Assessment of Health Information Systems

Project Number: 51141-002
September 2018

Bhutan: Health Sector Development Program

CONTENTS

ABBREVIATIONS

BHU	–	basic health unit
DHIS2	–	District Health Information System Version 2
DITT	–	Department of Information Technology and Telecom
DrukREN	–	National Research and Education Network
e-PIS	–	Electronic Patient Information System
HIS	–	health information system
HMIS	–	health management information system
ICT	–	information and communication technology
JDWNRH	–	Jigme Dorji Wangchuk National Referral Hospital
MOH	–	Ministry of Health
NEWARS	–	National Early Warning, Alert and Response Surevillance
OpenMRS	–	Open Medical Record Systems
RCDC	–	Royal Center for Disease Control
SMS	–	short messaging system

NOTES

In this report, “$” refers to United States dollar.

A. Background

1. The Ministry of Health (MOH) and Government of Bhutan has embarked on a digital transformation with the intent to provide cost-effective health services to its citizens. It envisions the provision of safe and secure health care supported by a responsive, real-time health information system (HIS) for personal care, program management, and public health.

2. Through the years, the MOH has accumulated e-Health applications in varying degrees of implementation. These include but are not limited to the (i) National Early Warning, Alert and Response Surveillance (NEWARS), (ii) Electronic Patient Information System (e-PIS), (iii) District Health Information System Version 2 (DHIS2), (iv) Electronic Bhutan Medical Supply Inventory System, (v) blood donation application, and (vi) Laboratory Information System. Each system has a separate business owner and are currently not connected to each other, so it is not yet possible to share data captured from one system and pass it on to another. For example, a communicable disease report in NEWARS will be stored in the server of the Royal Center for Disease Control (RCDC) but will not be automatically shared to the DHIS2—the national health management information system (HMIS). For its 12th 5-year plan, it is the desire of the MOH to create a comprehensive national HIS that ensure continuity of care given to a patient while rationalizing the costs.

B. Overview

3. There are several eHealth applications now being used by different departments of the MOH in varying degrees of implementation. These applications are owned and managed by specific departments and do not have the same governance structure. Among the major systems elicited were the following:

(i) Designated to be the official health statistics reporting platform, the DHIS2 is being managed by the Information and Communications Technology Management Department with support from external consultants. It is a web-based system with an accompanying mobile application. While the whole platform has been set up and the whole country has been trained, its current problems are the poor connectivity in the more remote areas of the country and persistent poor data quality.

(ii) NEWARS is a product of the RCDC and employs a combined web-based and short messaging system (SMS) approach to reporting weekly, immediate, and event-based reporting. It is used in all patient care facilities.

(iii) The e-PIS is a pilot program to test the use of an electronic medical record and hospital information system in select districts of Bhutan.

(iv) The Laboratory Information System is a proprietary software initially donated by external parties. These systems run standalone in hospital laboratories and do not transmit data outside of the hospital.

(v) The Blood Donation Program is a mobile application that collects the number of blood types available in all health facilities in the country.

(vi) The Electronic Bhutan Medical Supply Inventory System is to ensure timely procurement, distribution, and delivery of medical supplies throughout the country, and when required reallocation of supplies as per requirement.

(vii) Health Help Center accepts calls from patients and health workers, and provide coordination and assistance.

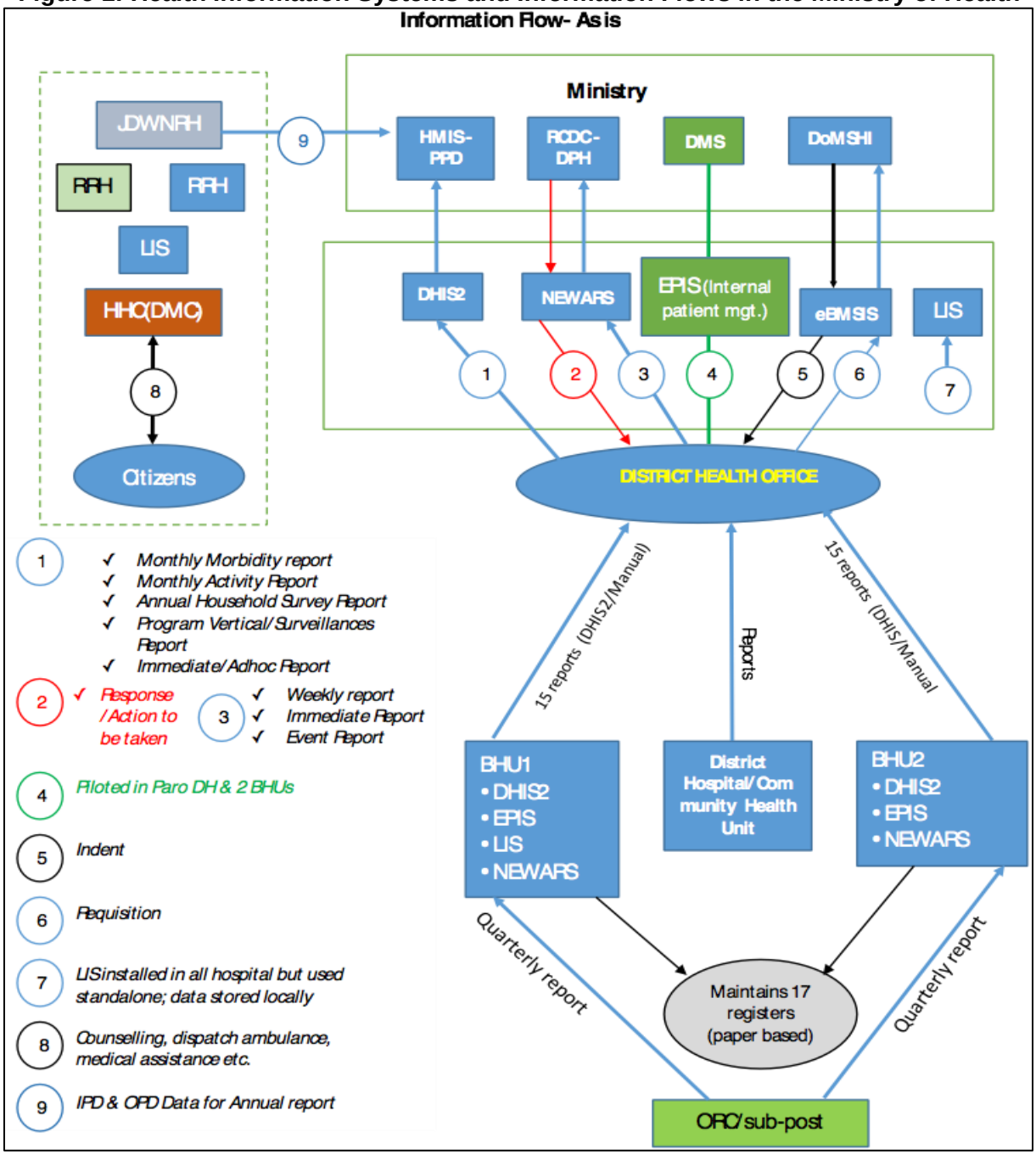
4. These systems lack a common enterprise architecture and interface to each other, and the resulting state of information systems in the MOH becomes fragmented as a matter of consequence. Information systems are created for these narrow, specialized purposes but without an interoperability framework, these special information systems contribute to worsening separation of the vertical programs. In summary, there is weak governance of the national HIS and common architecture to show how different applications can share data. Program management is also weak to coordinate the fragmented e-Health projects, and there are no common standards that all applications can use for interoperability and sharing data.

C. Analysis of Current Information Systems

5. Many countries have taken up digital solutions for health in the past decade, leading to digital health applications that address individual health programs but resulting in fragmented HIS that greatly undermines sector management efficiency. Such systems are not client or user-oriented, as often data must be collected multiple times in a redundant manner, and data about clients or services in different systems often do not match. Such fragmentation in the HIS duplicate resources and are not cost effective. To address this situation, countries should consider the HIS 'interoperability,' which is the extent to which various HIS and devices can exchange data, interpret data, and display data in a user-friendly way. The principles of interoperability are: (i) data should only be entered once and should be available for multiple purposes, (ii) consistent rules need to apply across different technical domains, and (iii) a single set of data elements need to be clearly defined and agreed as the building blocks. While there will be several information systems, it is critical to achieve interoperability across various systems.

6. Bhutan has nine key HIS with varying coverage, some of which are redundant, and all are serving individual program needs. Information from the health facility level ends up in different departments/divisions at the MOH level, making it difficult to create an integrated repository or data warehouse, which could be used for generating the required national level reports and indicators. The key information systems in Bhutan—NEWARS, DHIS2, and e-PIS—currently cannot share data electronically which leads to lot of manual work, duplication, and consequently the potential for data quality problems. Another serious limitation in the current HIS is the lack of computerization at the Jigme Dorji Wangchuk National Referral Hospital (JDWNRH) and that the JDWNRH data is not reflected in the Annual Health Statistics. Given that the JDWNRH is catering to nearly 60%–70% of the health care workload in the country, this reflects a serious gap. The different information systems in Bhutan are illustrated in Figure 1 below.

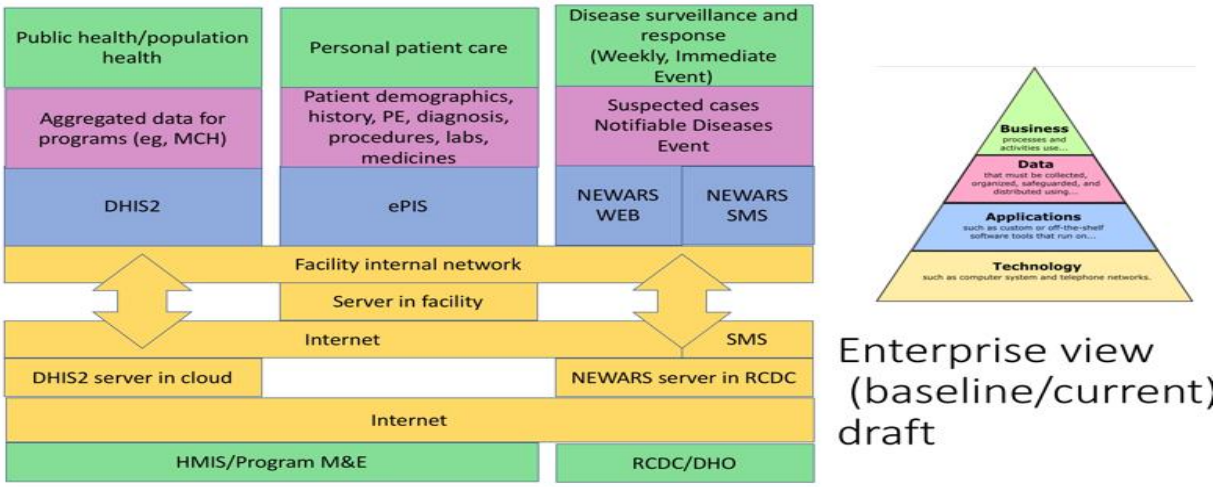
Figure 1: Health Information Systems and Information Flows in the Ministry of Health



Source: Government of Bhutan, Ministry of Health. Thimphu.

7. **Enterprise architecture.** The baseline architecture shows that there are gaps and overlaps at the data, application, and technology layers. There is no data integration component in the baseline (Figure 2). An interoperable target architecture would require the creation of data standards, data management capability, and integration of different e-Health applications as modules inside the target system.

Figure 2: Baseline Enterprise Architecture Flows in the Ministry of Health



Source: Government of Bhutan, Ministry of Health. Thimphu.

1. Strengths and Weaknesses of Key Systems

8. The strengths and weaknesses of the three key HIS (DHIS2, e-PIS, NEWARS) are examined below:

a. District Health Information System Version 2

9. The DHIS2 is an open source platform which hosts the Bhutan HMIS. It has improved rapidly over the years from handwritten data collection/compilation in 1984 to the web-based DHIS2 at present. The DHIS2 enables each district health office to generate information using various data elements. At the national level, the aggregate data are used to track indicators for monitoring progress of various programs. Based on this information, an Annual Health Bulletin is published by the Health Information and Management System Unit. The system is managed by the HMIS unit of the Policy Planning Division at the MOH and its staff are responsible to train district-level teams. The DHIS2 went online in 2014.

10. **Design considerations.** The DHIS2 is designed to serve as a data warehouse with inbuilt functionalities which allows it to import data from different sources and store it in a uniform format in both online and offline environments. The DHIS2 has dashboards with an inbuilt geographical information systems module which creates graphs, charts, tables, and maps which strengthens the ability to make evidence-based decisions. The DHIS2 can provide both case-based tracking and aggregate reporting but it is not a medical records system, such as the Open Medical Record Systems (OpenMRS), and it cannot link the various activities of a health facility (registration, outpatient department, inpatient department, drugs dispensing) to a unique patient ID. The DHIS2 could interoperate with a medical records system and data from individual patient encounters could be aggregated and shared with the DHIS2, which can then be used to generate disease specific reports or hospital quality of care indicators, such as average length of stay in the facility. The DHIS2 started in 1996 and has been adopted in more than 60 low- and middle-income countries. It is an open source platform and there are no license constraints.

b. National Early Warning, Alert and Response Surveillance

11. NEWARS has been running for the last 2 years, with three core processes performed at the facility level: weekly report (24 cases with codes), immediate report (16 cases with codes), and event report (ad hoc). These reports may be submitted online via NEWARS website or via SMS. It is the facility's most senior staff who submits weekly report, immediate report, or event report every Monday using web or SMS. The district health officer uses the web application to view reports for their district while the RCDC curates the reports for data quality. At the facility level, health workers still maintain individual paper records for the cases they see and then spend inordinate amount of time collating them into the RCDC weekly format. This tedious process has posed a challenge with timeliness and accuracy.

12. **Design considerations.** NEWARS is designed to support disease surveillance activities by notifying diseases, triggering response actions, and enabling visualizations through dashboards. It has not been designed as a data warehouse with the capability to accept data from different sources. NEWARS is being used by all the basic health unit level 1 (BHU-Is) and district hospitals in the country. Good technical documentation of the system is needed to further develop the system as now the system is dependent upon the knowledge of one worker.

c. Electronic Patient Information System

13. The MOH is currently working on development and introduction of the e-PIS in the country. This system is being piloted in four facilities in Paro district (three BHU-Is and one district hospital). The e-PIS is a health program as well as software, and the software is based on OpenMRS platform. The pilot generates outpatient department registration for patients with diabetes and hypertension at the BHU-I and data for mortality and morbidity, including consultations, laboratory, and prescriptions at the district hospital. There are shortfalls with the current pilot including a shortage of computers, and outpatient department data is only being entered for every fifth patient and the interface is not considered user- friendly. It is managed by the Department of Medical Services at the MOH. The roll-out of the e-PIS is expected to be funded as a flagship program under the 12th 5-year plan.

14. **Design considerations.** OpenMRS is a global standard software platform for electronic medical records and can support the development of various patient-based systems, such as integrated hospital information systems, disease registries for HIV and tuberculosis, and outpatient department clinics where patient-based details are required. It is not designed to support aggregate reporting, along a hierarchy of different reporting units, for example, across BHUs, district hospitals, and national and regional referral hospitals. It is also not designed as a data warehouse and cannot accept data from different kinds of systems, but OpenMRS has established features to support interoperability linkages with other databases such as with the DHIS2. OpenMRS has been operating for 15 years in several different countries. It is a web-based open source platform and once it is designed, any changes do not require the input of specialist programmers.

2. Governance, Management, and Human Resources

15. **Governance.** All policies, regulations, and information technology personnel in the government belong to the Department of Information Technology and Telecom (DITT) at the Ministry of Information and Communication. The e-Government standards are being developed by the DITT, including the Bhutan Core Health Standards to enable agencies to better share data

with other government systems. The DITT is also setting up a system of unique IDs and building an exchange layer for data.

16. **Management.** The government data center is managed by the DITT which provides data center services including hosting data recovery sites. Except for NEWARS, all other HIS of the MOH are hosted in the government data centre. Operation and system maintenance, including data backup, is the responsibility of the MOH, while the space, physical security, power supply, and so on is taken care of by the DITT.

17. **Human resources.** There are 11 people in the MOH who are DITT staff and support different HIS. The current capacity is largely information technology-oriented, focused on supporting the technical infrastructure. The implementation of the e-Health strategy will need to be supported by a variety of different skills and capabilities, including public health professionals, program managers, data analysts, core software professionals, and system configuration specialists. These skills can be found by developing a network of professionals such as university departments of computer science and public health, global communities, such as of open source software developers, private organizations, in addition to build in-house capacities of the MOH and DITT staff.

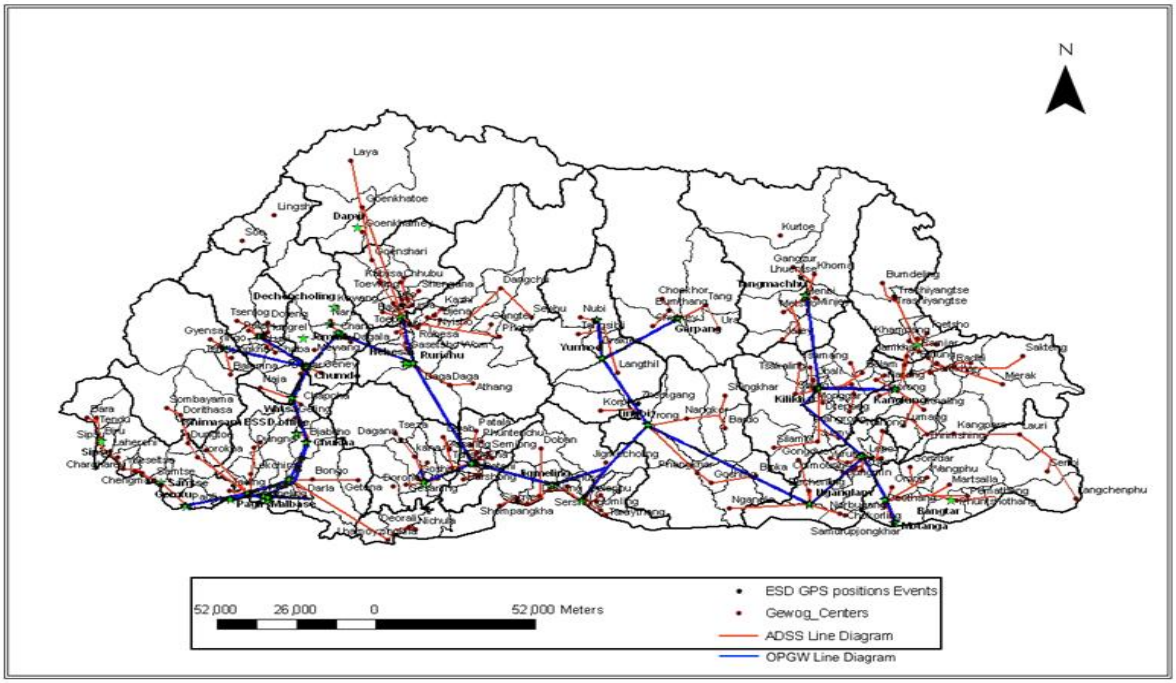
1. Infrastructure

18. **Internet and mobile phone connectivity.** Significant work has been done by the DITT to establish a nationwide infrastructure for internet connectivity. Coverage has already been established to the Gewog level with the DITT providing a fiber optic network to 199 Gewogs (in 18 districts) from where lines can be extended to government offices (Figure 2). The remaining two districts have All Dielectric Self-Supporting fiber connectivity down to the Gewog level. The fibers are owned by the government and are strung on the Bhutan Power Cooperation transmission towers and distribution poles who are responsible for maintenance. It is estimated that it would cost $500,000 to connect all the BHU-Is in the country to the DITT fiber optic network.

19. The DITT has also established a government intranet covering 20 districts and 166 community centers. This intranet connects most of the government agencies, including the JDWNRH and MOH. Bhutan's National Research and Education Network (DrukREN) connects universities, colleges and hospitals using a national broadband network and to date, the number of health facilities that are connected to DrukREN include three major hospitals (the national and two regional referral hospitals), 10 district hospitals,[1] and a BHU-I in Kanglung, Trashigang. Mobile services using 2G technology cover 90% of the country and this could be an option for BHU-II health facilities that cannot be connected to the DITT or DrukREN networks. The overview of the network at the national level is given in Figure 3. As the e-Health strategy is implemented, it will be important to promote the use of existing infrastructure. This applies not only to network infrastructure but to hosting servers and data exchange platforms.

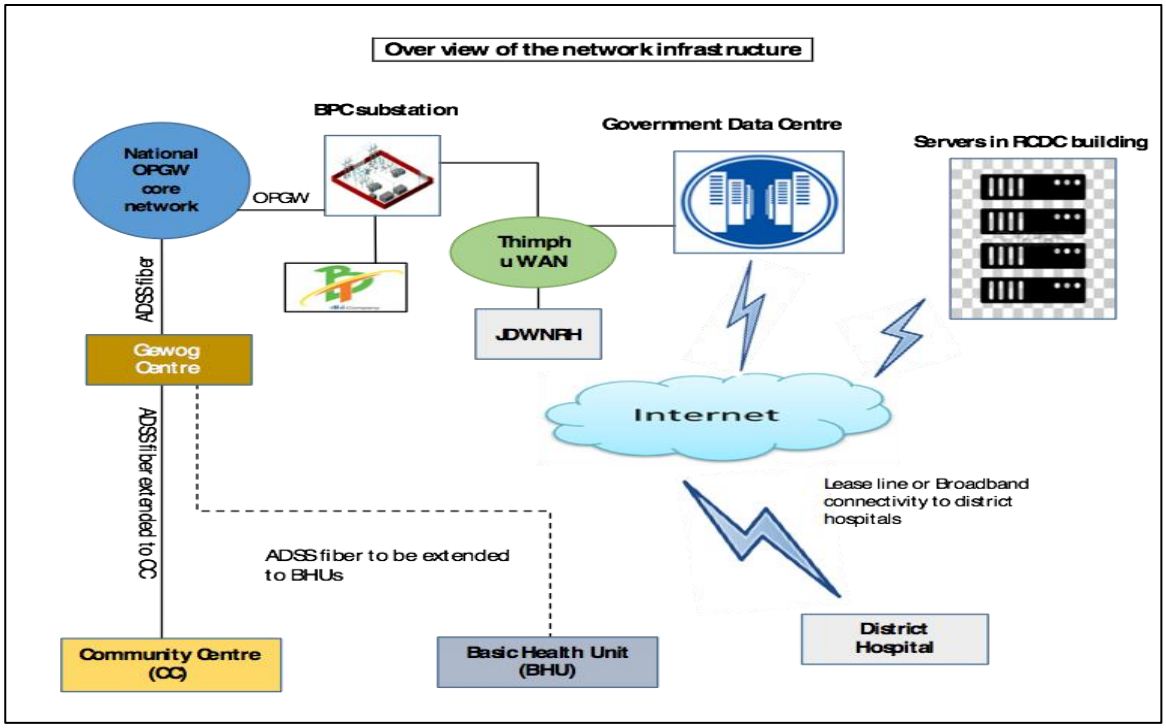
[1] Phuentsholing, Gedu, Paro, Trongsa, Bumthang, Monggar (RRH), Pema Gatshel, Samdrup Jongkhar, Punakha, Thimphu (JDWNRH), and Gelephu (RRH).

Figure 3: National Broadband Network



Source: Government of Bhutan, Ministry of Information and Communication. Thimphu.

Figure 4: Overview of the Network Infrastructure



Source: Government of Bhutan, Ministry of Information and Communication. Thimphu.

D. Government Strategy and Implementation Plan

20. The Government of Bhutan has accorded high priority to information and communication technology (ICT). To continue funding free basic public health care, the MOH recognizes the value of ICT to curb wastages and deliver care more efficiently, while also fulfilling the aspirations of a more informed population in providing quality health care service. As such, the government is in process of developing the eHealth Strategy and Action Plan, in line with the overall objectives and program of the 12th 5-year plan and with the e-Gov policy of the Ministry of Information and Communications. The mission of the e-health strategy s stated as follows:

> *«By 2023 eHealth solutions are used to support the provision of better health in communities, provide better person-based care to individuals, empower healthcare providers with their use of technology, and enable the exchange of individual and aggregate data to help health managers take better informed decisions.»*

21. Implementation of the e-health strategy is incorporated in 12th 5-year plan. The e-health implementation plan includes four core areas: (i) e-Health governance arrangements to guide the development of the strategy and ensure there is an agreed process for developing an e-Health architecture, and ensure that the necessary investment, legislation, policy, and compliance mechanisms are in place; (ii) focus on improvements in infrastructure at health facilities and the networks to connect them and in technical foundations such as agreed standards that enable better interoperability of systems; (iii) selectively improve the current systems, ICT services, and applications where significant impact can be made in Years 1 and 2 (because the systems are not complex, expensive or require legislation); and (iv) prepare the workforce for use of ICT which involves developing ICT literacy among the health workforce and behavior change.

22. The government's overall financing for strengthening of the HIS in the 12th 5-year plan is projected to be $17 million. The amount will cover government spending in areas such as infrastructure, services and applications, standards and interoperability, and e-health workforce capacity building to establish interoperable structure for more efficient and quality delivery of health services. Breakdown of estimated program cost by e-health component is in Table 1. Broad implementation timeline is in Table 2. The action plan proposes an architecture (Figure 5) with the DHIS2 as the national data warehouse for linking data from multiple data sources.

Table 1: Bhutan e-Health Action Plan Costing Summary

	eHealth components	2018	2019	2020	2021	2022	2023	Total (USD)
	1. Leadership & Governance	$8,281	$27,645	$44,155	$22,353	$552	$552	$103,538
	2. Strategy & Investment	$28,400	$29,012	$29,012	$29,012	$29,012	$29,012	$173,459
	3. Infrastructure	$129,266	$538,291	$512,438	$451,706	$451,706	$451,706	$2,535,114
	4. Standards & Interoperability	$1,829	$239,364	$197,145	$84,864	$16,323	$16,323	$555,849
	5. Services and Applications	$1,273,296	$1,811,296	$1,802,585	$1,802,585	$1,786,351	$1,786,351	$10,262,464
	6. Legislation, Policy & Compliance	$0	$151,809	$151,809	$128,982	$122,639	$122,639	$677,877
	7. Workforce	$44,276	$181,854	$173,337	$172,387	$123,789	$99,491	$795,134
	Annual Total (USD)	**$1,485,348**	**$2,979,271**	**$2,910,481**	**$2,691,890**	**$2,530,372**	**$2,506,073**	**$15,103,435**
Risk factor								
15%	Adjustment for risks and uncertainty	$222,802	$446,891	$436,572	$403,784	$379,556	$375,911	
	Annual Total Adjusted Cost (USD)	$1,708,150	$3,426,161	$3,347,053	$3,095,674	$2,909,928	$2,881,984	**$17,368,950**

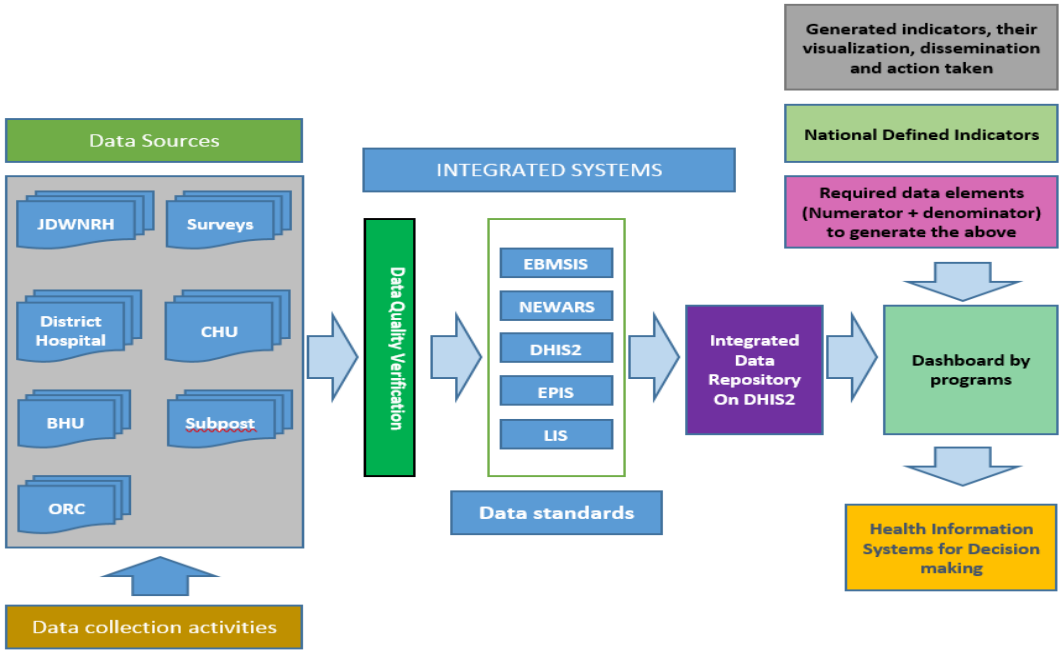
Source: Government of Bhutan.

Table 2: Implementation Timeline

2018–2019	eHealth Strategy Endorsed, Secure Budget, Form Governance & Team
2019–2020	ePIS Roll out, Interoperability of ePIS/LIS/PACS
2020–2021	Interoperability of ePIS/NEWARS/DHIS2
2021–2022	Interoperability of ePIS/DHIS2/eBMSIS/BTS
2023–2024	Interoperability of ePIS/DHIS2/HERCS
2024–2025	Interoperability of ePIS/DHIS2/CSIS/PEMS/
2025–2026	Interoperability of ePIS/DHIS2/Others

Source: Government of Bhutan.

Figure 5: Proposed Target Architecture



BHU = basic health unit, CHU = community health unit, JDWNRH = Jigme Dorji Wangchuk National Referral Hospital, ORC = out reach clinic.
Source: Asian Development Bank.