilities use their own hospital management systems that may also have a lab and diagnostic component. Most of the time, patients individually must make separate memos to obtain the lab and diagnostic services if they are visiting different facilities. (Several times the medical record is not linked with this module.)

Healthcare and Wellness Management

Module/Sub-module	Functionality	Illustrative Digital Services	Current status
Pharmacy	▸ To automate the processes in the pharmacies. ▸ To introduce standard codes for drugs and medicines. ▸ To integrate e-pharmacy with HIS.	▸ e-Prescriptions. ▸ e-Invoices. ▸ Integrated services of clinical departments and pharmacy.	▸ At present, there is no central system to manage this. ▸ However, the pharmacies empaneled with Aasandha (health financing scheme) use their e-prescription module.
Health Insurance	▸ Discussed as part of assessment of Aasandha application		

Human Resource Management

Module/Sub-module	Functionality	Illustrative Digital Services	Current status
Recruitment	▸ To semi-atomize the systems of recruitment. ▸ To enhance efficiency and transparency.	▸ Online application for positions. ▸ Online competitive examination.	▸ CS Viuga, used by the civil service commission, has a recruitment module (currently being used for doctors and nurses).
Training & Capacity Building	▸ To provide required orientation to the new recruits. ▸ To provide opportunities for self-development and continuous development to employees of all cadres ▸ To establish a system of online assessment of the knowledge/ skills at various levels.	▸ The entire range of services offered by standard LMS – Learning Management System. ▸ The entire range of services offered by standard KMS – Knowledge Management System.	▸ Currently, MoHFW does not have a learning management system.
Performance Management	▸ To build accountability into the functioning of institutions and individuals at all levels ▸ To enable institutions and individuals to organize their work efficiently and in an outcome-oriented manner.	▸ Performance measurement services at institutional and individual levels. ▸ Performance analysis reports for evidence-based decisions in HRM. ▸ Dashboard services.	▸ Comprehensive, integrated PMS does not exist. However, CS viuga does have a performance management component.

Table 3.1: High-level description of key functional modules of MDHEA

3.4

The case for federated architecture

A.

What is federated architecture?

Federated architecture (FA) is a pattern in enterprise architecture that allows interoperability and information sharing between semi-autonomous, decentral, organized entities, information technology systems, applications. In terms of the Technology Principle B3, specified in section 2.5, MNDHB is required to be designed using the principles of Federated Architecture.

B.

Benefits of federated architecture

- The federated architectural pattern supports independence, autonomy, and technological flexibility of distinct health systems while ensuring interoperability at the same time.
- Federated architecture enhances the security and privacy of the sensitive health information of the citizens due to the distributed data systems.
- Federated architecture supports person-centered, person-driven, and person-controlled health records by allowing access to the episodic records lying with different health facilities and piecing them together to form the longitudinal health record of the individual using the unique health ID.
- Federated architecture is particularly appropriate, as a wide range of health services are provided (and consequently health records created) by multiple entities, including public and private providers and NGOs, besides the records created by the citizen. Federated architecture enables easy 'integration' of these records to generate a longitudinal health record (or PHR).

C.

Principles of Federated Architecture

- Governance is divided between a central authority and the constituent units (public and private hospitals and other facilities), balancing organizational autonomy with enterprise needs.
- The central authority's architecture can focus on the dynamics of economies of scale, standards, interoperability, and the common requirements, while the constituent units have the flexibility to pursue autonomous strategies and independent processes for delivering services and managing transactions.
- The federation can agree upon the policies governing the roles and responsibilities of membership, resource discovery, and resource access.
- While the purpose of a federation is to collaborate and share resources, resource owners retain ultimate control over their own resources.
- The design of all the systems in the Federation shall conform to the prevalent laws and regulations relating to security, privacy, and data sharing.

D.

Guidelines in designing federated architecture for Maldives digital health

While the promised features of federated architecture are attractive, the question is how to contextualize the same for the Maldives. The following guidelines help us in this regard:

1. An architectural pattern that consists of core and common building blocks can be designed. While the core is held centrally, the common building blocks are reused by the rest of the ecosystem with appropriate customizations.

2. The Central Authority (presumably the department at the Ministry of Health, Family and Welfare described in Chapter 6) will have the mandate to co-design, develop, and manage the core building blocks, besides defining the rules of engagement with the ecosystem.

3. The constituents and agencies, like Aasandha, DNR, and IGMH, can align their platforms with the interfaces and terminology defined by the National Digital Health and Innovation Department (NDHID) and continue to develop their platforms further.

4. A multi-stakeholder steering committee will oversee and guide the initiatives of NDHID.

5. The MoHFW can decide to establish a set of shared platforms or common applications, conforming to the MDHEA and principles in respect of all the health facilities owned and managed by the government. This would avoid fragmentation, silos, and local servers currently in vogue. For instance, MoHFW can adapt the OpenERP or Bahmni platforms to provide the services of PHC, host a multi-tenant application centrally, and ensure that all the primary care providers in the public sector adopt the same. This application will also interoperate with the PHC-level applications developed by the private and NGO sectors. This will avoid multiplicity of versions within the public sector and autonomous development by the private/ NGO sector while ensuring interoperability of all these applications to generate consolidated views and reports.

3.5

Building blocks of MDHEA

The building block approach is fundamental to MDHEA. A building block, also called an 'architectural building block,' is defined as follows:

A building block
is a package of functionality defined to meet specific requirements of the domain. It is standards-based, independent, reusable, and interoperable.

In the context of MDHEA, a building block MUST have the following characteristics:

1. Provide standalone, useful, reusable, and implementable capability in the health domain.
2. Possess cross-functional uses across the digital health value chain by design.
3. Be applicable to multiple use cases in healthcare.
4. Be interoperable with other building blocks, using open APIs.
5. Use shared digital infrastructure.
6. Be built using standard protocols.
7. Be designed for scale.
8. Have a clearly identified 'business owner' and 'technology owner'.

A.

Types of Building Blocks

In a digital ecosystem, building blocks are of 2 types specified below.

I.

Core Building Blocks:

Core Building Blocks (CBBs) constitute the heart of the MDHEA, or the Digital Health Enterprise. Most of the CBBs act as the Single Source of Truth or System of Record (SoR) at the ecosystem level. Some of the CBBs (like the Health Information Exchange) help achieve interoperability between various building blocks. CBBs are designed, developed, and maintained by the government centrally at the national level.

II.

Common Building Blocks:

Common building blocks have a package of functionality that can be used by multiple actors of the ecosystem. They are created and maintained at the national level. They can be created by the public or private sector as open and shared resources that can be leveraged by the ecosystem players as per their needs. Very often, the applications constituting a common building block are hosted in a multi-tenant environment and/or in cloud environment to make it easy to onboard the users.

B.

Key capabilities, requirements and design considerations of building blocks

Common capabilities of the building blocks (user-facing)

1. Discovery: The building block and the services offered by it should be discoverable in multiple modes. The objective and functionality of each service should be clearly defined to enable the user to make an appropriate choice.
2. Registration: The process for registration to avail any service (offered by the building block) is defined, in case a registration is required. Associated capabilities or features for deregistration, login, and password management should be articulated.
3. Query: If a building block consists of sets of records commonly required by the user, appropriate search and query functionalities should be built in.
4. Access: The process of accessing the information or service provided by the building block should be defined in an intuitive or user-friendly manner. Where required, the API or the API specification should be provided.
5. Update: The process of updating a record should be defined, along with the constraints/validations that the data should satisfy. Updating is subject to the rights and privileges of the user.
6. Delete/Inactive/False: The building block should provide for deletion/inactivation/false of a record or part of a record by the authorized user.
7. A log of 3,5 and 6 should be made easily available for the system administrators upon need (e.g. court may require accessing this).

C.

Requirements and design considerations of the building blocks (architect-developer-facing)

1. Architecture: The architecture (high-level and detailed) of the building block shall be made available to the prospective developers. This should include functional and technological architecture along with the process of flow.
2. Schemas: The schemas and data models associated with the building block should be accessible for viewing, 'trying it out,' and download.
3. Error codes: The conditions and APIs relating to error codes should be published.
4. Access control: The process for management of rights and privileges of various users should be published, except for those that have implications of security. Appropriate alerts can be designed to inform the user on the requirements of the right or privilege if the user attempts to access a service or feature he/she does not have right or privilege to.
5. Event logs: A log of the events occurring on the building block can be maintained. Appropriate analytics can be developed to assess the usage levels, trends, and patterns.
6. Terminology bindings and standards: The terminology bindings built into the building block and the standards followed should be published.
7. Interoperability and integration: The requirements of interoperability and integration with the building block and the step-by-step process for the same can be published.
8. Developer space: Artifacts, code, SDKs, tools, and implementation guides required for the developers can be published on/by the building block.

D.

Governance-related requirements of the building blocks (architect developer-facing)

1. Governance: Details of the business owner and technology owner of the building block can be provided. Processes for change control, feedback, and rating of the services provided by the building block should be specified.

2. Version history: A description of the versions of the building block and the versions of the standards, products, and tools used by the building blocks should be published.

3. Implementation requirements: The requirements of hardware, software, and human resources required to 'use' (interoperate/integrate with and leverage) the building block can be provided.

4. Privacy: The privacy features incorporated in the design of the building block should be specified. In addition, the obligations of the users of the building block to protect privacy at their end should be specified.

5. Security: The security features incorporated in the design of the building block should be specified. In addition, the obligations of the users of the building block in respect of security at their end should be specified.

6. Conformance: A clear process should be defined and specified for assessing the conformance of any external system to the requirements of the building block. It is also desirable to establish a system for auditing and certification of such systems. (common for all the building blocks launched).

3.6

Maldives Digital Health Ecosystem Architecture (MDHEA)

Keeping in view the architectural considerations and the criticality of architectural building blocks outlined. A preliminary version of the Maldives Digital Health Ecosystem Architecture (MDHEA) has been designed. The schematic representation of the MDHEA is shown in Figure 3.2. The salient features of MDHEA are explained in what follows.

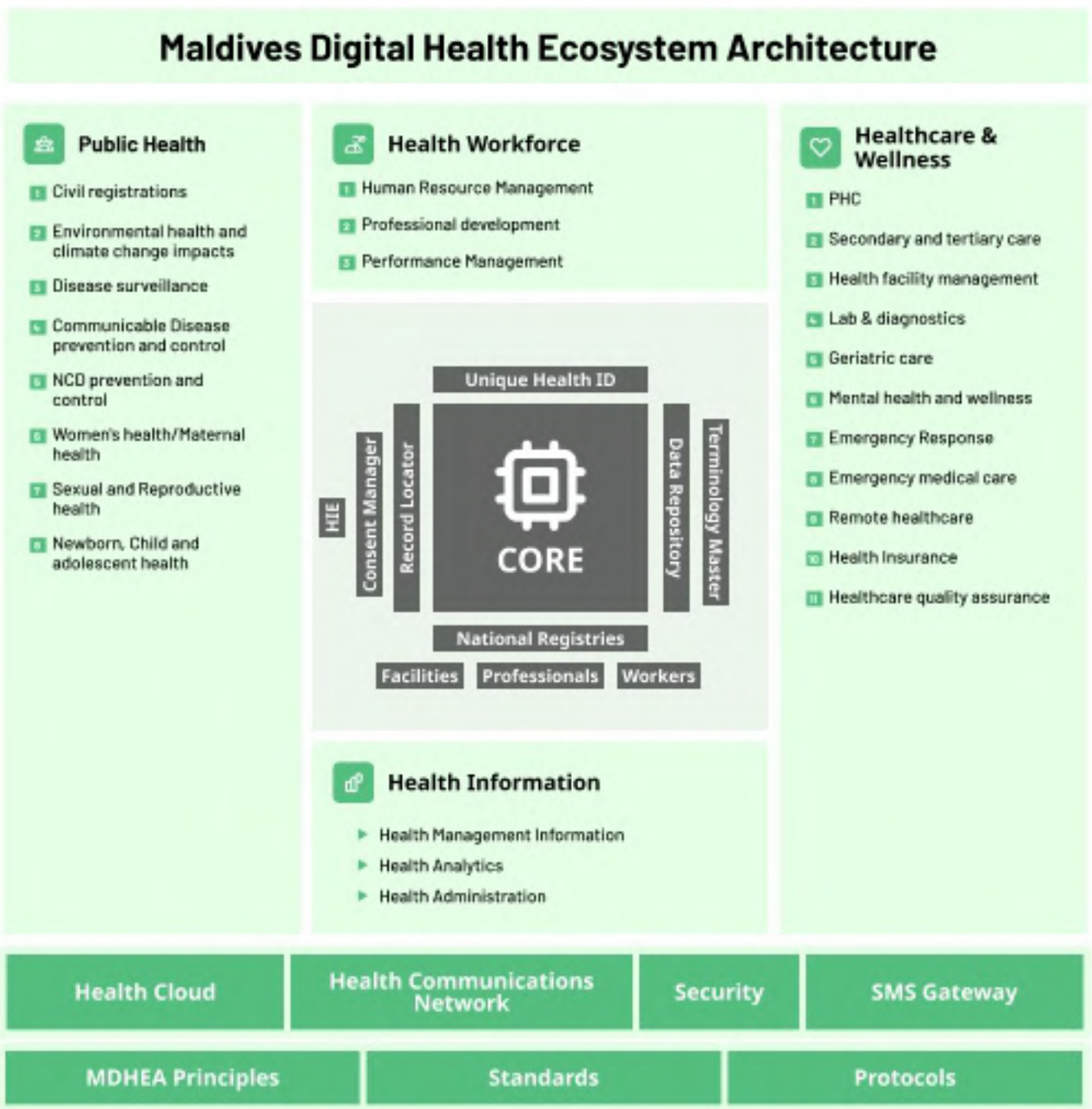


Figure 3.2: Maldives Digital Health Ecosystem Architecture

A.

Salient features of architecture

1. MDHEA has been designed using a Federated Architecture pattern. Only the MDHEA Core (with its components) is centralized. The rest of the components are/can be decentralized in terms of their development, deployment, and governance.

2. The logical layout of the MDHEA consists of 2 foundational layers and 4 'domain' clusters.

3. MDHEA Core is the 'kernel' of MDHEA. It comprises at least eight components, outlined below. Most of the other building blocks will have to use the core building blocks for the specific services they provide.

1. Unique Health ID

Core functionality Of CBB	Special requirements Of CBB
▸ The most pivotal CBB in MDHEA. ▸ Provides a random but unique health ID to the citizens and residents upon request/registration. ▸ Can provide a unique ID to the tourists depending on the policy of the government in this regard. ▸ Provides identification, authentication, and authorization services through appropriate APIs. ▸ The services of this CBB can be availed by the citizens, providers, and payers registered with MDHE and having the necessary privileges. ▸ Unique Health ID is an indispensable instrument for building the longitudinal health record (EHR) by the providers and Personal Health Record (PHR) by the citizens/residents, as the ID enables piecing together of various health records (EMRs) of the same individual lying with multiple providers.	▸ In line with the principles of A2 (person-controlled PHR) and B6 (privacy), the uniqueness shall be enforceable by the citizen/resident and not others. ▸ A citizen or resident can choose to have multiple health IDs and use each selectively at different times and/or for different episodes/services. For instance, a citizen or resident can have two 'unique health IDs, one linked to a national ID (A) and another (B) linked to a driving license. The citizen/resident can choose to use A to link records relating to particular diseases that he/she may have and use B for all other diseases. The citizen/resident may not upload the episodes linked to A to any Health Locker and keep them to himself/herself for reasons of extreme privacy. ▸ The unique health ID can be generated and maintained centrally by the MoHFW. It can be issued to the applicants based on the validation of one of the types of identity specified by the MoHFW. These types could typically be a national ID, passport, or driving license.

Unique Health ID | Special requirements Of CBB

- A unique health ID can be optional for the citizens or residents. Citizens/residents should have the option to stay out of the system. This can be implemented in two ways: Opt-out method, in which the unique health ID is issued to all citizens and residents automatically. Citizens and residents can opt out of the digital health program through deliberate action. Opt-in method, in which only those citizens/residents who are willing to join the digital health program are assigned a unique health ID on a specific request/application made by the citizen/resident.
- An awareness campaign should be undertaken by the government on the safeguards and privacy-by-design features built into the Unique Health ID so as to dispel the apprehensions and increase the adoption.
- Possession of a primary ID is essential for issuing a unique health ID. The unique health ID system should therefore provide multiple options for primary ID, like a national ID, passport, driving license, or ration card. Providing exceptions to the mandatory requirement of a primary ID would weaken the entire digital health ecosystem over a period.

2. Health Information Exchange (HIE)

Core functionality Of CBB

- HIE is the fulcrum on which the entire MDHE revolves.
- It enables exchange of health information/ data between Health Information Providers (HIPs) and Health Information Users (HIUs) in an authorized and privacy-protecting manner.
- HIPs and HIUs can avail the services of Health Data Repositories to be established by expert organizations.
- HIE shall maintain index(es) of the health records created by various players of the ecosystem (hospitals, PHCs, private practitioners, diagnostic centers and laboratories) to enable creation of the EHR or PHR 'on the fly' on demand/ need.

Special requirements Of CBB

- Principle B6 (Security- and Privacy-by Design) shall be observed in the architecture, design, development and deployment of HIE.
- HIE shall be highly scalable.
- The profiles and artifacts created by IHE can be leveraged while developing HIE.
- It is desirable that MDHE starts with one HIE (while technically it is possible to have multiple HIEs that can interoperate).
- HIE shall not store the health records of individuals, except pointers to the location of such records.
- HIE can maintain the metadata and indexes of health records.

3. National Registry of Health Facilities (NRHF)

Core functionality Of CBB

- An authentic record of the health establishments of all types authorized to operate under the applicable law.
- Contains the information of the profile of the institution, its infrastructure, address, geo-coordinates, and human resources.
- A unique Health Facility ID (HFID) is issued to each health facility upon registration with NRHF.
- HFID plays a key role in locating the health records of individuals.
- NRHF provides the services of identification, authentication, and authorization of health facilities in multiple use cases, most importantly in accessing health records maintained by repositories or other health facilities.
- NRHF shall be useful to provide location-based services like finding 'the health facilities near me.'

Special requirements Of CBB

- The profile data of every facility registered with NRHF shall be verified by MoHFW or by a third-party agency.
- The facilities shall be advised to update their information at periodic intervals, for instance, annually.
- The rights and obligations of the facilities registered with NRHF shall be specified. For this purpose, the facilities are treated as a "data fiduciary" under the applicable data protection regulation.

4. National Registry of Health Professionals (NRHP)

Core functionality Of CBB

- An authentic record of the health professionals registered with the relevant professional bodies such as the Maldives Medical and Dental Council.
- Contains the information of the profile of the professional.
- A unique HPID is issued to each health professional upon registration with NRHP.
- HPID plays a key role in identifying the professional authentically and thereby enhancing the trust of the patients and providers.
- NRHP provides the services of identification, authentication and authorization of health professionals in multiple use cases in which health professionals have a role to play, most importantly in accessing telemedicine services.

Special requirements Of CBB

- The information of professional qualification of every professional shall be verified by the system with reference to the registry of the professional body.
- The professionals shall be advised to update their information at periodic intervals such as annually, especially with reference to additional qualifications acquired and the health facility for which they are working.

5. National Registry of Health Workers (NRHW)

Core functionality Of CBB	Special requirements Of CBB
▸ An authentic record of the health workers employed by the Government and the health facilities/ organizations run by the private and NGO sectors. ▸ Contains the profile of the health worker. ▸ A unique HWID is issued to each health worker upon registration with NRHW. ▸ HWID plays a key role in identifying the health worker authentically and thereby enhancing the trust of the patients and providers. ▸ NRHW provides the services of identification, authentication and authorization of health workers in multiple use cases in which health workers have a role to play.	▸ The scope of the term 'health worker' may be appropriately defined. It could include nurses, frontline health workers, lab technicians, and pharmacists who interface the citizens/ residents. ▸ The information of every worker shall be certified by the employer.

6. Reference Data

Core functionality Of CBB	Special requirements Of CBB
▸ Reference Data (Master data) relates to the standardized codes assigned to places, materials, conditions etc which need to be used by/ in most applications. ▸ Reference data is agnostic of the domain. ▸ These are single sources of truth maintained by the respective owners of the reference dataset. ▸ Reference data services, accessible by APIs enable applications to access the up-to-date version of the master data.	▸ Copy(ies) of the reference datasets which change infrequently, can be hosted centrally in the Repository, which is one of the Core building blocks (See Figure 3.2) with periodic updating by accessing the source (owner).

7. Code systems (Terminology)

Core functionality Of CBB	Special requirements Of CBB
▸ Code systems are similar to reference data, except that they are domain-specific and technical in nature. Code systems are maintained by specialized organizations and made available free or for a charge. ▸ From the context of MDHEA, the code systems like ICD10/11, SNOMED-CT, and LOINC are relevant. ▸ The DH program may coordinate with owners of the code systems and make it simple for developers of DH applications to access/use the same.	▸ Adoption of the code systems is complex. Firstly, developers have to adopt and incorporate the solution into the software. Secondly, the end users need to adopt and use them in their work. ▸ Persistent efforts at sensitization and capacity building are needed to promote adoption of the code systems.

8. MDHEA Repository

Core functionality Of CBB	Special requirements Of CBB
▸ An online collection of all the architectural artifacts to be used by the developers. ▸ The artifacts include the detailed designs of architectural components (especially the building blocks), workflows and processes, and open APIs. ▸ The artifacts are developed using a standard language (like UML) or a popular tool (like ArchiMate).	▸ Version management needs to be handled with the aid of appropriate tools to ensure consistency and compatibility. ▸ An effective governance structure should be established to ensure that all the relevant artifacts are hosted and kept updated all the time.

Table 3.2: Description of Core Building Blocks of MDHEA

4 Common Building Blocks, as alluded to earlier, are designed to provide a wide range of digital services to stakeholders. They are interoperable among themselves and with the DH Core through standard interfaces (APIs). The functionality and illustrative list of digital services that the common building blocks provide have already been described in Table 3.1. The following guidelines are useful to the designers and developers of DH initiatives related to the common building blocks.

a. Common building blocks are placed in 4 categories, based on their broad functionality (see Table 3.1).**More building blocks can be added** in any category during the design phase.

b. The existing (legacy) applications shall be critically analyzed and assessed on a scale of 0-100 with regard to their characteristics like functionality, conformance to the principles of MDHEA (specified in Chapter 2 of this blueprint), conformance to data standards, citizen-centricity, UI/UX, privacy protection, secure access, scalability, configurability, capability to interoperate through APIs, reusability, maintainability, and performance. The template provided in Annexure 4 may be used for assessing the legacy of applications.

c. Applications scoring less than 60% may be retired [from the perspective of MDHEA]; those scoring 61-90% may be further evaluated for the feasibility of being enhanced to meet the requirements of MDHEA, and those scoring above 90% may be straightaway enlisted to be part of MDHEA.

d. Common building blocks and applications need to be designed and developed afresh (not necessarily by the government or a single agency) in respect to the gap areas and areas where the existing application does not qualify (as per c above).

e. A clear roadmap may be prepared for the coordinated development (including enhancement) of common building blocks aligned to the priorities of the domain.

f. Multiple (for instance, 2 to 5) solutions may exist or evolve for some of the building blocks, especially those that provide citizen services. They would all be interoperable and/or would enable the porting of data from one to the other by following the MDHEA standards.

3.7

Approach to building a Unique Health ID

It is essential to uniquely identify an individual across healthcare providers to ensure that the medical records are related to the correct individual or accessed by authorized users through appropriate consent. The role of a unique health ID is critical in this context.

The following guidelines provide an approach to building a unique health ID.

1 Why one more ID?

A unique health ID is preferred for several reasons, including the following:

- National ID is issued only to the citizens of the country, while health services are required to be provided to all the residents of the country, including foreigners on work visas and tourists. Incidentally, the foreign workers constitute a significant proportion of the residents of the Maldives. Issues of compatibility, interoperability, and system complexities arise if multiple IDs are to be handled by all the health systems.
- Health data constitutes one of the most sensitive categories within the ambit of 'personally identifiable information' or PII. Creating medical records and building EMR, EHR, and PHR is significantly based on the trust of the end-users—patients and their attendants. Forming a ring fence around health data through the instrumentality of a unique health ID is a strong and sustainable mechanism for building trust.
- Longitudinal health records, the essence of EHR and PHR, contain information of multiple encounters across several facilities. Given the requirements of federated architecture, the information is dispersed across multiple locations. Collating these records 'on the fly' to create EHR and PHR requires a unique 'key field' like the unique health ID.
- Use of a unique health ID prevents medical errors arising out of wrong identification of the patient records.

2 Designing a Unique health ID as a derivative ID

A unique health ID may be generated based on reliable foundational information efficiently and with a good user experience (UX). These objectives can be achieved by leveraging the existing well-established systems of ID issued by the government, like the national ID, passport, and driving license. The requirement is that these government IDs are verifiable online through the use of OTP or biometric authentication. The practical benefits of Unique Health ID include the following use cases:

- A visit by prior appointment immediately becomes feasible. This applies to visits to health facilities and visits to specialists. This will reduce the pressure on the OP/cash/lab counters in all health facilities.
- Repeat visits require no fresh registration.
- Telemedicine and teleconsultation get accelerated with trust established instantaneously through a Unique Health ID.
- Building EMR/EHR/PHR and accessing the same becomes systematized and efficient, as threading the multiple records of the same patient using a unique health ID becomes almost trivial.
- Consent management can become more efficient and transparent with the use of a unique health ID.
- Adoption of the International Patient Summary (IPS) for cross-border data exchange with relevant policy frameworks and/or patient empowerment will greatly help patients who need to go abroad for treatment, as well as tourists falling sick while in the Maldives.

3 Responsibility for Unique Health ID

Unique health IDs should be designed, developed, and managed **centrally** to derive the benefits listed above. Various organizations and individuals can make use of its **authentication service**. Unique Health ID systems may, under consent requirements, optionally provide basic user information based on the needs of the application. Unique health **ID is one of the core building blocks of MNDHA.**

3.8

Design requirements of Registries

Registries play a key role in enhancing the efficiencies in all use cases, besides enabling interoperability of various building blocks and systems of digital health. Being the single-source truth that provides identification and authentication functions, the registries enhance the trust of the users in dealing with the entities that are the objects of the registries.

A detailed listing of the elements of the registries will not be provided here. However, the following guidelines will help to accelerate the design of the registries.

1 The following registries are designed as core building blocks of MDHEA.

   a. National Registry of Health Facilities

   b. National Registry of Health Professionals

   b. National Registry of Health Workers

2 All the registries are preferably maintained at the national level.

3 The registries shall comply with the design considerations of building blocks specified in Section 3.5.

4 The functional and non-functional requirements of these registries, specified in the OpenHIE specifications, are available at h ttps://guides.ohie.org. These requirements may be suitably customized to suit the local requirements and to be compatible with the legacy applications built on the DHIS2 platform so that the records already built can be leveraged with the least additional effort.

5 Clear ownership and responsibilities should be established for the creation and maintenance of each registry to ensure that the records in the registry are always up-to-date and reflect the current reality on the ground. It is good practice to link these building blocks to the related digital subsystem that registers, licenses, or permits the facility, professional, or worker under the relevant statute.

3.9

Electronic Medical Records (EMR), Electronic Health Records (EHR) and Personal Health Records (PHR)

The concepts, practices, and standards of Electronic Medical Records (EMR) and Electronic Health Records (EHR) have evolved historically over the last 4 decades. PHR is a later concept that has gained popularity with the increasing emphasis being given to the privacy of personal data. These three concepts are discussed briefly, and an appropriate approach is suggested in the context of MDHEA.

EMRs primarily focus on the electronic documentation of a patient's medical and clinical data within a single healthcare organization, such as a hospital or a clinic. They contain patient histories, diagnoses, medications, treatment plans, and other clinical information relevant to the healthcare provider using them.

EHRs are longitudinal records of a patient's health information, designed to be more comprehensive and can include data from multiple healthcare organizations and settings. EHRs are aimed at improving overall healthcare delivery by facilitating the exchange of information among different stakeholders, reducing duplicate tests, improving patient safety, and providing a more comprehensive view of a patient's health history. Annexure 5 provides a list of the key components of a typical EHR and the content of each component.

PHRs are patient-centric and are controlled and maintained by individuals to track their own health information. They can include personal medical history, test results, medications, and other health-related information.

American Health Information Management Association (AHIMA) defines PHR as follows:

The personal health record (PHR) is an electronic, lifelong resource of health information needed by individuals to make health decisions. Individuals own and manage the information in the PHR, which comes from healthcare providers and the individual. The PHR is maintained in a secure and private environment, with the individual determining rights of access. The PHR does not replace the legal record of any provider.

The common data elements of PHR are defined by AHIMA at Defining the Personal Health Record (ahima.org).

A comparison of EMR, EHR, and PHR is provided in Table 3.3, not with the objective of recommending the selection of one of them for the purposes of MDHEA, but with a view to enabling appreciation of the relative emphasis to be given to them by different stakeholders of the digital health ecosystem.

Attribute	EMR	EHR	PHR
Content	Health information of individual episodes of interaction of the patient with a health facility.	Aggregated and longitudinal record of health information of the patient with multiple health facilities.	Longitudinal record of health information of the patient
Ownership	Patient	Patient	Patient
Control	Health facility	Health facility	Patient
Portability	Limited	Limited	Fully portable
Interoperability	Limited	Feasible	Difficult*
Efficiency	High	High	Low*
Empowerment	Low	Medium	High
Cost-effectiveness	Low	Medium	High
Availability of software applications	High	High	Medium

Table 3.3: Comparison of EMR, EHR and PHR

*PHRs are hosted fully or partly by the patient or by a service provider offering Health Locker Services (a digital platform for securing personal health records) licensed by the government. Establishing the licensing and audit of the health lockers may pose an additional administrative burden on the government. Moreover, the records purely in the possession of the patient, including patient-generated health records (e.g., from home medical devices and wearables), are difficult to find on search by the authorized health professional or facility. Hence, 100% interoperability is difficult.

** The rate of adoption of PHR may be slower, as it requires considerable user awareness and training. There may be delays and missing records, making the use of such records tedious and inefficient during the transition period till PHR becomes popular, user-friendly, and mainstreamed.

Despite the above two adverse factors, it is advisable to go for a person-controlled PHR system (as an additional layer over EMR and PHR) in the overall assessment of all the attributes shown in Table 3.3.

A.

Approach to design and development of health records

As mentioned earlier, it is inappropriate to consider EMR, EHR and PHR as mutually exclusive options. The digital health ecosystem needs to promote an appropriate combination of all three and use them as per the needs of the context and settings. The following considerations are suggested in the approach to a harmonized development of health records.

1. PHRs advance the cause of human-centered health systems, whereby people are empowered to make choices on their health issues.

2. PHRs can be at the core of a wide range of digital health services, like immunizations, prescriptions, test results, NCD and CD programs, and telemedicine.

3. The WHO has established a consultation process on the development of PHRs, which seeks to achieve a consensus on the required functionality, standards and processes for establishing PHRs, operational models and to build the requisite capabilities across countries.

4. The key requirements of PHR systems include the following:

    a. Standards compliance.

    b. Data privacy.

    c. Ethics in the use of health data for research and innovation.

    d. Data sharing and managing trust.

    e. Regulatory framework and.

    f. Implementation of considerations with regards to infrastructure constraints.

5. It is essential to establish the necessary digital public infrastructure (DPI) to empower individuals to create their own PHRs. Along with effective information, education, and communication campaigns on the creation, use, and benefits of PHRs. This can lead to the rapid proliferation of digital health. An empowered and informed population would be able to build their PHRs more quickly than a government agency attempting to create them centrally or in a federated manner. The DPI to support PHR draws from the following building blocks:

    a. Unique health ID.

    b. Registry of Health Facilities.

    c. Registry of Health Professionals.

    d. Registry of Health Workers.

    e. Record Locator Service.

    f. A system of health locks.

6 The functional architecture of a typical PHR system is represented in Figure 3.2. The salient features are mentioned below.

a. The PHR system is based on the architecture of Federated Health Records (FHR), whereby the concerns of various stakeholders are decoupled and managed independently. For instance, the patient's interest may lie in accessing the latest relevant record and ensuring the privacy and security of individuals' health records. The physician may be interested in the longitudinal health record containing the patient's history, allergies, medications and procedures undergone. The provider would be interested in ensuring the security and privacy of the mass of health records it holds and in ensuring that access to the right record(s) is provided to the authorized users on demand - preceded by the patient's consent. The protocols of the federation may be commonly agreed to ensure that all these interests (and those of the other stakeholders) are appropriately taken care of.

b. The health information relating to the same patient can have multiple origins or sources. The effort, however, should be to ensure that all the sub-systems adopt the interoperability standards defined by MDHEA.

c. Depending on the requirements of the specific use case, the PHR is configured, created in real-time, and presented to the authorized user in different views.

d. The Health Information Exchange (HIE) together with the consent manager(s), acts as the gateway for information flows. There can be multiple consent managers, which operate on a federated model.

e. Another important capability that a HIE (or the DPI of PHR) should possess is Record Locator Service, which contains the index of various health records, the unique health ID and the location.

f. Patients will have the option to store and manage their health records on their own devices like PCs/laptops/smartphones, through an app or can host them in licensed Health lockers operated by public or private entities.

g. Significant efforts are required in the initial years to build the necessary awareness and capabilities among the various actors, especially the patients/citizens, to align to the FHR ecosystem.

B.

Functional architecture of a typical PHR system

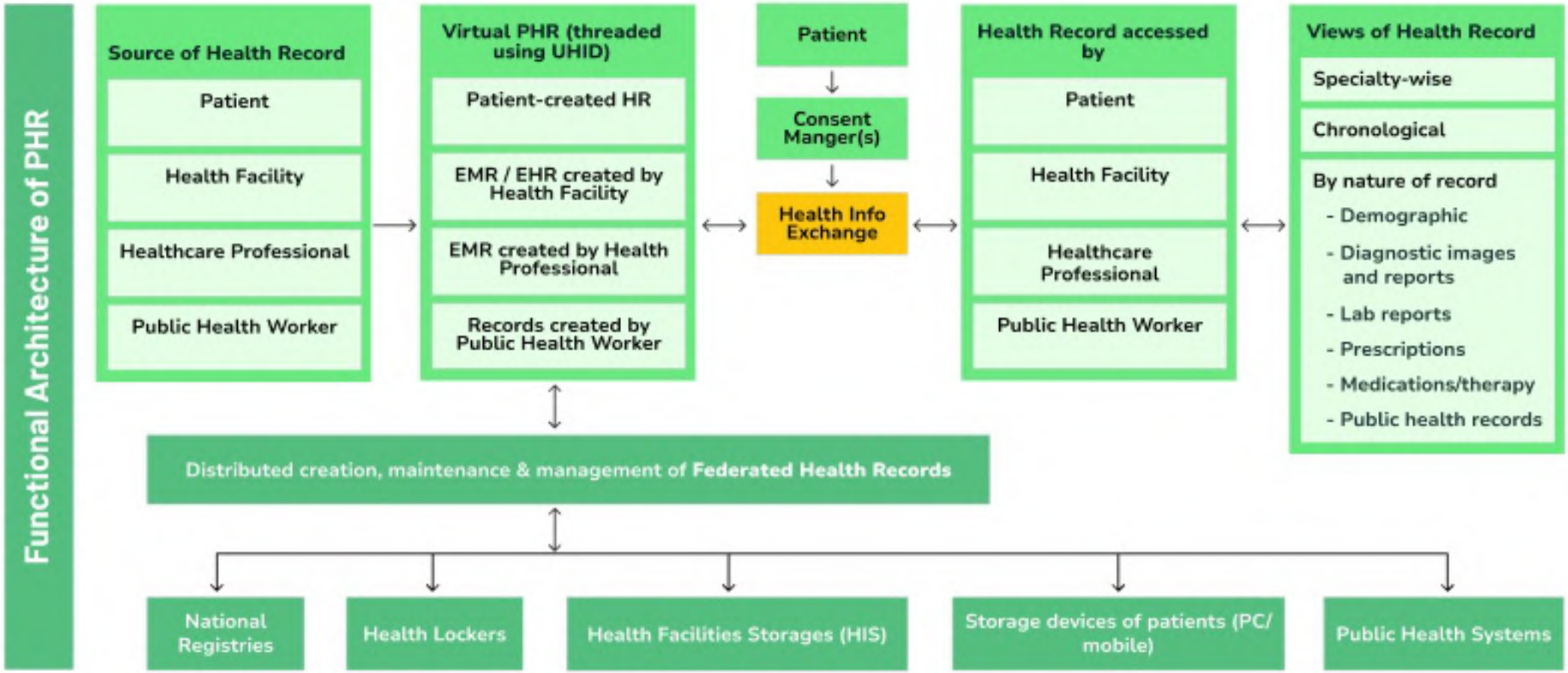


Figure : 3.4 Functional architecture of a typical PHR system

3.10

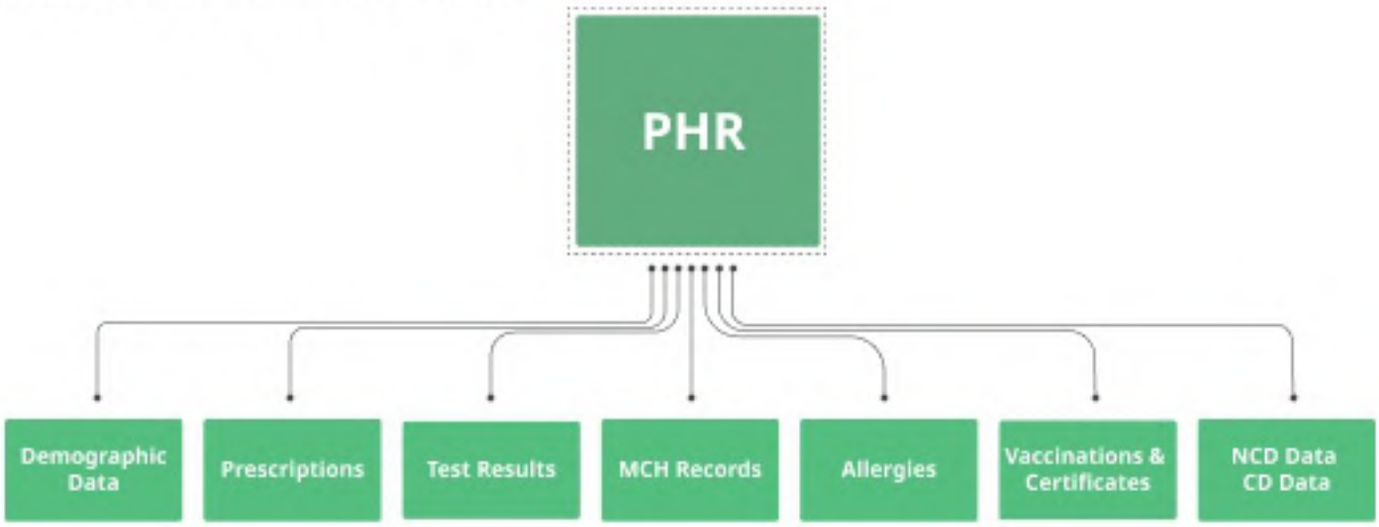
The core value of PHR

A person-controlled PHR is the ultimate instrument to empower the citizen to make choices on each and every health decision based on the relevant circumstances. Such empowerment will become increasingly real as certified AI-driven personal health solutions emerge in the future.

The significant role that PHR can play in a 360-degree view of the health system around an individual is portrayed in Figure 3.4. In the future, individuals are likely to be as empowered in managing their 'health account' as they are with their bank accounts. This is only possible if we lay a solid foundation for the emergence of PHRs, ensuring both convenience and safeguards.

A.

Multiple use cases of PHR



Prevent health workforce burnout: Follow the Quadruple AIM2

The following steps may be taken alongside implementing digital health (especially EMR) to eliminate or reduce workforce burnout due to spending excessive time on the computer rather than with the patient.

1. Implement team documentation, where nurses, medical assistants, or other staff present during a patient visit enter some or all information into the EHR to assist with order entry, prescription processing, and charge capture. Team documentation has been linked to higher satisfaction for both physicians and staff, improved revenue, and the ability for the team to manage a larger number of patients, making their work efficient.
2. Use pre-visit planning and pre-appointment laboratory testing to reduce time wasted on the review and follow-up of laboratory results.
3. Expand roles, allowing nurses and medical assistants to assume responsibility for preventive care and chronic care of health coaching under physician-written standing orders.
4. Standardize and synchronize workflows for prescription refills, an approach which can save physician's 5 hours per week while providing better care.
5. Co-locate teams so that physicians work in the same space as their team members; this has been shown to increase efficiency and save 30 minutes of physician time per day.

3.11

Summary and next steps on MDHEA

The DH Ecosystem Architecture is quite complex to design and develop. It requires close coordination between domain experts, health informaticians, and digital architects. Success depends on establishing a minimum viable architecture and carrying out the design, development, and deployment with close engagement from stakeholders. Numerous techno-managerial decisions must be made during the design phase. These include choosing between the EHR or PHR approach, selecting between established (proprietary) EMR products or open-source solutions, prioritizing the initial set of services and modules to be designed, deciding on hosting options, determining whether to use a federated or centralized architecture, addressing localization needs, adopting and adapting standards, reaching a consensus on creating a Unique Health ID, managing change, promoting user awareness, and building capacity at multiple levels.

While the list of demands may seem long and challenging, these issues can be overcome through a governance system built on regular communication and dialogue, as discussed in a later chapter.

The architecture proposed in this chapter was critically discussed and reviewed in a multi-stakeholder workshop held on September 24-25, 2024.

CHAPTER 4

Legislation, Policies, Standards And Regulations

4.1

Legislation and digital health policies

Digital health program is a multi-dimensional initiative that touches upon a wide range of subject institutional and persona like healthcare, public health, technology, process, adoption of standards, exchange of personal information, cybersecurity, innovation, procurement, and partnership.

The Maldives Health Services Act 2015 provides an overarching framework for healthcare in Maldives. In particular, the following features are noteworthy from the digital health perspective.

1. The Act is silent on the use of technology in healthcare. An amendment may have to be made to the Act to provide for the key requirements of digital health systems.
2. The Act enables guidelines and/or regulations to be notified for ensuring the quality, availability, and accessibility of health services.
3. The Act provides for the establishment of guidelines on managing, sharing, and reporting essential information to be stored at the health establishments and in the health information systems [Section 38(b)], and procedures for managing health records [Section39].
4. The Act provides for confidentiality [Section 39], the need to obtain informed consent for the collection of data [Section 30], and disclosure of medical records to other service providers for treatment [Section 41].

Thus, while a broad legal framework exists that enables some key components of the digital health architecture, there is an imminent need to put in place an effective statute to support digital health and to provide for its effective implementation and enforcement. We can conceive of two options to achieve this.

Option 1:

Formulate fresh legislation on digital health that contains specific provisions for the wide gamut of activities to be undertaken to provide digital health services and provide effective safeguards for the security and privacy of health data. The legislation should also provide for penalties for contravention of the provisions of the Act. Examples of countries like USA and UK, which have brought in such legislation, may be studied, and legislation suitable to the Maldives landscape can be designed. This option may take a long time to materialize, or at least 1 to 2 years with sustained commitment and effort.

Option 2:

Bring out a set of regulations under the existing Health Services Act 2015 touching upon the requirements of digital health. This may require extensive amendments to the existing Act, besides detailed regulations. While it may be a faster route, the effective implementation of the same may be a challenge.

The Data Protection Bill, which has been in development for some time, must be fast-tracked into law along with clear operational rules and regulations. Drawing from the European Union's (EU) General Data Protection Regulation (GDPR) and other global frameworks, the Bill should establish strong safeguards for processing sensitive health information while ensuring timely access for medical care. A "Break-the-Glass" provision is essential to allow healthcare providers to access critical patient data in emergencies, pandemics, or cases involving incapacitated individuals where obtaining consent is impractical. Additionally, the Bill should incorporate principles of lawful processing, including provisions for opt-out (preferably) or opt-in mechanisms and deemed consent for essential healthcare purposes, balancing data protection with efficient and life-saving healthcare delivery.

As an immediate measure, the MoHFW may examine the feasibility and desirability of issuing administrative policies and regulations on important aspects like the security and privacy of health data. The objectives and key features of a few (prioritized) policies are described below.

A.

National Health Data Management Policy (NHDMP)

As mentioned in Maldives Health Services Act 2015 recognizes the need to lay down the policy and procedure for managing health data, managing the sharing of health data and protecting the privacy of individuals.

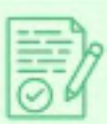
I.

Objectives of National Health Data Management Policy (NHDMP)

To mandate testing and assessment/ certification of digital health systems for compliance with the standards specified in this blueprint.

To enhance the trust of individuals in the digital health ecosystem.

To prescribe the methods for the exchange of health information.



To prescribe the requirements of consent management.

To streamline the methods and procedures for collection, storage and processing of health data and health records by the healthcare providers.

To mandate the exchange of health information in certain circumstances.

II.

Salient features of NHDMP

The proposed policy should have the following essential features to subserve the above objectives.

- A system of / for registration of individuals, health facilities, healthcare professionals, healthcare providers and health workers.
- Allocation of unique IDs for the individuals (Unique Health ID), health facilities (Health Facility ID – HFID), health professionals (Health Professional ID – HPID), and health workers (Health Worker ID-HWID).
- A system of online validation / verification of the identity of any individual, facility, professional, provider or worker to enhance trust in conducting a transaction related to healthcare.
- A framework of consent management to be invoked / used at various stages of the health data management, that prescribes the methods and formats for:
    - Mandatory requisites of valid consent
    - Obtaining consent
    - Revocation of consent by the data principles
    - Principles for consent management
    - Rights of data principles
- Prescribes the obligations of healthcare providers and others dealing with / processing health data. Methods and compliance requirements for sharing health data.
- Grievance redressal.
- Reporting and compliance requirements.

B.

Information Security policies

Given the sensitivity of health data and medical records and the privacy involved, it is essential to lay down an appropriate information security policy that is applicable to all sectors. A comprehensive approach to information security involves establishing a 3-tier security system that consists of a cybersecurity strategy, a cybersecurity framework, and information security policies. Annexure 6 provides a high-level view of the three tiers of Cyber Security. It also provides a schematic view of the Cyber Security Framework, drawing from the Cyber Security Framework of NIST, USA.

Given the constraints of time and resources, it is advised that the Ministry of Health, Family and Welfare, in collaboration with government technology agencies, begin by formulating a set of security policies that are operational and actionable by the players of the digital health ecosystem. These are listed below:

1. Network Security Policy
2. Identification and Access Management Policy
3. Mobile Device Management Policy
4. Password Policy
5. Web Application Security Policy
6. Workstation Security Policy
7. E-Mail Policy
8. Remote Access and VPNPolicy
9. Digital Signature Policy
10. Anti-virus Policy
11. Disaster Recovery and Business Continuity Policy

The above policies can be designed and implemented in the short term and would provide a substantial measure of security to the digital health ecosystem and would enhance the trust of the stakeholders significantly.

C.

Telemedicine guideline

Comprehensive guidelines have been issued by the government of Maldives on Telemedicine in 2022. It is appropriate that these guidelines are updated with reference to the recommendations of this blueprint. The areas requiring modification / amplification include the following:

- Incorporating the mandatory use of Health ID, Health Facility ID, Health Worker ID, Health Professional ID and online verification of the same.
- Use of telemedicine applications compliant with MDHEA.

  Conformance of the digital systems and processes with the National Health Data Management Policy. Establishing appropriate cybersecurity measures complying with the security policies notified by the government.

Legislation examples: A quick reference is made to the statutory provisions prevailing in the 6 countries selected for benchmarking. A summary is provided below:

1.AUSTRALIA

Legislation/Regulation:	▸ National digital heath strategy 2023–2028
Thrust of Legislation:	▸ Strengthening data privacy, ensuring secure and transparent health data sharing, and enforcing interoperability standards so systems work seamlessly across sectors. ▸ They define clear governance roles for health authorities and tech partners while supporting legal recognition of telehealth, e-prescriptions, and remote care, and promote cybersecurity, ethical AI use through regulatory sandboxes, and equitable access to digital health services for all, including rural and underserved populations.

2. CANADA

Legislation/Regulation:	▸ Personal Information Protection and Electronic Documents Act (PIPEDA) ▸ Provincial Health Information Acts ▸ Federal-Provincial Coordination
Thrust of Legislation:	▸ It prioritizes secure data sharing, seamless healthcare access across provinces, and ethical AI integration. ▸ Public-private partnerships drive innovation, while regulations evolve to balance technology with privacy, security, and patient-centered care.

3. ESTONIA

Legislation/Regulation:	▸ Estonian eHealth Strategy 2020
Thrust of Legislation:	▸ Ensuring data protection and patient consent, enabling cross-border health data exchange, defining roles for health institutions and IT providers, and supporting the legal use of telemedicine and digital prescriptions. It emphasized interoperability, cybersecurity, and aligning with EU regulations like the GDPR to create a trusted digital health environment.

4. INDONESIA

Legislation/Regulation:	▸ Regulation of the Minister of Health No. 21 of 2020 emphasizes health governance reform and integration of information systems. ▸ Presidential Instruction No. 4 of 2019 focuses on improving health security capabilities. ▸ Law No. 39 of 2009 governs health financing and accountability.
Thrust of Legislation:	▸ Legislation aims to standardize data and services, protect patient rights and privacy, and ensure equitable access to healthcare.

5. SINGAPORE

Legislation/Regulation:	▸ Personal Data Protection Act, 2021
Thrust of Legislation:	▸ A baseline standard of protection for personal data. https://www.pdpc.gov.sg. ▸ Regulatory requirements of digital health devices for manufacturers, importers. ▸ Regulatory requirements of Software as a Medical Device. ▸ Safeguards for preventing/mitigating adverse effects of use of AI in healthcare solutions. ▸ Provisions relating to exceptions and obligations under PDPA 2021

6. SRI LANKA

Legislation/Regulation:	▸ Personal Data Protection Act 2022
Thrust of Legislation:	▸ To safeguard the rights of individuals and ensure consumer trust in information privacy in online transactions and information networks resulting from growth and innovation in the digital economy.

4.2

Standards

Standards are the lifeline of interoperability. Standards are generally classified into two types – domain standards and technology standards. A seamless interoperability is possible only if all the building blocks and digital health systems are built using the defined standards.

Adoption and implementation of standards in the health domain is a relatively slow process. Hence, it is proposed to recommend a set of minimum viable standards for adoption in the initial stages.

A.

Terminology and Interoperability Standard(s)

Terminology standards are essential to ensure that the large number of medical and clinical terms are understood uniformly across the ecosystem and are machine-readable.

The following 4 important standards are recommended in this regard:

1. Fast Healthcare Interoperability Resources (FHIR):

FHIR Release 4 specification is a standard for exchanging healthcare information electronically. It ensures that electronic health records are available, discoverable, understandable, structured, and standardized to support automated exchange of information. FHIR R4 has identified 155 'resources' (including across the entire value chain of the healthcare ecosystem). It may be sufficient in the first instance to shortlist about 30 resources for focused adoption by the existing DH systems and for developing the building blocks.

Similarly, it is appropriate to design a subset of FHIR (like FHIR-Lite) that has the terminology most used in the primary care setting, especially in resource-challenged geographies. This not only enables the development of standards-based applications at the PHC level but also makes it easy for the personnel at the PHC and sub-PHC levels to adopt these standards in their work without much resistance.

The 'lite-standard' principle advocated above applies equally to the other standards specified below, especially SNOMED-CT and LOINC. These two standards have extremely large footprints and are difficult to adopt even when they are made quite user-friendly. It is expedient to prepare and use a shortlist of the terms used at the PHC level. For instance, PHCs do not have sophisticated equipment like CTs, MRIs, etc., nor do they conduct complex lab tests. It is therefore appropriate to develop lite versions of these global standards that are sufficient to capture data related to the basic equipment and tests available at the PHC level.

Note

1. FHIR-compliant data formats should be adopted while designing all the building blocks.
2. FHIR Release 4 resources should be leveraged while designing the database schemas for all the building blocks.
3. All the APIs to be developed should comply with the FHIR R4 schema.
4. A global effort is needed for developing lite-standards for PHC and resource-challenged settings.

2. ICD-10/11

ICD-10 is currently being used by most of the legacy systems in Maldives for classification of diseases and related health problems. A special drive should be undertaken to migrate to ICD-11 as it is more agile and versatile.

3. LOINC (Version 2.74, Feb 2023)

LOINC (Logical Observation Identifiers Names and Codes) provides a set of universal names and codes for identifying laboratory and clinical test results. LOINC is currently not being used in most of the IT systems in Maldives. Even where it is used, it is not interoperable with other systems. As in the case of the other standards, a special drive needs to be undertaken to ensure adoption of LOINC and the interoperability of the related solutions with other systems, like HIS and HMIS.

4. SNOMED-CT

Systematized Nomenclature of Medicine-Clinical Terms (SNOMED-CT) provides a standardized set of codes and concepts for describing clinical information in a manner that is universally understood. FHIR and SNOMED-CT are complementary. While FHIR handles the technical aspects of data exchange, SNOMED-CT ensures that the clinical content within FHIR resources is semantically consistent.

ICD-10/11 and SNOMED-CT are complementary classification systems. While ICD-10/11 is primarily used for administrative, billing, and statistical purposes, SNOMED-CT is more suited for clinical decision-making, electronic health records, and interoperability, ensuring more precise and standardized health data exchange.

Since the adoption of SNOMED-CT has recurring financial implications, the Technical Working Group (TWG) has to take a considered decision on adopting this standard. The TWG should also evaluate the use of SNOMED GPS (Global Patient Set) in the initial stage of 3 years as it is freely available.

GPS is a managed list of existing SNOMED-CT unique identifiers, fully specified names (FSN), preferred terms in international English, and status flags, made available at no cost to users.

GPS supports the sharing of patient health information coded with SNOMED-CT without the need for a SNOMED International license.

B.

Other Standards

In addition to the terminology standards explained above, it is necessary to adopt the standards specified in table 4.1 so as to cover the wider spectrum of healthcare system requirements.

Theme	Recommended standards
Information security	ISO 27500 series TLS/SSL SHA-256 AES-256 ISO 22600:2014 (Access Control)
Consent Management	ISO/TS 17975:2015
Patient safety	ISO/TC 62 series.
Clinical Documents	FHIR CDA
Data Quality	ISO 8000-110
Biometrics	ISO 19794-6
Medical records	MRN
Patient Identifier/Unique health ID	FHIR:OID/EMPI

Table 4.1 Standards required for health systems

C.

Testing and Assessment/Certification

The formal adoption of standards by digital health ecosystem players is a crucial first step, but ensuring their accurate implementation and ongoing compliance with evolving versions is equally important. Establishing a framework for testing and assessment/certification is essential to maintaining trust and discipline across the ecosystem. This framework should be developed in consultation with healthcare providers, clinical societies, and patient-support organizations, ensuring a balance between innovation, regulatory compliance, and patient safety. Future consultations should focus on refining implementation strategies based on real-world experiences and feedback.

CHAPTER 5

Infrastructure For Digital Health

5.1

Introduction

Given the sensitivity and large size of each health record and the need to retrieve the record (lying in part in several systems) almost in real time to provide health services, the architecture of the digital health ecosystem (MDHEA) requires to be supported by a robust IT infrastructure. The infrastructure required by MDHEA is represented in the second bottom-most layer of the architecture depicted in Figure 3.2. Broadly, the ICT infrastructure consists of 4 major components:

- Health Cloud or Compute
- Health Communications Network
- Information Security
- SMS Gateway

The purpose of this chapter is to estimate the broad requirements of the ICT infrastructure and suggest approaches to establish the same in a time-bound manner.

Several major infrastructural challenges are created by the unique geography of Maldives, including the following:

1. The widely scattered atolls and islands make it expensive to lay optical fiber cable.
2. The per capita cost of laying the cable to the curb could be significantly higher due to the sparse population.
3. Establishing data centers that conform to Tier 3 or Tier 4 specifications is logically a difficult and expensive proposition to meet the requirement of providing power from two independent grids and bandwidth from two independent sources.

Currently, different agencies involved in the IT initiatives have their own infrastructure, as alluded to earlier. It is necessary to develop an appropriate roadmap for the core IT infrastructure to derive the following benefits.

- Consolidation of the core infrastructure brings economies of scale and, more importantly, professional management in terms of uptime, security, and privacy.
- While the core infrastructure required for the Core Building Blocks can be centralized, the 'domain owners' of the common building blocks may have the option of hosting them as per their preference or can co-locate them with the central location.
- Several issues of interoperability are resolved or reduced in complexity.
- The scaling of infrastructure can be planned together for multiple building blocks. Some of the building blocks may have less traffic, and the servers would be underutilized, while some others would be overloaded. Appropriate load-balancing would add greatly to efficiency.
- Similar benefits as above extend to storage and bandwidth.

While it is difficult to estimate the size of the requirements of IT infrastructure in a comprehensive program such as that envisaged by MDHEA, it is possible to estimate the approximate requirements based on a few broad assumptions, as has been attempted in this blueprint. The corresponding costs are incorporated in Chapter 9.

5.2

Sizing hardware requirements

It is necessary to align the hardware size (over 5 years) to the desired range of digital services and the expected number of users. Table 5.1 represents the assumptions made with respect to fulfilling the mandate of the National Digital Health and Innovation Department (NDHID) described in Chapter6.

Desired performance/outcomes assumed for hardware sizing

Topic	Assumption on performance / outcome of MDHEA	
Mandate of NDHID	▸ To create the Core Infrastructure required for implementing NDHID ▸ To create Universal/ Unique health Id for all citizens and residents ▸ To create PHR Platform & Infrastructure on a Federated Architecture	▸ To enforce Health Informatics Standards ▸ To develop & manage CORE building blocks ▸ To leverage the existing major DH Application ▸ To provide for Health Informatics, AI and ML ▸ To undertake/ facilitate Capacity Building to achieve the above mandate
Targets to be achieved in 5 years	▸ 80% of all households in Maldives to be enrolled under NDHID ▸ 80% of all normal residents (citizens and expatriates) will be provided with a unique health ID. ▸ 90% of all Health Service Providers/ Institutions registered (public+ Pvt)	▸ 90% of all Health professionals registered (Public + Private) ▸ 100% of all frontline Health Workers registered ▸ Personal Health Records created for 50% of all new cases admitted/ screened ▸ Integrated fully with existing major DH Programs
Infrastructure to be created	▸ Health Cloud, SoC, NoC established ▸ Privacy Operations Centre established ▸ Health Information Exchange established	▸ Health Analytics capabilities established ▸ Basic AI/ML capabilities established.
Capacity Building	▸ Undertake Capacity Building at 4 levels	▸ Intensify outreach and awareness creation

Table 5.1: Desired performance/outcomes assumed for hardware sizing

It is also necessary to estimate the number of users who access/use these services to arrive at the TPS (transactions per second) that the IT infrastructure should support.

Table 5.2 provides an estimate of the TPS requirement in the aggregate across all major users. It is estimated that when MDHEA is implemented to the level envisaged in the foregoing table, the servers are required to handle about 22.2 million transactions per day. The hardware (compute) requirement is derived as below:

1. Number of transactions to be handled per day of 8 hours = 22.1 million
2. Number of transactions to be handled per hour = 22.1/8 = 2.8 million per hour
3. Peak time requirements at double the above load = 5.6 million per hour.
4. This works out to 5.6 million / 3600 = 1556 transactions per second, rounded to 1600 TPS.
5. As per the sizing guide provided by a reputable site, an 8-core vCPU can process 220,000 transactions (calls/requests) per hour, or about 60 TPS.
6. Going by the above, the requirement of a fully mature MDHEA would be 1600/60= 26.7, rounded to 27 VMs.
7. The requirement of the disaster recovery is assumed to be 50% of that of the data center, assuming that the master data, core and common applications, and data of (up to) 5 years are maintained in the DR and an active-active mode of architecture is adopted. This comes to about 14.
8. The total computes estimated to be 27+14=**41 VMs with 8-core vCPUs.**
    a. It is presumed that the data center of the Maldives Digital Service (MDS) can provide the above server capacity on a co-location basis. The cost has been included accordingly in Chapter 6.
9. While the estimate provides for 41 VMs, the following may be noted:
    a. The servers may be procured in a phased manner over 5 years.
    b. The capacity utilization may be reviewed at the end of each year, and further requirements re- estimated appropriately to ensure that the demand and supply balance well.
    c. For the purpose of costing (in Chapter 9, the procurement is spread evenly across 5 years).

5.3

Estimate of transactions per day for providing digital health services

Type of user	Total number of users	No of active users	Frequency of transactions per day per user	No of API Calls made to the Servers per transaction	No of API calls made to the server by all users of this type	Remarks
Citizens	0.5 mil	0.4 mil (80%)	1 transaction per week (of 5 days)	10	0.8 Million	400,000*0.2*10 (Registrations, enquiries, appointments)
Expats & Tourists	0.5 mil	0.4 mil (80%)	1 transaction per week (of 5 days)	10	0.8 Million	400,000*0.2*10 (Registrations, enquiries, appointments, insurance claims)
Doctors	500	500 (100%)	100 transactions per day	50	2.5 Million	500*100*50 (OP and IP examination, observations, prescriptions)
Health Workers	1000	100 (100%)	100 transactions per day	20	2 Million	1000*100*20 (NCD/CD-related services)
Health Facilities	500	400 (80%)	500 transactions per day	20	4 Million	400*500*20 (Registrations, Admissions, SCM, Medical Records, Billing)

Type of user	Total number of users	No of active users	Frequency of transactions per day per user	No of API Calls made to the Servers per transaction	No of API calls made to the server by all users of this type	Remarks
Other service providers (Pharmacies, Labs)	200	200 (100%)	100 transactions per day	50	1 Million	200*100*50 (Sales of medicines, preparation and issuance of lab reports)
Sub-total					11.1 Million	
Internal system calls					11.1 Million	Assumed at 100% of external transactions
					Total: 22.2 Million	

Table 5.2: Estimate of transactions per day for providing digital health services

5.4

Bandwidth, connectivity, and networks

The design of the network(s) to support MDHEA requires detailed study and discussion. However, based on the preliminary discussions held with the experts from MDS and DHIRAAGU during the multi- stakeholder workshop held at Male on 24-25 September 2024, the following high-level approach is recommended:

1 Status of Optical Fiber Cable (OFC)and networks in Maldives

a. Significant length of the OFC network available in the country with the ISPs OOREDOO and DHIRAAGU may be leveraged for MDHEA/MDHB.

- 6 OFC landing points are available. (see submarinecablemap.com)
- Most inhabited islands have OFC Cable connectivity, and the rest have microwave connectivity

b. 60% of mobiles have 5G, and the 5G coverage will reach 90% by 2025

c. SD-WAN already connects all governmentinstitutions.

Based on the foregoing, the following recommendations are made with respect to the connectivity required for MDHEA:

a. A group of experts from MDS and Ministry of Health, Family and Welfare may be formed to design the 'Health Communications Network' to support MNDHEA. This network may take into consideration the bandwidth requirements (intranet and Internet) of all the health facilities, public and private, besides the supporting institutions/ offices in the health ecosystem. The future requirements of establishing additional services (AI-based applications, Real-time Observatory for 24x7 surveillance of diseases) may also be factored in.

b. The existing OFC network may be leveraged fully. Uncovered/unconnected areas may be identified for laying additional OFC.

c. The existing SD-WAN may be critically examined with regards to (i) providing connectivity to all the health facilities/ offices, (ii) the adequacy of the bandwidth to each category of locations, and (iii) whether the technology used in SD-WAN can serve the current and future (10-year) needs of MDHEA. Clear recommendations may be made to meet the short, medium, and long- term requirements of these institutions.

d. The size of the investment required to support MDHEA may be estimated.

e. The need for enhancing the CPE (customer premises equipment) [switches, routers, LAN] may be assessed, and recommendations made for the 3 categories of facilities primary, secondary, and tertiary.

f. The cost of enhancement/creation of the network should be added to the financial estimate made in Chapter 9.

CHAPTER 6

Institutional Framework

6.1

Need for an institution dedicated to digital health

The National Digital Health Ecosystem evolves through the continuous and dedicated efforts of all the actors in the ecosystem, coordinated by a central organization. The following specific reasons support the need for a central organization dedicated to digital health.

1. Implementing MDHEA calls for a mission approach requiring multi-dimensional, deep techno-legal- functional-operational expertise, not usually available together in any existing public agency or division of a department.

2. MDHEA requires a set of specific, complementary skills and capabilities brought together consciously as a composite team. The following key capabilities are necessary for the team.

    a. High-quality design, development, and deployment of the technically complex CORE building blocks.

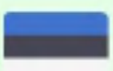
    b. Coordinating with multiple agencies to ENABLE them to design and build the COMMON building blocks or enhance the existing applications as common building blocks.

    c. Leveraging agile development frameworks, protocols, and tools.

    d. Ability to hire and retain talent best suited to the tasks.

    e. Agility and speed in development and implementation, always abreast of the latest technologies.

Organizational structures responsible for digital health in the countries selected for benchmarking.

Name of the agency	Organizational /legal status	Role
 **Estonia** Ministry of Social Affairs	The Ministry of Social Affairs of Estonia (Sotsiaalministeerium) is a government ministry and part of the executive branch of the Republic of Estonia.	▸ Sets national policy and strategy for health and social systems, including digital transformation. ▸ Owns and steers major national e-Health infrastructure projects.

Name of the agency	Organizational /legal status	Role
 **Australia** Digital Health Agency	Reports to the Minister for Health and Aged Care. Governed by an independent Board of Directors appointed by the minister.	▸ Manages the My Health Record system (national electronic health record). ▸ Leads initiatives like • Secure messaging • Digital prescriptions • National Health Interoperability Plan ▸ Develops national frameworks, including: • National Digital Health Strategy • Cybersecurity and data governance policies for health IT.

Organizational structures responsible for digital health in the countries selected for benchmarking.

Name of the agency	Organizational /legal status	Role
 **Canada** Digital Health Canada	Incorporated as a non-profit organization under Canadian federal or provincial corporate law, it operates separately from the Canadian government, though it works collaboratively with public and private sector stakeholders.	▸ Provides: • Professional development & certifications (like CHIME, CPHIMS-CA). • Advocacy for digital health innovation. • Thought leadership, events, and networking.

Name of the agency	Organizational /legal status	Role
 **Indonesia** Ministry of Health	The Indonesia Health Services (IHS) Platform serves as a central digital health ecosystem, facilitating data connectivity and integration of health applications.	▸ The MOH oversees policies, including telemedicine and health information systems, and collaborates with various stakeholders to advance digital health transformation.

Name of the agency	Organizational /legal status	Role
 **Mauritius** Ministry of Health and Wellness (MOHW)	The MOHW is a ministerial department established under the Constitution of Mauritius and the Public Service Act.	▸ Oversees rollout of digital health systems such as ▸ Electronic Health Records (EHR) ▸ Telemedicine services ▸ Health Information Systems (HIS) ▸ Digital vaccination and COVID-19 tracking systems.

Name of the agency	Organizational /legal status	Role
Singapore Synapxe	Led primarily by the Ministry of Health (MOH) of Singapore.	▸ Interoperability across systems. ▸ Data security and governance. ▸ AI and predictive analytics in care delivery. ▸ Chronic disease and elderly care support using digital tools. ▸ Citizen empowerment through digital access to health services.

Name of the agency	Organizational /legal status	Role
Sri lanka Health Info Unit	Special unit within the Ministry of Health.	▸ Lead the implementation of the Digital Health Blueprint.

Figure 6.1: Comparative picture of organizational structure of digital health in a few countries

Figure 6.1 provides a comparative picture of the organizations responsible for the design and implementation of digital health programs in some countries. Countries like Singapore has demonstrated an impressive result in providing the benefits of digital health to the people. The success is the cumulative result of multiple factors like the size of investments, availability of high-end resources and skills, robust ICT Infrastructure, geographical advantage and high levels of health awareness and digital literacy of the population. Establishment of an autonomous agency for digital health might have also contributed significantly to the success of the program.

Keeping the above factors and circumstances in view the government of Maldives should also have a dedicated department/agency for the design and implementation of digital health program (MDHB).

6.2

Role of the National Digital Health and Innovation Department (NDHID)

The design, development, and implementation of digital health need to be carried out in a mission mode. It is proposed to name the specialized department the National Digital Health and Innovation Department (NDHID). NDHID should be a department established under the Ministry of Health, Family and Welfare. The key responsibilities of NDHID are specified below:

1. Implementing the technical and managerial tasks enumerated in 6.1(2).
2. Promoting the adoption of standards for collection and maintenance of health data by the providers and patients.
3. Facilitating the creation of PHR through a unique identifier for the providers and patients across the health system.
4. Enabling the interoperability of health systems by establishing a Health Information Exchange (HIE).
5. Improving the quality of health data collection, storage, and analysis for research and policy decisions.
6. Capacity building on health informatics, safety, security, and privacy.
7. Leading the process of transformation for enhancing efficiency, effectiveness, and transparency in the delivery of health services, especially in moving towards paperless, Q less, and cashless delivery of services.
8. Adopting agile systems of governance and procurement.
9. Adopting public-private partnership models for the establishment of DH infrastructure and the proliferation of digital health services.

6.3

Establishing NDHID in two stages

There are two stages in establishing NDHID:

- Stage 1: The Ministry of Health, Family and Welfare may establish a new department DEDICATED to the design, development, and implementation of MDHEA. The new department will be called NDHID and should comprise the core experts and professionals as per the organizational structure suggested in Section 6.4. The NDHID will implement all the actions scheduled for year 1 in Chapter 8 relating to the action plan.
- Stage 2: An appropriate decision may be taken by the government within a year.
- Of the commencement of stage 1, to establish the legal entity to be called NDHID, or National Digital Health Authority. NDHID or NDHA may be incorporated and established before the end of stage 1, i.e, within 1 year from the start of stage 1, along with a roadmap for its expansion into a full-fledged organization.
- Stage 2: Within one year of the commencement of Stage 1, the government may take an appropriate decision to formally establish the legal entity of NDHID or the National Digital Health Authority (NDHA). This process may involve the enactment of necessary legal and legislative measures to grant NDHID or NDHA the required statutory powers, authority, and framework to operate effectively. The establishment of NDHID or NDHA will involve the creation of a legal framework, governance structures, and a roadmap for its expansion into a fully functional department or authority.

Given the urgency of realizing MDHEA, it is expedient that Stage 1 is reached at the earliest so that multiple parallel activities can be implemented.

6.4

Organizational structure of NDHID

The following basic principles guide the design of the (initial) organizational structure of NDHID for Stage 1.

1. A multi-dimensional team that has, among its members, all or most of the capabilities to deliver on the mandate indicated in section 6.2.
2. NDHID is empowered to take all the operational decisions required in the design and development stages.
3. Sufficient financial resources need to be placed at the disposal of NDHID. An indication of the budget requirement for the first 5 years provided in Chapter 9 needs to be taken into consideration.
4. One of the critical success factors of NDHID will be the selection of the right champion to lead the initiative in its formative stage.

Figure 6.2 presents an indicative organogram of the proposed NDHID at the top level. It is derived from the above-stated mandate, guiding principles, and the best practices recommended by the World Health Organization in the Digital Infrastructure Investment Guide. The structure of the department or its constituent units may be revised and updated in accordance with the most recent Maldives Public Service Pay Framework.

Organizational structure of National Digital Health and Innovation Department Maldives (NDHID)

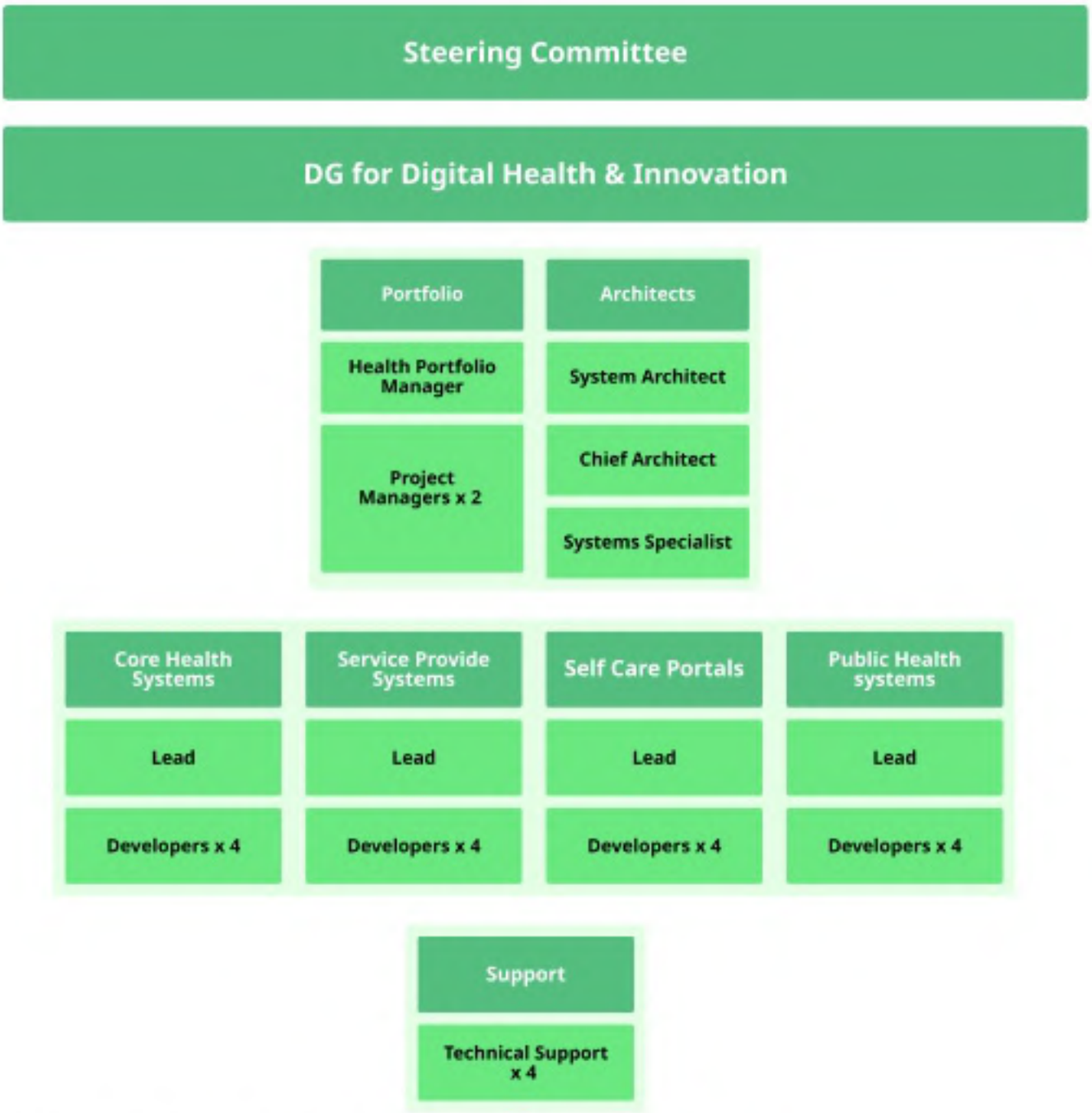


Figure 6.2: Organizational structure of Digital Health and Innovation Department

6.5

Steering Committee

The complex responsibilities of NDHID require coordination with and support from multiple organizations within the government. To facilitate this, a high-powered multi-stakeholder steering committee may be established to guide and support NDHID at the policy level. The steering committee would broadly be responsible for laying down the enabling policies for digital health, providing direction and guidance to the DG for Digital Health & Innovation, and performing a supervisory role, besides playing the coordinating role.

The suggested composition of steering committee is given below. However, the MoHFW may review the composition of the Steering Committee from time to time and make necessary changes.

1. Senior representative from MoHFW (Chair)
2. Representative from the division / department at MoHFW responsible for implementation of MDHB (Vice Chair)
3. Digital Transformation Strategist / Chief Technology Officer / Senior Representative from President's Office
4. Representatives from MCGH
5. Representatives from NSPA
6. Representatives from MDS
7. Representatives from Aasandha Company Limited
8. Technical partners supporting MDHB implementation
9. Representatives from agency responsible for supply of medicine and medical equipment
10. Representatives from WHO
11. Other technical experts and stakeholders as determined by the Steering Committee

6.6

Interim arrangement

1. Since the formal constitution of NDHID and SC and staffing the NDHID might take several months, an interim arrangement may be made to ensure that the foundational activities of the department are initiated. A steering committee chaired / vice chaired by the permanent secretary (Ministry of Health, Family and Welfare) with appropriate cross sectoral composition may play the role of SC. A Technical Working Group (TWG) can assist in the initiation of NDHID.
2. The suggested composition and terms of reference of these two interim bodies are provided in Annexure.

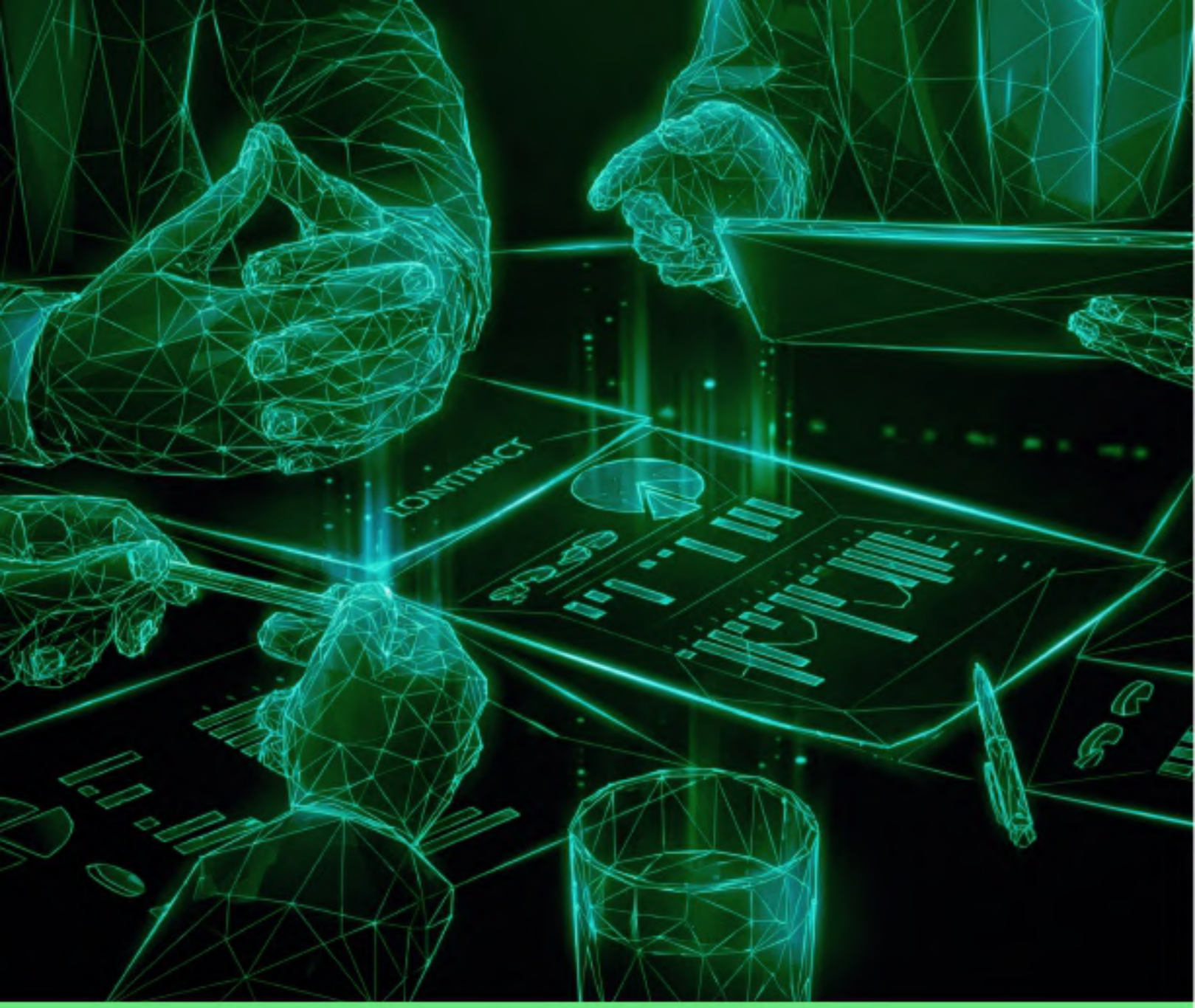
6.7

Role of the digital health ecosystem players

1 Successful implementation of digital health calls for a coordinated effort of all the players in the ecosystem. The matrix in Table 6.1 indicates these roles. It is desirable, for reasons of sustainability, to promote a few Communities of Interest around digital health to carry this agenda forward.

Community of Interest	Role and scope of involvement
Health Professionals	▸ Provide valuable inputs on the domain processes and workflows. ▸ Play an active role in the adoption of the new ways of dealing with cases - digitally.
HealthTech Companies	▸ Provide technical inputs on improving the architecture and design. ▸ Suggest incorporation of best practices. ▸ Help accelerate the adaptation and adoption of standards. ▸ Partner with the government in the development and enhancement of DH solutions to be in conformity with MDHEA. ▸ Partner with the government in establishing the core infrastructure for digital health, especially the data center and the HIE.
Number of Users	▸ Provide feedback and comments on the architecture and designs. ▸ Take an active part in the community activities to be planned under the DH Program
Healthcare providers	▸ Adopt the architecture, principles, and standards. ▸ Participate in/promote change management and capacity-building programs planned under the DH initiative.
Health Workers	▸ Actively participate in the digital health literacy programs planned under the DH initiative.

Table 6.1: Roles of the digital health ecosystem player



CHAPTER 7

Building Capacities For Digital Health

7.1

Capacity building critical to success

A major nationwide initiative like the implementation of the Maldives Digital Health Blueprint requires to driven by top leadership to produce speedy and impactful results and deliver transformational digital services to the residents. Equally important and critical to enable people within the health systems to implement or adopt digital health and empower patients and other stakeholders to leverage digital health.

The importance of capacity building is narrated below:

1. Digital health calls for a radical change in the way doctors manage cases and frontline health workers interact with the community. The workflows relating to ADT (admission, discharge, transfer), diagnosis, and treatment can be significantly different from the traditional methods. The manner of documenting each case changes from paper-based systems to digital systems. It is necessary to reskill the personnel to manage healthcare digitally.
2. The processes of logistics of supply chain management (for medicines and supplies), maintenance of medical equipment and infrastructure, and management of assets would be reengineered and hence different from the earlier regime.
3. Providers must adopt standards relating to the disease codes, drug codes, and clinical terminology.
4. Security and privacy of sensitive personal information require systemic and cultural changes at all levels in addition to education and training on security and privacy procedures.
5. Providers need to adopt the new regime where exchanging health records in strict compliance with the data protection regulations is imperative. Ecosystem thinking should prevail over enterprise thinking.
6. Importantly, it is necessary to sensitize policymakers and administrators to the special requirements of policy and support, monitor, and evaluate the design, development, deployment, and functioning of digital health programs.

All of the above underscores the need to design and implement a comprehensive capacity-building program across multiple areas and levels.

7.2

Salient features of the Digital Health (DH) Capacity Building Program

1. DH Capacity Building Program is a professionally designed multi-level program that ensures deriving optimum benefits of the DH program.
2. It is organized at 4 levels:
   a. Policy makers
   b. Health Professionals
   c. HealthTech Professionals
   d. Frontline Health Workers
3. It is spread over 3 years to cover the entire health workforce and technical personnel. It may be noted that the capacity-building plan is proposed to be completed in 3 years, while the action plan for implementation of MDHB is proposed over 5 years. This is because, in years 4 and 5, they are substantially related to the implementation of digital health programs and the delivery of services. If the workforce were fully trained in digital health in 3 years, they would be in a better position to ensure that the program is implemented smoothly.
4. It is preferably funded substantially by the Ministry of Health, Family and Welfare with possible supplementation by donors and the private sector.
5. The program may be conducted in a hybrid mode, i.e., a combination of in-person and virtual training sessions.
6. Training courses shall be conducted in batches of 15 to 30, depending upon the number of participants targeted.
7. Train-the-trainer mode would be adopted for frontline health workers, considering the large number of functionaries to be trained.
8. Participants could be incentivized through financial and non-financial rewards for successfully completing the assigned program.
9. A panel of expert speakers and practitioners (local and international) may be developed to ensure continuity and uniformity of the quality of training.
10. An effective system of monitoring and evaluation would be established to monitor the progress of various capacity-building programs. Online dashboards, reporting, feedback, and evaluation systems shall be a part of the proposed monitoring and evaluation system.

7.3

Outline of the 4 categories of capacity-building program

The following is a high-level view of the proposed 4-category CB Program. A detailed CB plan may be prepared based on the outline given below:

Category A: Policymakers & top management

Target Group:

Top functionaries of Ministry of Health, Family and Welfare (top 3 levels, including the minister(s) of Health, Family and Welfare), heads of the departments under the control of MoHFW, and CEOs of tertiary hospitals (public and private).

Structure of the Course:

- **Estimated size of the target group:** 20.
- **Duration:** 3 days
- **Mode of participation, venue:** In-person, preferably off-site
- **Format of the course:**
  - Strategy sessions (interactive)
  - National/International case studies
  - Group discussions
  - Virtual tours of facilities (relating to best practices)

Themes/topics of the course:

1. Overview of Digital Transformation
2. Digital Health Blueprint
3. Digital Health Architecture and Core Building Blocks (High-Level View)
4. Governance & Institutional Structure
5. Digital Health Legislation, Data protection and privacy issues, Regulations, and health data management policy
6. Health analytics, data-driven decision-making
7. mHealth
9. Digital Health Infrastructure, Standards, and Interoperability
10. Case studies of global best practices

Category B: Health professionals

Target Group:

Administrators and medical superintendents of tertiary hospitals, principals of medical and nursing colleges, and medical and surgical specialists with 10+ years of post-qualification experience.

Structure of the Course:

- **Estimated size of the target group:** 50.
- **Duration:** 2 days
- **Mode of participation, venue:** In-person
- **Format of the course:**
  - Strategy sessions (interactive)
  - National/International case studies
  - Group discussions
  - Virtual tours of facilities (relating to best practices)

Themes/topics of the course:

1. Overview of Digital Transformation
2. WHY and WHAT of Digital Health
3. Digital health as an enabler of progress towards health-related SDGs
4. Prioritization of digital health interventions
5. Overview of HMIS, HIS, and DHIS2 Monitoring and Evaluation System

6. Basics of PHR, EMR, and EHR
7. Criticality of health data, data quality, data standards and interoperability, data protection, privacy (basic concepts)
8. Telemedicine, e-Prescriptions, and e-Pharmacy
9. eLearning and CDSS
10. Health call center(s)
11. mHealth
12. Collaboration of IT and health professionals

Category C: Health Tech Professionals

Target Group:

IT architects, system analysts, developers, DBAs, and maintenance personnel.

Structure of the Course:

- **Estimated size of the target group:** 50
- **Duration:** 3 days + virtual sessions of 24 hours
- **Mode of participation:** In-person + virtual
- **Format of the course:**
  - Technical sessions (interactive)
  - National/International case studies
  - Group discussions
  - Virtual tours of facilities (relating to best practices)
  - Project work

Themes/topics of the course:

1. Overview of Digital Transformation
2. Digital Health Strategy, Blueprint, Architecture, and core building blocks of digital health (Detailed Exposure)
3. Role of unique/universal health ID and Registries (Registries of Health Professionals, Health Facilities and Health Workers)
4. Principles and Methods of Digital Public Goods
5. Overview of HMIS, HIS, DHIS2, Management, and Evaluation
6. Detailed exposure to the concepts and implementation of PHR, EMR, and EHR
7. Criticality of data quality, data standards, and interoperability
8. Detailed exposure to Telemedicine, e-prescriptions, and e-Pharmacy
9. mHealth & call center
10. Privacy-by-design, security-by-design (detailed exposure)

Category D: Front line Health Workers

Direct Target Group:

Trainers (Health Supervisors with 10+ years of field experience in public health management)

Indirect Target Group

Field Health Supervisors, Nurses,ANMs, Lab Technicians, Pharmacists, and Community Health Workers.

Structure of the Course:

- **Estimated size of the target group:** 100 (trainers) + 1000 (end trainees)
- **Duration:** 3 days + annual refresh of 1 day for trainers; 2 days for end trainees
- **Mode of participation:** In-person
- **Format of the course:**
  - Technical input sessions
  - Practice sessions
  - Quizzes

Themes/topics of the course:

1. mHealth (operating the system at user level, data entry, editing, reports,etc.)
2. Basics of HMIS and POC devices
3. Basics of PHR, EMR, and EHR
4. Ensuring quality of data, the basics of standards, and interoperability.

5. Digitally driven health surveys, campaigns, and mass screening
6. Role of field health workers intelemedicine
7. Targeted interventions, PHC-centric approach
8. Reporting formats and quality
9. Using social media tools for IEC activities
10. Using disease-specific applications
11. Basics of privacy of health data, role of the field health workers, do's and don'ts

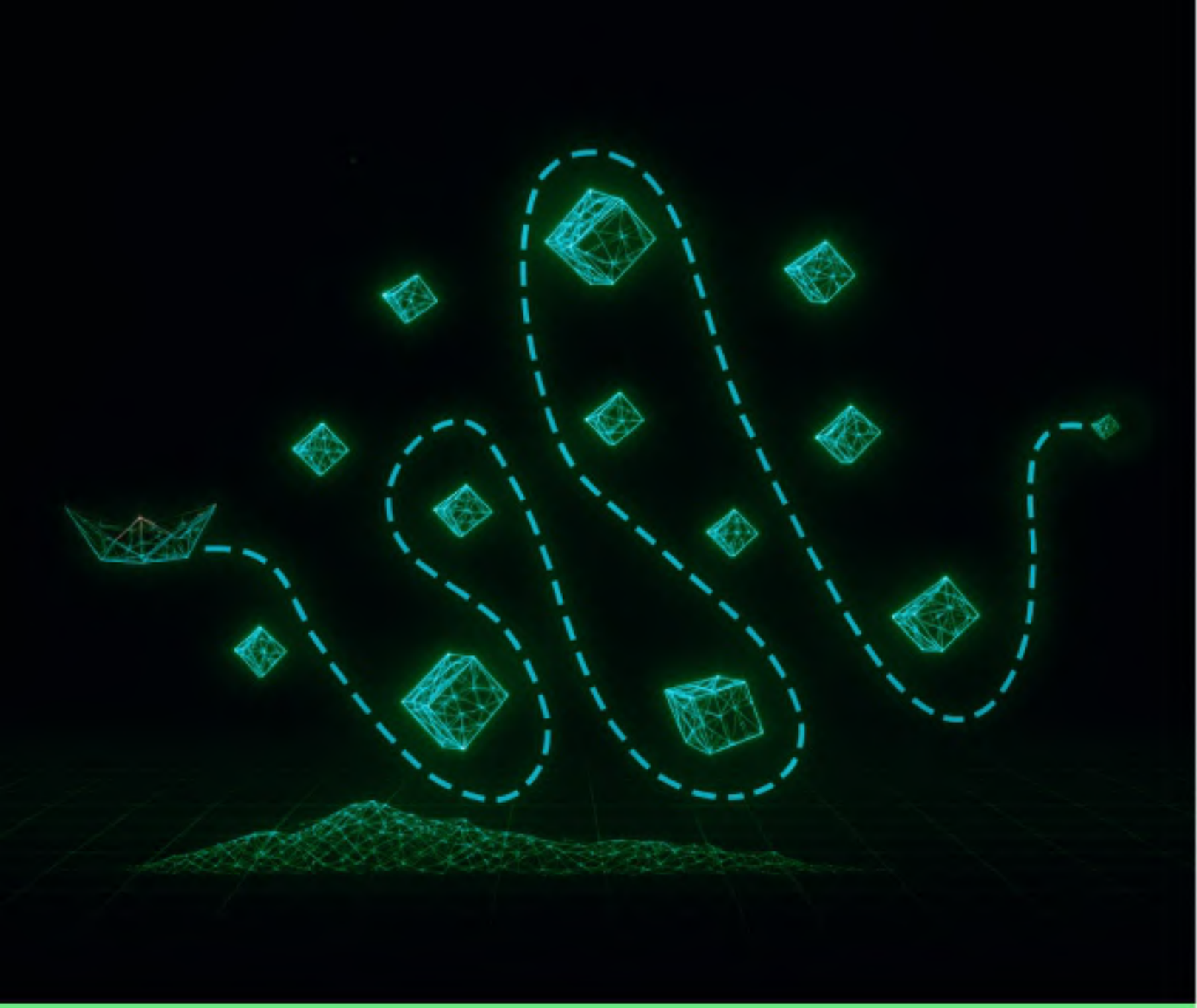
7.4

Need for introducing digital health in the curriculum of medical and nursing education

The pivotal role of digital skills at all levels of the health system and the difficulties of educating the existing workforce while managing the change cannot be overemphasized. A more sustainable approach would be to impart the required skills during the education period itself. Digital health should be mandatory and not an elective in the curriculum. In fact, relevant topics of digital health should be taught alongside the relevant clinical and administrative subjects in all semesters instead of teaching digital health as a separate module. This ensures that digital health is mainstreamed in the teaching-learning environment.

Several high-ranked medical schools in the USA, Europe, and Asia have integrated and mainstreamed digital health in the medical curriculum. These include Stanford, Harvard, Johns Hopkins, UCSF, Duke, Oxford, Edinburgh, Toronto, and NUS. Some of them, like Harvard Medical School, have launched a one-year program on medical informatics.

To meet the requirements of a digitally proficient health workforce, appropriate academic committees may be constituted to formulate suitable courses to mainstream digital health into the curriculum of medical and nursing schools.



CHAPTER 8

Roadmap For Implementation

8.1

Strategic approach to implementing MDHEA

Implementing MDHB requires coordinated efforts by multiple agencies over a prolonged period. Achieving the required degree of coordination and efficiencies of a high order is the need of the hour to meet the challenges of digital health transformation effectively.

The following core principles may guide the implementation, as is evident from the best practices.

1. Adopt a strategic approach to implementation based on the following principles:
   - Hold the MDHEA principles (stated in Chapter 2) as supreme.
   - BUILD minimum, ENABLE most.
   - Establish agile governance and practice agile development.
2. Architecture and design of MDHEA is preferably done by a team of experts under a Technical Working Group (TWG)
3. Internally develop or outsource the implementation through a transparent bidding process, preferably in 3 packages.
   - Solution Development (Core BuildingBlocks)
   - System Integration (Deployment, integration, and Interoperability)
   - Capacity Building
4. Adopt a performance-linked payment system for all service providers and implementation agencies.

8.2

Documentation: the first step to successful implementation

Several architectural artifacts and design documents need to be developed, mainly during the design phase. Significant effort is required to detail the strategies and models recommended in this blueprint. The list of key artifacts to be developed by the TWG is given in Table 8.1. These constitute the minimal set. Supplementary documentation may be required.

Artifacts relating to Business architechture

#	Name of the Artifact	Purpose and nature of the Artifact
1	**Portfolio of Services**	Prioritized list of digital services to be targeted, including integrated and cross-cutting services; service definitions, service levels, and delivery modes. The problems posed by the geography of a SIDS country like Maldives may be kept in view while designing the portfolio and prioritization. The principle of inclusivity needs to prevail.
2	**Process-reengineering needs**	List of processes (forms and workflows) to be reengineered, pain points, reasons for business process reengineering, and methods of business process reengineering.
3	**Functional Requirements of Services**	Functional requirements of prioritized services and the [re-engineered] processes required to support them.

Artifacts relating to Application Architecture

#	Name of the Artifact	Purpose and nature of the Artifact
4	**Application Portfolio**	Description of applications (existing and future) required to provide/ support the prioritized digital services. Touchpoints of the applications with other components; data requirements.Microservices may be designed to allow flexibility, agility, and reusability.
5	**Designs of Core Building Blocks**	Detailed design of the Core Building Blocks, namely, Unique Health ID, National Registries [of facilities, professionals, and workers], master data, code systems; interoperability of core building blocks and with other (common) building blocks.

#	Name of the Artifact	Purpose and nature of the Artifact
6	**Functional Requirements of Common Building Blocks**	High-level requirements of Common Building Blocks (adequate to enhance the existing applications and to design new applications), special emphasis on adoption of terminology standards and interoperability through open APIs.

Artifacts relating to Interoperability Architecture

#	Name of the Artifact	Purpose and nature of the Artifact
7	**Interoperability Designs**	Architecture that depicts and defines the methods of interoperability and integration required to provide integrated/cross-cutting and value-added services; list of integration touch points.
8	**API Portfolio**	Portfolio of APIs and requirements of each [nature of input parameters and response], non-functional requirements of each API.
9	**HIE Design**	High-level design of the HIE and its major components, adequate to enable procurement of a product/solution.

Artifacts relating to Data Architecture

#	Name of the Artifact	Purpose and nature of the Artifact
10	**Core Data**	Structure of core data and methods to create and maintain the same, along with process flows. Ownership and responsibilities for management, privacy, and security.
11	**Master Data, Code Systems**	List of master datasets required, and plan to create/ maintain them.
12	**Data Standards**	List of the required data standards and coding systems, and a plan to adopt/migrate to the standards, basing on the principle of minimality.
13	**Health Data Management Policy**	A policy to ensure privacy of health data and enable sharing health data the principle of ' person-controlled health records'.

Artifacts relating to Technology Architecture

#	Name of the Artifact	Purpose and nature of the Artifact
14	**IT Infrastructure roadmap**	A roadmap for enhancing the IT infrastructure (compute, storage, network, and communications) to the desired state and the resource requirements for the same. Open specifications of each component of the infrastructure.
15	**Policy on Open-Source Software**	A clear policy on the preferential approach to procuring solutions and products built using open-source components.
16	**Policy on Open APIs**	A policy on the criteria to be satisfied for publishing Open APIs and for providing API access to authorized users (service providers, innovators, or researchers)

Artifacts relating to Security Architecture

#	Name of the Artifact	Purpose and nature of the Artifact
17	**Security Strategy, Framework & ISMS**	IS Strategy, CSF (as per NIST), and Information Security Management System in accordance with the ISO-27500 series.
18	**Security Policies**	Security policies as identified and listed in the blueprint.

Artifacts relating to Governance Architecture

#	Name of the Artifact	Purpose and nature of the Artifact
19	**PMU Structure**	The structure, composition, size, role and capabilities of PMU
20	**Budget**	A detailed estimate of the CapEx and OpEx and sources of funding.

Table 8.1: List of important artifacts to be developed

8.3

MDHEA Action Plan

The implementation of MDHEA may be planned over a 5-year period. The milestones and the suggested timelines are indicated in Table 8.2. The action plan is laid out in 3 stages INITIATE, LAUNCH, and SCALE each stage taking 1 to 2 years.

The plan is indicative and dynamic. It needs to be updated every 3 months, including new activities, while keeping the cumulative timelines intact.

INITIATE Phase (Year1)

Milestone	Timeline (in months)	
	Individual	Cumulative
Establishment of Steering Committee and Technical Working Group (TWG)		
Approval of the Maldives Digital Health Blueprint		
Design detailed architecture (adopting modeling tools)		
Detailed designs of Core Building Blocks		
Design implementation model, procurement plan and bid documents as required (parallel to item 4)		
Notify minimum set of viable standards (parallel to item 5)		
Identify implementation partner(s)		
Design and notify policies (Health Data Management, Security) (parallel to item 7)		
Initiate Capacity Building Program (for Categories A&B)		

LAUNCH Phase (Years 2-3)

Milestone	Timeline (in months)	
	Individual	Cumulative
Launch Core Building Blocks (in continuation of item 7)		
Enhance legacy systems to conform to MDHEA and leveraging CBBS (in continuation of item 7)		
Notify a policy to incentivize adoption of MDHEA and Standards		
Drive creation of Unique health ID by/ for citizens and expatriates		
Initiate Capacity Building for Categories C and D		
Launch telemedicine 2.0 (leveraging CBBs) (in continuation of item 10)		
Incorporate NDHID and establish governing council (after item 10)		
Enable launching of 10 Common Building Blocks (after item 10)		
Publication of Security and Privacy Policies by major agencies and organizations (public and private) (after item 10)		
Launch the initial set of 10 prioritized digital services (after item 17)		

SCALE Phase (Years 4-5)

Milestone	Timeline (in months)	
	Individual	Cumulative
Establish Health Information Exchange (HIE) (after item 17)		
Enable launching of 10 more Common Building Blocks (after item 17)		
Establish Security Operations Centre (SoC) (after item 20)		
Establish Privacy Operations Centre (PoC) (after item 20)		
Establish repository of architecture artefacts, standards (after item 20)		
Launch full range of digital health services		

Table 8.2: MDHEA Implementation Action Plan

CHAPTER 9

Financial Implication

9.1

Introduction

Investments in the health sector and digital health have a multiplier effect of 4.8, compared to a multiplier of 1.61 for overall government spending. The benefits would be in terms of reduced burden of disease and the consequent reduced cost of healthcare, the increased economic value from a more productive population, and the social benefits due to increased wellness. The investments in digital health accelerate the movement of Maldives towards attaining UHC and health-related SDGs, especially anemia in women, RMNCAH Index coverage, reduction of out-of-pocket expenditure, and to provide health services more accessible to the population living in the remote islands.

The estimates provided in this document are based on the benchmarks published by the vendors for IT infrastructure costs and on broad assumptions for other components.

The estimate has been made along 4 major cost components, namely, IT infrastructure, application development, management, and capacity building. However, the cost incurred by the sector and the cost of providing hardware and software are not included. It is presumed that the IT infrastructure would be established in 3 years, the application development and capacity building would be done in 3 years, and the full-fledged manpower of NDHM would be established in 5 years. The costing is done for 3 years for all except manpower, which is costed for 5 years.

9.2

Estimated cost of IT Infrastructure

For MDHEA, IT Infrastructure includes the compute, storage, system software, database, and bandwidth requirements of the core and common applications. It is difficult to estimate the exact size of compute and storage required to meet the MDHEA requirements. However, an approximate estimate is made based on the following assumptions:

- The transaction handling capacity required at peak time after MDHEA has become fully functional has been estimated to be 1600 TPS (transactions per second) and has been explained in section 5.2.
- As per the sizing guide provided by a reputable site, an 8-core vCPU can process 220,000 transactions (calls/requests) per hour, or about 60 TPS. [Link: Number of TPS servers Recommendation (oracle.com)].
- Going by the above, the requirement of a fully mature MDHEA would be 1600/60 = 26.7, rounded to 27 VMs. The requirement of DRC is assessed to be 14, making the total requirement 41 VMs.
- Discussion with MDS reveals that they support the co-location model. Hence, the CapEx of procuring the hardware has been included in the cost estimate. It is split evenly across the 5 years. Table 9.1 provides the estimate and the assumptions underlying the same.

Item	No of Units by Y5	Unit cost (US$)	Basis of cost estimation	Y1	Y2	Y3	Y4	Y5	Total US$
Health Cloud - VM with 8 vCPU) -Storage of 1 TB per unit - DB of appropriate capacity	41 8-vCPU or 82 4-VCPU		The published price of 4-CPU Xeon rack server with 4x32 GB RAM and 2 TB Storage : Basic cost = 17,750 Shipping = 2,000 Installation = 2,000 TOTAL COST= 21,750 Requirement of DR = 27x2x4CPU rack servers = 54 Requirement of DRC = 14x2x4CPU= 28 Total requirement = 82 Cost of Servers = 82x 21,750 = 1,783,500 rounded to 1.78	356,700	356,700	356,700	356,700	356,700	1,783,500
Bandwidth (1 Gbps)	3 Gbps	150,000 p.a	100% redundancy provided. 2. Usage of Institutional users – Heavy, Medium and Low bandwith users – considered. 3. Scaling assumed at 1 / 2/ 3/3/3 Gbps for Y1/Y2/Y3/Y4/Y5 5. Cost is assumed at 5 times the bandwidth cost in India	150,000	300,000	450,000	450,000	450,000	1,800,000

Item	No of Units by Y5	Unit cost (US$)	Basis of cost estimation	Y1	Y2	Y3	Y4	Y5	Total US$
SoC and NoC			Lumpsum	100,000	150,000	200,000	200,000	200,000	850,000
Cost of Management of Infrastructure			Estimated @ 20% of Infrastructure cost (0.2*[1+2+3])	120,000	160,000	200,000	200,000	200,000	880,000
			TOTAL COST OF IT INFRASTRUCTURE	**726,700**	**966,700**	**1,206,700**	**1,206,700**	**1,206,700**	**5,313,500**

Table 9.1: Estimated cost of IT Infrastructure (in US$)

9.3

Estimated cost of application development

The following is the basis for estimating the cost of application development:

1. An expert estimation method has been used for the effort required for application development.
2. The effort is estimated building block-wise, based on the degree of complexity.
3. The estimated effort includes the requirements of architecture, design, development, testing of each building block, development of APIs, and integration testing.
4. The estimate has been made for 7 core building blocks and 20 common building blocks, corresponding with the building blocks included in MDHEA in Figure 3.2.
5. An average effort of 10 man-months has been taken per common building block, considering that some of the legacy applications can be enhanced and the others need to be developed afresh.
6. The estimated effort is shown module-wise in Table 9.2

Name of the building block	Effort in man-months
UNIQUE HEALTH ID	24
Registries (3)	6
HIE	10
Consent Manager	6
Reference Data & Terminology (Code systems)	10
Common Building Blocks (20 BBs @ 10 man-months per BB)	200
Development of APIs and Integration	24
Management of software development	20
	TOTAL 300

Table 9.2: Estimated effort in application development

7 It is assumed that 20% of the effort goes into architecture, 30% into design, and 50% into development and testing.

8 The cost of engaging software professionals has been estimated based on the rates prevailing in India.

Category of software/ IT Professional	Effort in man-months	Unit cost per month (in US$)	Cost of the personnel of this category (in US$)			
			Year 1	Year 2	Year 3	Total
Architects & team managers (20%)	60	6.000	144,000 (40%)	108,000 (30%)	108,000 (30%)	360,000
Designers (30%)	90	4.000	108,000 (30%)	144,000 (40%)	108,000 (30%)	360,000
Developers (50%)	150	3.000	90,000 (20%)	225,000 (50%)	135,000 (30%)	450,000
Total	**300**	-	**342,000**	**477,000**	**351,000**	**1,170,000**

Table 9.3: Estimated cost of application development

9 The effort of software development is 300 man-months or 25 man-years. A mixed team of 15 IT professionals can develop the first version of the majority (~70%) of the applications in a year and a half.

9.4

Estimated cost of Establishment and Management of NDHID

As emphasized earlier, establishing a dedicated organization (NDHID) for the design and implementation of MDHEA is critical to the entire initiative. The ideal composition of NDHID proposed in chapter 6 is costed in Table 9.4. The deployment is proposed over 3 years considering optimal utilization and the challenge of availability of the right professionals. The costs prevalent in India are taken as the basis. The cost is again re- projected to 5 years maintaining the cost estimated for Year 3 for the years 4 and 5.

As noted earlier, the organizational structure and staffing plan for NDHID may need to be revised in line with the latest Maldives Public Service Pay Framework. Once the Blueprint is updated, the job titles, grades, and salary scales should be reviewed and aligned accordingly. The positions listed in the current version represent the recommended functional roles, but titles and classifications may be adapted as required during formal approval and implementation.

Role	No of positions	Engagement Period (Yrs)	Remuneration p.a (US$)	Personnel Cost of NDHID (in US$)			
				Year 1	Year 2	Year 3	Total
Director General	1	3	2892	34,704	34,704	34,704	104,112
Health Portfolio Manager	1	3	1716	20,592	20,592	20,592	61,776
Project Manager	2		1622	19,464	19,464	19,464	116,784
Architect - Chief Architect	1		2591	31,092	31,092	31,092	93,276
Architect - System Architect	1		2400	28,800	28,800	28,800	86,400
Architect - System Specialist	1		2270	27,240	27,240	27,240	81,720
Core Health System - lead	1		2400	28,800	28,800	28,800	86,400

Role	No of positions	Engagement Period (Yrs)	Remuneration p.a (US$)	Personnel Cost of NDHID (in US$)			
				Year 1	Year 2	Year 3	Total
Core Health System - Developers	4		1946	93,408	93,408	93,408	280,224
Self Care Portals - lead	1		2400	28,800	28,800	28,800	86,400
Self Care Portals- Developers	4		1946	93,408	93,408	93,408	280,224
Public Health System - lead	1		2400	28,800	28,800	28,800	86,400
Public Health System- Developers	4		1946	93,408	93,408	93,408	280,224
Support - Techical Support	4		1000	48,000	48,000	48,000	144,000
Benefits - Roadha Allowance	31		195	6,045	6,045	6,045	18,135
Office rental			5890	70,680	70,680	70,680	212,040
Furniture (Table and Chair)	31		390	12,090	12,090	12,090	36,270
IT infrastructure							4,962
Security and Utilities setup							2,076
Contingency							39,728.85
						Total	2,101,151.85

Table 9.4: Costed HR plan of NDHID

* These 4 positions may be filled optionally depending upon a fresh assessment of the need.The proposal for establishing the technology wing at an investment of US$ 0.71 million may appear to be 'duplicative' in the face of including an IT team of 31 proposed in figure 6.3

It is also pertinent to mention that it may be feasible to fill some of the above positions through deputation and secondment from the government of Maldives and the cost may correspondingly get reduced.

9.5

Estimated cost of capacity building

The requirements of capacity building have been described in Chapter 7. In addition to the considerations mentioned in Chapter 7, the following approach has been adopted for costing the capacity-building initiative.

1. Commercial conference space would be hired for conducting all the in-person training programs. If appropriate facilities are available within the public sector, the cost would be reduced significantly.
2. If some of the expert faculties are sourced locally, the cost would be reduced further.
3. The costing is done for the 4 levels of personnel. It is assumed that the training programs would be done in a single batch for Categories A, B, and C; it would be done in 2 batches for Category D1 (trainers) and 20 batches for Category D2 (frontline health workers).
4. The cost of travel and stay (where required) shall be borne by the respective departments/ organizations from their respective budgets.
5. Online sessions for Category C are not costed as they may not involve additional resources. The speakers for the in-person sessions shall be required to conduct these online sessions.

Estimated cost of the capacity-building program over 3 years (in US$)

Category	Duration	No of participants / batches	Timing	Cost of hiring venue	Honorarium for speakers	Cost of travel and stay of external speakers	Cost of developing content	Assumptions for costing	Total cost
Cat A	3 days	20 (1 batch)	Y1 Q1	30,000	6,000	15,000 + 3,000 = 18,000	12,000	Venue in an offsite hotel @ 10,000 per day. 2. 6 speakers with honorarium @ 1000. 3. 3 external speakers with travel cost @ 5000 and stay for 5 days @ 1000 4. Development of content for 12 sessions @ 1000 per session.	66,000
Cat B	2 days	50	Y1Q2	10,000	4,000	10,000 + 1,600 = 11,600	8,000	Venue in a hotel in Male @ 5,000 per day. 2. 4 speakers with honorarium @ 1000 3.2 external speakers with travel cost @ 5,000 and stay for 4 days @ 800 4. Development of content for 8 sessions @ 1000 per session	33,600

Category	Duration	No of participants / batches	Timing	Cost of hiring venue	Honorarium for speakers	Cost of travel and stay of external speakers	Cost of developing content	Assumptions for costing	Total cost
Cat C	3 days	50	Y103	15,000	6,000	15,000 + 3,000 = 18,000	12,000	Venue in a Male hotel @ 5,000 per day. 2. 6 speakers with honorarium @ 1000. 3. 3 external speakers with travel cost @ 5000 and stay for 5 days @ 1000 4. Development of content for 12 sessions @ 1000 per session.	51,000
Cat D1 (Trainers)	3 days in Y1 + 1 day in Y2, Y3	100 (in 2 batches)	Y1 03 Y2 01	30,000	5,000		10,000	Venue in Male hotel @ 3,000 per day for 10 days (in 3 spells for each batch) – (3+1+1)*2. 2. 6 speakers with honorarium @ 500 in Y1. 2 speakers in Y2 and Y3 3. All speakers sourced locally 4. Development of content for 12 sessions @ 500 per session in Y1 and 4 sessions each in Y2,Y3	45,000

Category	Duration	No of participants / batches	Timing	Cost of hiring venue	Honorarium for speakers	Cost of travel and stay of external speakers	Cost of developing content	Assumptions for costing	Total cost
Cat D2 (Health Workers)	2 days in Y1 + 1 day in Y2, Y3	1,000 (in 20 batches)	Y1 Q3, Q4 Y2, Y3(Q1-Q4)	20,000	25,000		10,000	Venue in a hotel in Male @ 5,000 per day. 2. 4 speakers with honorarium @ 1000 3.2 external speakers with travel cost @ 5,000 and stay for 4 days @ 800 4. Development of content for 8 sessions @ 1000 per session	55,000
	Total	**1,220**							**250,600**

Table 9.5: Estimated cost of the capacity-building program over 3 years (in US$)

9.6

Overall cost of implementing MDHEA (over 5 years)

Table 9.6 indicates the overall cost of implementing MDHEA over 5 years, by which time the initiative is expected to reach a stable stage and make a noticeable impact on the stakeholders. The following aspects may be noted.

1. The cost estimates are based on benchmarks where available and a fair assessment in respect of the other line items.
2. The costs proposed may be optimized through further due diligence.
3. The cost of hardware and POS devices, etc., to be installed in the health facilities to enable them to leverage the MDHEA building blocks has not been included in the costing and needs to be met by MoHFW and the facilities from their regular budgets.

Cost item	Estimated cost over years (in US$)
IT Infrastructure (see section 9.2 for detail)	5,313,500
Application development (see section 9.3 for detail)	1,170,000
Establishment of NDHID (see section 9.4 for detail)	2,101,151.85
Capacity Building (see section 9.5 for detail)	250,600
Awareness campaign among citizens (lumpsum)	250,000
TOTAL Cost of MDHEA over 3 years	**9,085,251.85**

Table 9.6: Estimated Overall Cost of implementing MDHEA

ANNEXURES

Annexure 1

Indicative list of Digital Health Services

Citizen/Patient Services

Name of the Digital Service provided
Single, Secure Health ID to all citizens
Personal Health Record
Single (National) Health Portal
Health App Store
Specialized Services for Remote Areas/Disadvantaged Groups
Health Call Centre
Digital Referrals & Consultations
Online Appointments, Q to QR
e-Prescription Service
Access to disease-specific programs
Telemedicine
Health Insurance Services
Nutrition
Immunization

Services by/for Providers & Professionals

Name of the Digital Service provided
Summary Care Record
Emergency Services
RMNCAH, Nutrition, Immunization

Clinical Decision Support (CDS)
Digital Pharmacy & Supply Chain (LMIS)
Hospital Digitization (HIS)

Services to the Government & Academia

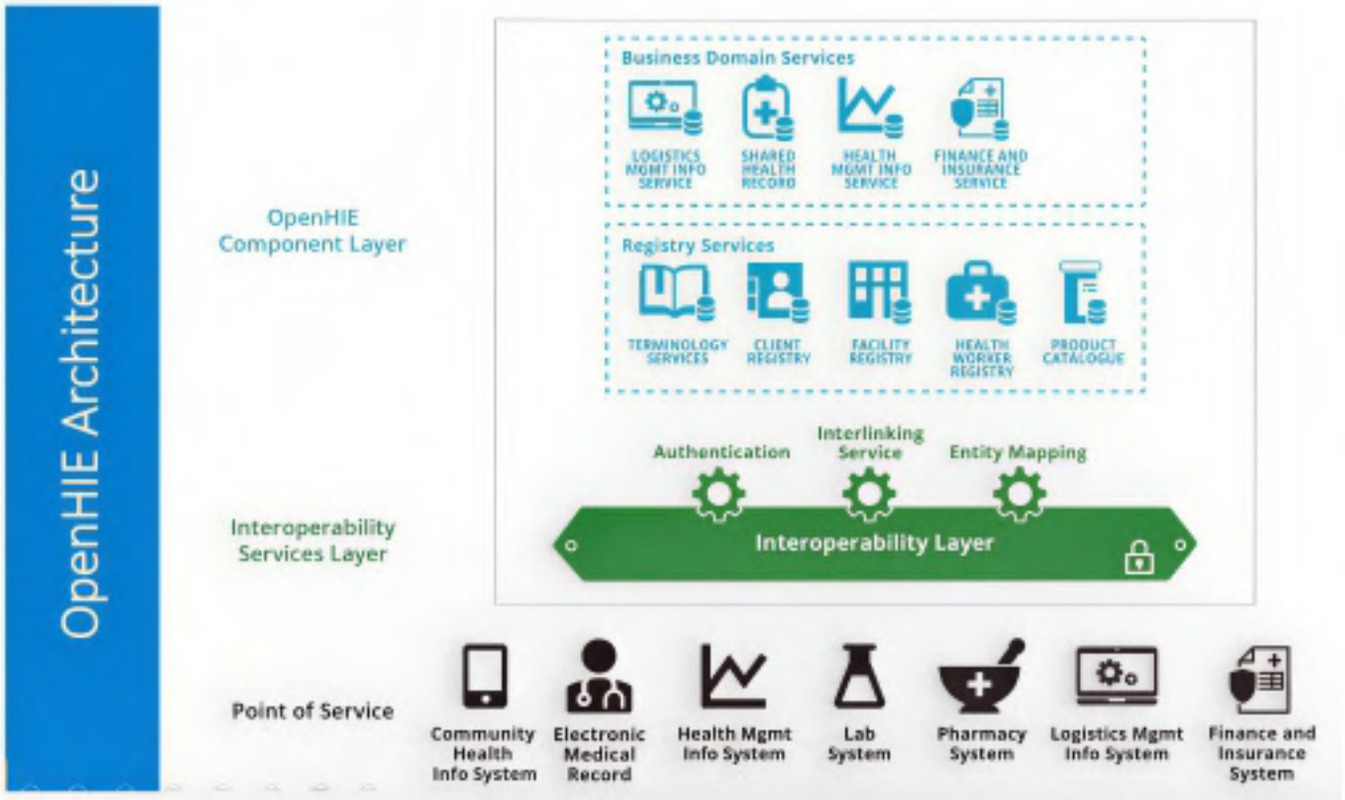
Name of the Digital Service provided
Evidence-based decision-making through analytics, DSS
Effective management of programs
AI-based predictive analytics, big data analytics
Geo-spatial data, visualization
Human Resource Management Services
Financial Management Services

Services to the Frontline Health Workers

Name of the Digital Service provided
Effective digital reporting and performance management
Digitally-enabled IEC

Annexure 2 (A)

Overview of architectures of global Digital Health Public Goods



OpenHIE Offerings

1. Organization

- OpenHIE is a community of practice dedicated to promote interoperability between health systems. Run by volunteers. Supported by a few donor organizations.(*Pl see https://ohie.org for more information*)

2. Current Offerings

- A conceptual high-level 'architecture' of Health Information Exchange (depicted in the previous slide).
- High-level functional requirements and workflows of some of the components of HIE listed below:
  - Client Registry | Facilities Registry | Health Worker Registry | Shareable Health Record | Terminology Service

3. Dependencies

- The core of HIE is the Data Exchange. This relies completely on the specifications (profiles) developed by IHE.
- IHE, in turn, is dependent on FHIR

4. Assessment of Open HIE from the perspective of Maldives DH Blueprint

- OpenHIE does not offer any applications or tools. It offers a set of requirements for a few components (and not the entire value chain of digital health). These are generic and/ or high-level. It is heavily dependent on IHE Profiles and HL7 and FHIR standards.
- ***At best, the high-level requirements given by OpenHIE can be referred to while designing DH solutions.***

Annexure 2 (B)

IHE – Integrating Health Enterprise

1. Organization

- IHE is an initiative by healthcare professionals and industry to improve the way computer systems in healthcare share information. It has a membership of over 100 organizations in the Government, non-profit, Health IT, Consulting and Standard-development.

  (*Pl see https://ihe.net for more information*)

2. Current Offerings

- The offerings of IHE are in the form of Profiles. Each profile provides an integrated view of the workflow for a specific use case. The profile also maps to FHIR Resources and PACS.
- Currently IHE has established 12 domains (given below) and developed 100+ profiles, about 60 of which are at 'trial' stage.
  - Cardiology| Dental | Device| Eye Care| Endoscopy | IT Infrastructure | Pathology and Lab Medicine | Patient Care Coordination | Pharmacy | Quality, Research and Public Health | Radiation Oncology | Radiology

3. Dependencies

- IHE profiles have been developed based on HL7. Updating w.r.t FHIT R4 is not reported.

4. Assessment of HIE from the perspective of Maldives DH Blueprint

- IHE has reported several (over 20) use cases of health institutions adopting their framework. Especially the workflows and profiles mentioned below have been used extensively:

  - Patient ID (PIX) | PPPC (consent management) | ATNA (Audit Trail) | XDS, XDS-SC, XD-Lab (cross-enterprise document sharing)

- ***The available and relevant IHE profiles may be used while developing the detailed designs of the components DH architecture***

Annexure 2 (C)

DHIS2

1. Organization

- DHIS2 platform has been developed by HISP (HIS Project) of the University of Oslo during the last 2 decades. It is supported by several Governments and International Organizations. (*Pl see https://dhis2.org for more information*)
- DHIS2 is an open-source software that can be used free and/ or customized as per local needs.

2. Current Offerings

- DHIS2 offers the DHIS2 platform, which is customizable along two broad tracks – Aggregated Data 9HMIS) and individual data (Tracker).
- DHIS2 in association with WHO has developed metadata packages for the following domains/ use cases
  - Immunization (EPI)| HIV | Malaria| TB| RMNCAH CRVS & Mortality| Covid-19 (Surveillance, Vaccination)| IDSP| Community Health Info System | Nutrition| NCDs |

3. Standards

- DHIS2 supports all major standards like FHIR, SNOMED-CT, ICD-10, LOINC and DICOM.

4. Assessment of DHIS2 from the perspective of Maldives DH Blueprint

- Over 70 countries have adopted DHIS2 to some extent, including Maldives, which has the following modules operational and a few in the pipeline

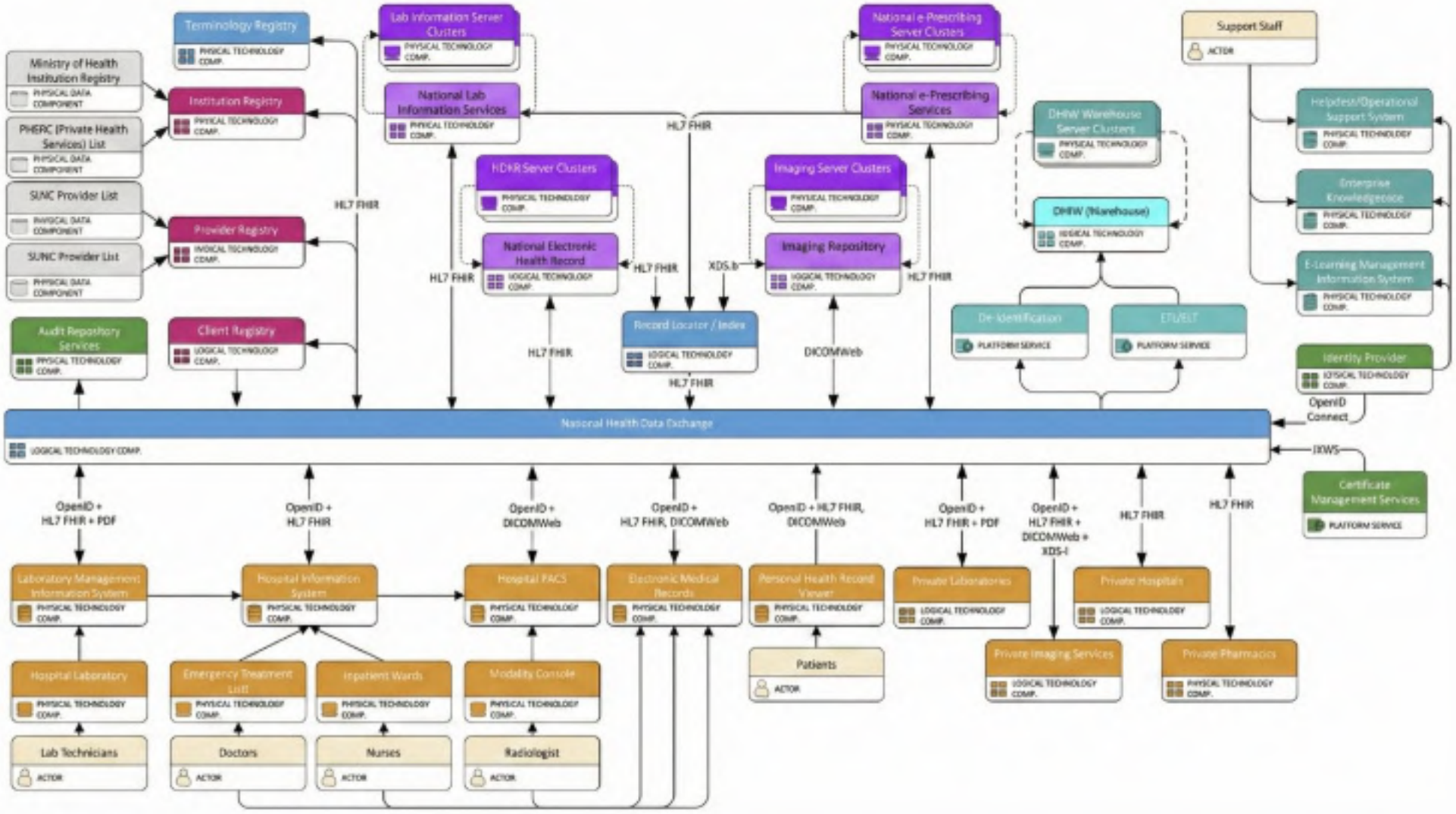
  - RHIS| Immunization| PHC| Cancer Registry | Nutrition | RMNCAH | IDSP

DHIS2 can be one of the key building blocks of DH Architecture

Annexure 3

Digital Health Architecture of Sri Lanka

The technology architecture is represented below. The Business Architecture, application architecture, and Information architectures are available in Sri Lanka's digital health blueprint.



Annexure 4

Template for assessment of legacy applications

Sl No	Criterion for assessment	Max score	Yes/ No	Score
A	**Functionality**	**20**	----	
A1	Does the application support the end-to-end functionality expected for the service?	5	----	
A2	Has the application been designed with 'enterprise' / whole-of-healthcare-sector perspective? [i.e it is not stand-alone]	5	----	
A3	Does the application provide electronic/ digital service(s) to the stakeholders?	5	----	
A4	Does the application have/ support analytics / visualization capabilities?	5	----	
B	**Performance**	**10**	----	
B1	Is the application efficient (i.e comply with a TAT comparable with the best benchmarks for the service globally?)	6	----	
B2	Is there an established system of maintenance of the application?	4	----	
C	**Process**	**20**	----	
C1	Does the system ensure avoidance/ elimination of Queues and waiting times?	5	----	
C2	Does the application eliminate the need for paper forms, reports?	5	----	
C3	Does the application adopt the principle of "ONCE ONLY" i.e enable data entered once to be used at all places/ whenever required again?	5	----	
C4	Does the application adopt privacy-protecting processes and/ or consent-based collection/ processing of personal data?	5	----	

Sl No	Criterion for assessment	Max score	Yes/ No	Score
D	**Technology**	**40**	——-	
D1	Is the application completely web-based?	5	——-	
D2	Does the system support APIs?	5	——-	
D3	Is the application built on open-source?	5	——-	
D4	Is the application secure? (i.e following laid down security policies?)	5	——-	
D5	Is the application interoperable?	5	——-	
D6	Does the application enable remote access?	5	——-	
D7	Does the system automatically validate the data entered?	5	——-	
D8	Is the UI/UX designed professionally?	5	——-	
	Total	**100**		

Annexure 5

Key components of EHR

Electronic Health Records (EHRs) are comprehensive digital systems designed to capture, store, manage, and exchange patient health information. They consist of various components that work together to support the efficient delivery of healthcare services and the management of patient data. The key components of an EHR system typically include:

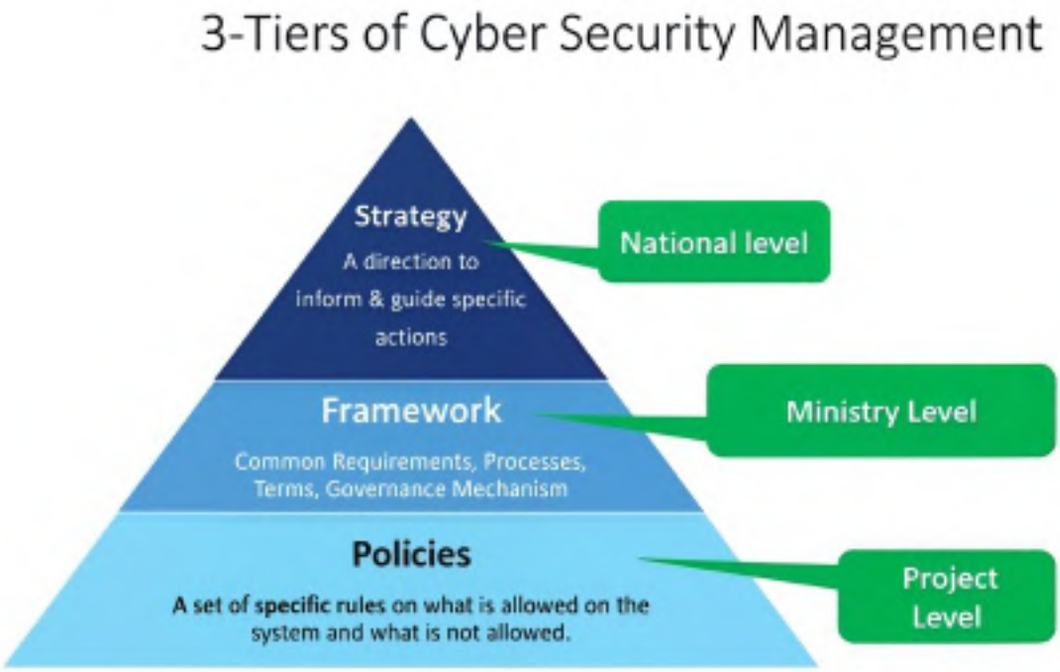
1. Patient Demographics: This component includes essential patient information, such as name, date of birth, contact details, gender, and identification numbers (e.g., medical record number or social security number).
2. Clinical Documentation: EHRs allow healthcare providers to create and manage electronic clinical documentation, including patient history, progress notes, assessments, diagnoses, treatment plans, and care coordination notes. These documents are often structured and can include free-text notes.
3. Medical History: The EHR captures the patient's medical history, including past illnesses, surgeries, allergies, medications, and immunization records. This information helps healthcare providers make informed decisions about patient care.
4. Medication Management: EHRs provide tools for medication management, including medication lists, prescribing, medication reconciliation, and drug interaction checking. They also support electronic prescribing (e-prescribing) to send prescriptions directly to pharmacies.
5. Orders and Results: Healthcare providers can create and manage orders for laboratory tests, imaging studies, medications, and other treatments within the EHR. Results of these orders are often electronically delivered back into the EHR for review and documentation.
6. Clinical Decision Support (CDS): EHRs incorporate CDS tools that assist healthcare providers in making informed decisions based on clinical guidelines, best practices, and patient-specific data. CDS can include alerts, reminders, and clinical pathways.
7. Imaging and Diagnostic Data: EHRs store and display diagnostic images (e.g., X-rays, MRIs) and other diagnostic reports. They integrate with Picture Archiving and Communication Systems (PACS) and Radiology Information Systems (RIS) for managing imaging data.
8. Laboratory Information System (LIS) Integration: EHRs interface with LIS systems to receive and manage laboratory test results and other diagnostic data. This ensures that clinical data is readily available within the EHR.
9. Vital Signs and Observations: EHRs capture and track patient vital signs (e.g., blood pressure, heart rate, temperature) and clinical observations. This data helps monitor patients' health status over time.
10. Clinical Notes and Annotations: Healthcare providers can add clinical notes and annotations to patient records, documenting important information related to patient care, treatment decisions, and progress.

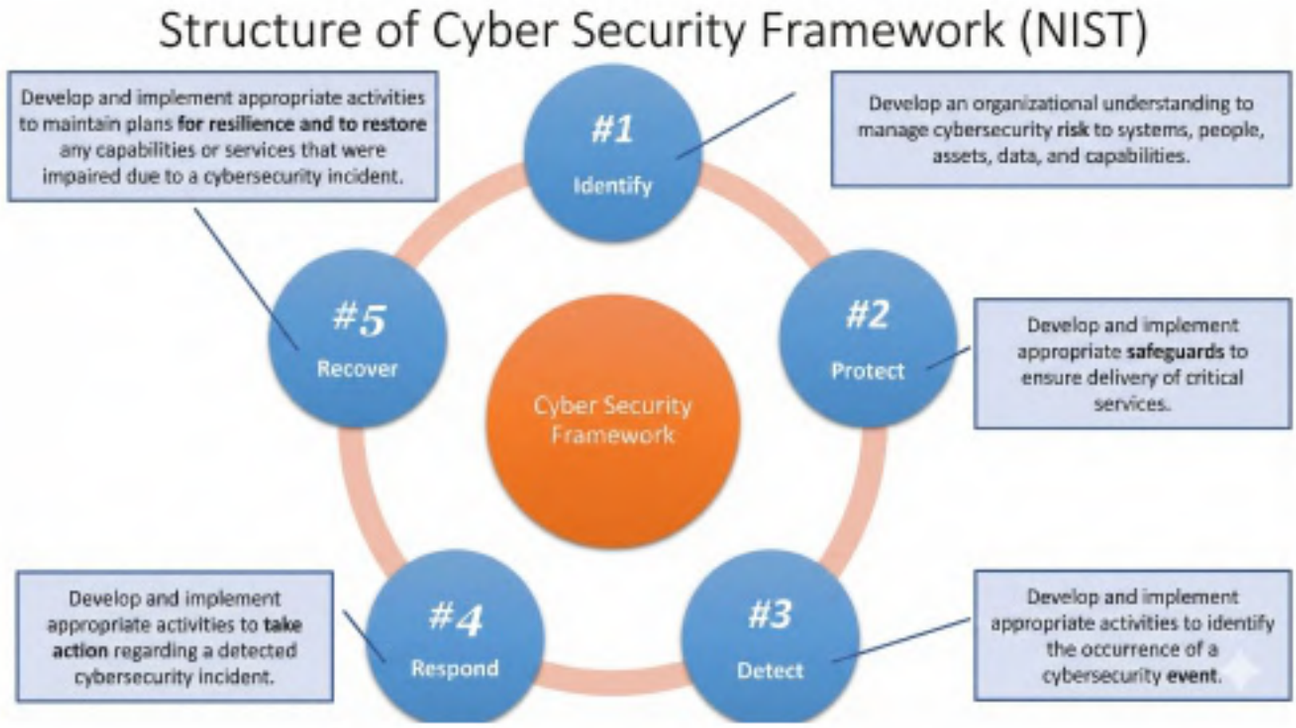
11. Patient Portal: Many EHRs include patient portals that allow patients to access their health records, schedule appointments, communicate with healthcare providers, and view test results. Patient portals enhance patient engagement and self-management.
12. Consent Management: EHRs may include features for managing patient consent, such as consent forms for treatment, research, or data sharing.
13. Audit Trail and Security: EHRs maintain audit trails to track who accessed patient records and made changes. Robust security features are essential to protect patient privacy and comply with regulations like HIPAA.
14. Interoperability Interfaces: EHRs have interfaces to enable interoperability with other healthcare systems, such as health information exchanges (HIEs), other EHRs, and third-party applications. Standards like HL7 and FHIR facilitate data exchange.
15. Administrative Functions: EHRs include administrative tools for tasks like appointment scheduling, billing, insurance claims processing, and revenue cycle management.
16. Reporting and Analytics: EHRs offer reporting and analytics capabilities to help healthcare organizations track clinical outcomes, improve quality of care, and meet regulatory reporting requirements.
17. Mobile Access: Many modern EHRs provide mobile access through apps or web interfaces, enabling healthcare providers to access patient information and perform clinical tasks on smartphones and tablets.
18. Data Backup and Disaster Recovery: Robust EHR systems have mechanisms for data backup, disaster recovery, and data protection to ensure data integrity and availability.
19. Health Information Exchange (HIE): EHRs can participate in HIE networks to securely exchange patient information with other healthcare providers and organizations for improved care coordination.
20. Customization and Configuration: EHRs often allow customization and configuration to adapt to the specific needs and workflows of healthcare organizations and specialties.

EHR systems are complex and multifaceted, designed to enhance the quality of patient care, streamline healthcare processes, and improve data accessibility and accuracy. The integration of these components enables healthcare providers to deliver more efficient and patient-centered care while maintaining comprehensive patient records.

Annexure 6

Overview of cybersecurity tiers





Annexure 7

Structure and ToR of Steering Committee and Technical Working Group

Preamble

The government of Maldives has been working towards the establishment of an integrated and interoperable digital health information system with a view to transforming the portfolio of services while ensuring equity, sustainability, and citizen-centricity. The overall vision is to enable the country to move faster towards achieving universal health coverage and the Sustainable Development Goals. Several initiatives have been implemented in this direction. These include Aasandha Vinavi Portal, the Electronic Immunization Registry, and multiple hospital information systems. A critical analysis of the existing initiatives has revealed several shortcomings, including a lack of interoperability, provider-centric designs as against person-centric designs, and a system approach as against an enterprise or ecosystem approach.

Experiences of other countries indicate the need to design a Maldives Digital Health Blueprint (MDHB) that adopts a holistic approach to address the requirements of human, technological, and financial resources and, above all, supports the development of an interoperable digital health ecosystem. To this end, the government considers it expedient to constitute a steering committee and a working group with specific responsibilities and timelines to design MDHB, which shall also consist of a specific, implementable, and time-bound action plan for realizing the goals. The composition and terms of reference of the steering committee and the working group are specified below.

Steering committee on MDHB Composition:

The Steering Committee shall consist of the following:

- Senior representative from MoHFW (Chair)
- Representative from the division / department at MoHFW responsible for implementation of MDHB (Vice Chair).
- Digital Transformation Strategist / Chief Technology Officer / Senior Representative from President's Office
- Representatives from MCGH
- Representatives from NSPA
- Representatives from MDS
- Representatives from Aasandha Company Limited
- Technical partners supporting MDHB implementation
- Representatives from agency responsible for supply of medicine and medical equipment
- Representatives from WHO
- Other technical experts and stakeholders as determined by the Steering Committee.

The terms of reference of the steering committee are specified below:

1. To define the Vision of MDHB
2. To set the direction for the Working Group and guide itsfunctioning
3. To specify the national priorities of the health systems and digital health
4. To coordinate with the stakeholders of the health ecosystem, external to the Ministry
5. To review and approve the report and recommendations of the Working Group on MDHB
6. To conduct a public consultation on MDHB in its draft form, eliciting comments, incorporate the acceptable suggestion, and notify MDHB in its final form.
7. To recommend to the government a framework for implementation of the MDHB, including the requirements of budget, human resources, infrastructure, capacity building, and policy and technology enablers to be put in place.

The Steering Committee may meet once every 6 weeks or more often as required.

Working Group on MDHB Composition:

The membership and composition of the Technical Working Group may be reviewed and amended from time to time based on the needs of implementation and decisions of the Steering Committee.

Technical Working Group composition:

1. Representative from the department/ division of MoHFW responsible for implementation of the MDHB (Chair)
2. Technical partners supporting MDHB implementation
3. Representative from MCGH
4. Representative from Aasandha
5. Representative from NSPA
6. Representative IT Division, MoHFW
7. Representative from the section/division responsible for health information management and health statistics at MoHFW
8. Representatives from agency responsible for supply of medicine and medical equipment
9. Representative from World Health Organization (WHO)
10. Other technical experts and stakeholders as determined by the Steering Committee.

The Terms of Reference of the Technical Working Group are specified below:

1. To define the Scope and Principles of MDHB
2. To identify and define the prioritized list of digital health services to be targeted by MDHB
3. To undertake a landscape analysis of the digital health in Maldives, leveraging the studies already done.
4. To envision the Future State of digital health ecosystem in Maldives
5. To design the architecture of the Digital Health Ecosystem of Maldives (DHEM), which may include the following components:

    a. High-level architecture of health enterprise.
    b. Building blocks of MDHB.
    c. Structure of the Core Registries, including Registry of Health Professionals and Registry of Health Facilities.
    d. Structure of National Health ID.

6. To identify and specify the technology standard sand health-sector standards required to be adapted and adopted to support MDHB.

7. To define the principles, framework, and specifications for interoperability of digital health systems.

8. To define the principles, framework, and specifications for interoperability of digital health systems.
    a. Health data management, protection and sharing
    b. Public-Private Partnership in implementing digital health
    c. Procurement
9. To suggest appropriate institutional framework for implementing MNDHB including the following components:
    a. Legal structure
    b. Organizational structure
    c. Methods of sourcing human resources, including technicalresources
    d. Capacity building on digital health at the national and institutional level
    e. Monitoring and evaluation framework
10. To prepare an implementable, time-bound Action Plan, refer to word document
11. To prepare an estimate of financial requirements for implementing MDHB.

The working group may meet once every 2 weeks or more often as required.

The Working Group may constitute sub-groups as required to conduct detailed studies and come up with specific artifacts on distinct aspects of MDHB.

The Working Group may report the progress periodically to the Steering Committee.