Master Thesis

Towards an Integrated Health Management Information System in Pakistan

A situational analysis

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Abstract

An integrated health management information system (HMIS) involves a series of streamlined information processes i.e., data generation, compilation, analysis and synthesis, and communication and use; where data is compiled from different sources and is transferred to an integrated data repository to generate reliable information for the decision-makers. Available literature shows many countries face a set of socio-political, administrative, economical and institutional challenges related to the implementation of integrated health management information system. This qualitative thesis explores the challenges in developing and implementing an integrated HMIS as a strategic resource for HIV, TB (Tuberculosis) and Malaria using District health information system (DHIS) in a lower-middle income country i.e., Pakistan. It also investigates the opportunities available to establish such a system and provides recommendations for the decision makers to tackle the challenges. This study employs the protocol of a case study that involved both primary and secondary data collection through semi-structured interviews with the key stakeholders, and document analysis of the relevant documents and observations through field visits.

The findings include a number of key challenges across three levels of interoperability i.e., syntactic, semantic and organisational. At the syntactic level, the barriers include non-uniform data standards, unorganised or muddled data and data duplication. The semantic level illustrates challenges such as fragmentation, nonexistence of any data exchange or data sharing protocol and data incompleteness and poor quality. The barriers observed at the organisational level include lack of a national regulatory authority, lack of e-health informatics competence hub, organisational uncertainty and unrealistic policies, the issue of capacity building and prolonged power and internet outages. In terms of opportunities, it was informed that reporting has improved from a significant number of facilities, staff and users are supportive of the integration design, and there are available vacancies for researchers and epidemiologists. The HMIS of Pakistan needs to work on the semantic and organisational level. There is a strong need to standardise data collection and use of common standards across systems and programs at all three levels i.e. at syntactic, semantic and organisational level. The creation of a regulatory body that can work on harmonising and regulating the standards and coding schemes among the various health systems, would be an effective step towards gaining integration in HMISs. Since Pakistan shares its health situation with many LMICs, there is a need for an international collaborative effort to standardise the health information collection, management, sharing, and reduce fragmentation to enhance public health data quality.

Acknowledgements

I am thankful to many people. First and foremost, my supervisor Sandeep Sahay. His timely guidance helped me in every step of my research and thesis writing. He steered me in the right direction by providing me with his valuable feedback and insightful comments.

Secondly, I would like to extend my appreciation to my colleagues and friends who helped me with my fieldwork in Pakistan especially in reaching out to the remote areas of Punjab and coordinating the interviews.

Finally, I must express my very profound gratitude to my parents and to my wife for providing me with unfailing support and continuous encouragement throughout my study and through the process of researching and writing this thesis.

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Abbreviations

BHU	Basic Health Unit
CMU	Central medical unit
CNIC	Computerized national identity card
DEWS	Disease Early Warning System
DHIS	District health information system
DMIS	District management information system
DRAP	Drug Regulatory Authority of Pakistan
EPI	Expanded Programme on Immunization
GF	Global fund
HIS	Health information systems
HISP	Health Information System Programme
HIT	Health information technology
HMN	Health Metrics Network
HMN	Health Metrics Network
HPSIU	Health Planning, System Strengthening & Information Analysis Unit
ICD	International Classification of Diseases
IHIA	Integrated Health Information Architecture
JICA	Japan International Cooperation Agency
LHW	Lady Health Workers
LMIS	Logistic management information system
LQAS	Lot Quality Assurance Sampling
M&E	Monitoring and Evaluation
MNCH	Maternal, New-born and Child Health
NACP	National AIDS Control Programme
NATPOW	National Trust for Population Welfare
NHSR&C	National Health Services, Regulations and Coordination

NHV	National Health Vision
NIH	National Institute of Health
PIMS	Pakistan Institute of Medical Services
SDG	Sustainable Development Goals
TB	Tuberculosis
VCCT	Voluntary Confidential Counselling and Testing
WEF	World Economic Forum
WHO	World Health Organisation
WMIS	Warehouse management information system

1. Introduction

1.1 An overview

This thesis, based on a qualitative analysis, explores the challenges in developing and implementing an integrated health management information system (HMIS) as a strategic resource for HIV, TB (Tuberculosis) and Malaria using the District Health Information System (DHIS) platform in a lower-middle income (LMIC) country i.e., Pakistan. It also looks into the opportunities available to establish such a system and provides recommendations, at the policy level, for the decision makers to tackle the challenges of integration.

This introductory chapter constitutes the motivation behind the study, a brief description of the context of the study and a section that entails the organization of the entire thesis.

1.2 Motivation

1.2.1 Theoretical motivation

Integrated health information architecture

The theoretical background of my thesis comes from the available literature on HMIS and their intricacies in the developing world. Although many countries in the world have developed an integrated HMIS and several are on the road to develop such a system, the situation is unsatisfactory and at times not up to the mark in majority of the LMICs. Fragmentation is a rampant problem in these countries. I have explained the theoretical framework of this study in more detail in the next chapter. To briefly describe the framework which helped me to analyse my empirical findings, I will start with Braa and Sahay, who describe an Integrated Health Information Architecture (IHIA) as a base for a good HMIS design (Braa & Sahay, 2012). To construct an IHIA, a data warehouse is key, and an approach to its development requires a database that gathers and manages information from different sources and executes it for analysis and dissemination of data to relevant stakeholders. The DHIS2 is an example of such a warehouse. DHIS2 is a platform developed by Department of Informatics (IFI), University of Oslo (UiO) in collaboration with the Health Information System Programme (HISP), which is a research and development initiative of UiO ongoing over two decades. This platform is designed as a one-stop solution for all the multi-faceted

entities of a HMIS and includes the collection, analysis and reporting of data for all the health programs. It is described as:

> *"a software application for collection, validation, analysis, and presentation of aggregate statistical data; tailored (but not limited) to integrated health information management activities. (Braa & Sahay, 2012, pg. 23)"*

The DHIS2 is an open source software and has been implemented in more than 40 countries (DHIS2 User guide, 2016) at various levels and for different applications around the world, particularly those which are resource constrained. Braa and Sahay in their book, illustrate the close relationship between the development of the enterprise architecture and the DHIS as a data warehouse (Braa & Sahay, 2012). According to them, the solution to fragmentation in most LMICs is to develop an integrated HMIS design, entitled 'enterprise architecture or IHIA'. Such a design stresses on information usage across the various enterprises and systems for management. This strategy turns into a common theme with different entities comprising the health system (Braa & Sahay, 2012).

Next, it is essential to understand the types of data sources in an IHIA. The Health Metrics Network (HMN), under the World Health Organisation (WHO), classified the types of data sources for the data warehouse as 'health services-based data sources', which includes data on individuals, resources, service records, and 'population-based data sources', which includes census data, civil registration and population surveys. However, due to the ever-evolving nature of technology and the fact that there would be many warehouses in a country with various data sources, and uncertainty being a confounding factor, an incremental growth of the IHIA is recommended rather than an explosive one, illustrated as "big bang" in their book (Braa & Sahay, 2012).

Integrated HMIS and improved public health

In the last two decades, establishment of a robust health system that provides valid health information has become imperative for the governments to plan and administer successful healthcare services in their countries. A solid HMIS system plays a vital role in supporting health decision-making and health monitoring processes as it provides information on public health services, their delivery, utilization and gaps in coverage. According to the report on framework and standards for a country HMIS by HMN and WHO, HMIS produces "relevant information that health system stakeholders can use for making transparent and evidence-based decisions for health system interventions" (Health Metrics Network &

World Health Organization, 2008). Such a system can become a strong source of valid and timely health data that helps the decision-makers to act when needed, ultimately improving the general health and well-being of the public. Strengthening HMIS is crucial for all countries worldwide, however, many LMICs are struggling to establish and strengthen their systems and face technical and institutional challenges in doing so (Health Metrics Network & World Health Organization, 2008).

It is in LMICs where a strong HMIS has the highest potential to make the greatest difference in strengthening health systems. A key element of such a system is a strong overall health system and a robust public health data collection system (Health Metrics Network & World Health Organization, 2008). The compiled data through such an effective HMIS are used for different purposes at patient, health facility, population and public levels of the health system. Globally, the importance of HMIS in generating timely and reliable information is increasing. However, many countries have failed to produce quality health data due to several bottlenecks of which fragmentation of HMIS is a key barrier. Hence, countries are looking to implement an integrated HMIS approach to improve the overall performance of their health services (Health Metrics Network & World Health Organization, 2008; Petrich, L. Ramamurthy, Hendrie, & Robinson, 2013).

An integrated HMIS involves a series of streamlined information processes i.e., data generation, compilation, analysis and synthesis, and communication and use; where data is compiled from different sources and is transferred to an integrated data repository to generate reliable information for decision-makers across different domains and administrative levels (Health Metrics Network & World Health Organization, 2008). Available literature shows that many countries face a set of socio-political, administrative, economical, technical and institutional challenges related to the implementation of an integrated HMIS (Health Metrics Network & World Health Organization, 2008; Nishtar et al., 2013; Nyella, 2009; Petrich et al., 2013).

In summary, an integrated health system involves an IHIA. However, establishment of an IHIA is a complex process and depends on a number of factors, in which the social context plays an important role in addition to technical and administrative aspects.

1.2.2 My personal position and motivation

I have a bachelor's in information technology (2002-2007) from one of the most prestigious institution of Pakistan, NUST (National University of Sciences and Technology). I have worked in several IT firms. Since the last three years, I have been working on projects related to the development of health management systems at IFI, UiO. During my master's coursework, I have obtained training on scientific research. My supervisor and I had frequent meetings on the objectives and the design of this study. In principle, these learnings have helped me in understanding the complex nature of a field study and the requirements of writing a thesis.

Before becoming a part of UiO, I have been working for several multinational companies in Pakistan and the Middle East, and hence I already had some contextual understanding of my study setting. In 2018, I got a chance to be part of a DHIS2 implementation project in Sindh, Pakistan. During this trip, I developed an interest to conduct a situation analysis of the HMIS in Pakistan. I felt that HMIS in Pakistan is complex and that there should be an exploratory study that unveils the processes and the associated challenges, especially related to the integration of components of the HMIS. I felt the need to study the issue of HMIS strengthening in Pakistan in detail and to do something for its betterment.

1.3 Research problem

Every country in the world cannot deny the usefulness of health data. However, it is an established fact that current HMISs are not of good quality and the standards are poorer in LMICs. Governments worldwide are seeking to reform and improve their HMISs. I believe that building an HMIS is one milestone and has been achieved by many governments. It is the sustainable management and maintenance of such a system that requires strong commitment and resources and is a real challenge. HMN, under the WHO, drafted an assessment tool for counties to assess their HMIS based on context and resources, process, plans and indicators, and results (Braa & Sahay, 2012). However, the HMN reform process could not be taken to fruition, and still many LMICs have HMIS of relatively poor quality. Understanding these shortcomings requires a deep contextual and social analysis, as these challenges are often neglected and tend to be as significant as the technical constraints (Braa & Sahay, 2012).

There is a dearth of literature on major challenges and opportunities to implementing integrated HMIS in LMICs, especially in the context of Pakistan. It is an important area and requires exploration. Previous literature has reported several challenges in implementing strong health systems and HMIS (AbouZahr &

Boerma, 2005; Braa, Monteiro, & Sahay, 2004) in LMICs. This thesis aims to produce knowledge to fill this gap in Pakistan—a LMIC. Historically, the HMIS in Pakistan has been of poor quality and fragmented with no integrated disease surveillance system. Little research has been previously done on health systems in Pakistan (Nishtar et al., 2013) and particularly related to implementing integrated HMIS. There have been recent measures taken by the government to implement Health Planning, System Strengthening & Information Analysis Unit (HPSIU), to study the provision of relevant data to decision-makers. Building on this, my study focuses on evaluating the possibilities of implementing and scaling a unified and integrated HMIS Project rollout in Pakistan based on the DHIS2 platform – which can help analyse the status of Key Performance Indicators (KPIs) reflecting the performance of the districts & DHQ hospitals. Particularly, my focus is on the integration of the information systems for HIV, TB and Malaria.

1.4 Research Questions

This thesis investigates the following research questions:

1) What are the challenges in developing and implementing an integrated HMIS for HIV, TB and Malaria using DHIS2 in Pakistan?
2) What are the opportunities in developing and implementing an integrated HMIS in Pakistan?
3) What are some approaches to tackle these challenges?

1.5 Expected outcome of my thesis

This thesis has focused on the issues in the implementation of an integrated HMIS based on DHIS2 in Pakistan. The HMIS in Pakistan is a complex field. So far, a number of studies have focused on the local challenges of HIS integration, but none have focused on the integration challenge as relevant to Pakistan. This thesis will seek to develop a strategic roadmap to facilitate the implementation of DHIS2 in Pakistan. It can serve as a resource for the government and health organizations to manage their health management operations more effectively, monitor processes and improve communication to strengthen optimal decision making. Moreover, after assessing the current HMIS landscape in Pakistan, I will seek to produce policy and governance guidance for the building of an integrated HMIS for the country.

1.6 Thesis Structure

This thesis comprises of seven chapters.

Chapter 1 presents the theoretical background of the study including research rationale and questions, research background and knowledge gaps.

Chapter 2 entails the literature review and the theoretical framework

Chapter 3 describes the study context and background

Chapter 4 shows the methodology of this study

Chapter 5 presents the case analysis by reporting the findings

Chapter 6 entails discussion of the key findings and my contribution

Chapter 7 presents the conclusions

2. Literature review and theoretical framework

2.1 Background

There is no shortage of research on ways to strengthen the HMIS of countries, and many researchers have highlighted the various challenges that are needed to be overcome to implement a strong HMIS in a country. However, there is a dearth of literature on country-wise situational analysis on investigating the scope of HMIS integration, particularly in Pakistan. This section gives a thorough, incremental and systematic summary of the available literature on the challenges in terms of building an integrated HMIS. First, an overview of key elements of a successful HMIS are illustrated. Next, barriers to integration in a country are described as extracted from several academic papers. Also, the study identifies some proposed strategies to address these challenges available in the literature.

2.2 Key elements of a successful HMIS integration

Although many LMICs have succeeded in developing their HMIS, a significant amount of timely and reliable data on health indicators is still missing. Also, proper and efficient use of data has been reported to be largely absent (Armitage, Suter, Oelke, & Adair, 2009). Integrating all the health systems of a state is imperative to health systems strengthening. A strong HMIS provides information for evidence-informed decision making, for managing and allocating the resources and for examining the overall performance of the health indicators (Alwan et al., 2017) Such a health system is made up of many building blocks, and Suter and colleagues, have identified ten key elements of a successful integration of health system. They highlighted that one of the key principles of an integrated health system is a strong and state of the art information system, that integrates all the health-related stakeholders at one place and helps supervise health access and provision, through models of cost-effectiveness (Suter, Oelke, Adair, & Armitage, 2009). This is similar to the IHIA (Braa & Sahay, 2012).

A successful example of HMIS integration was reported by Mao and colleagues (Mao et al., 2010). They reported that after a situational analysis, one major barrier found in the Chinese HIV/AIDS programmes

was the overlapping of different public and private data collection organisations. The presence of several actors for the same disease group resulted in an abundance of data resulting in confusion. To tackle this issue, over a period of two years a three-step data unification program was launched in China that worked on creating a unified platform for all the stakeholders. It began with standardizing the data collection tools such as using questionnaires and forms, followed by the creation of a single online data collection platform nationwide. After the successful launch of this integrated HIV/AIDS information system with eight subsystems, access to data became timely and meaningful (Mao et al., 2010). Hence, incremental planning to develop integrated HMISs can prove helpful in combating infectious diseases like AIDS by providing reliable data.

Two essential elements to strengthen a HMIS as described by Alwan and colleagues include prioritizing core health indicators for the national HMIS i.e., formulating a metadata registry suited to the context, and improving the civil registration and essential statistics systems (Alwan et al., 2017). Both these elements require resources and capacity building, which are limited in LMICs and hence, international cooperation and careful planning would be required to access additional resources.

Due to a knowledge gap between the technical field and the users, HMIS at times, is a failure. Heeks (Heeks, 2006) proposed a 'design-reality gap' model that can work as a useful tool to analyse the situation and causes of failure of the HMIS of a country by measuring the gap between seven design and reality dimensions, which include information, technology, processes, objective and values, staffing and skills, management system and sources and other resources. The larger the gap between the design and reality, the more the chances of failure. This framework can be used as an evaluation and a risk assessment tool (Heeks, 2006). A study in Nairobi applied the design-reality gap model to comprehend and estimate the dimensions affecting HMIS availability. It was reported to be an effective tool and they found that dimensions related to corporate willingness, staff expertise and technology were the toughest challenges and needed to be bridged for an HMIS to be successful (Chege, 2015).

2.3 Barriers in HMIS Integration

It has been broadly stated that many countries in the world lack reliable health data due to several reasons, which hinder the adoption of evidence-based policies and decisions. There are several challenges in healthcare, for instance, increasing costs and demands and an ageing population with increasing multiple long-term morbidities. Health information technology (HIT) is often seen as a solution to addressing

current challenges in healthcare with potential to improve healthcare safety, quality and efficiency. Above all, to establish a unified HMIS in a country requires resources, commitment and political will.

There are numerous challenges that LMICs face to implement an integrated HMIS. In relation to the contextual situation, countries vary in their health policies and systems due to numerous socio-political differences. First, the population size varies across countries and within the country. As a result, a health system that would work for a less populated country might not work for a densely populated one. Second, the political landscape together with the health policies vary across nations. Third, the availability of resources to invest in strengthening the health systems fluctuate too (Armitage et al., 2009). Although there is no one-size-fits-all mechanism, a review by Armitage and colleagues lists several factors that are considered essential to integrate health systems. Some of these include powerful leadership, patient-focused care and focus on primary care, accountability appraisals and data sharing throughout the system (Armitage et al., 2009). These factors are at times missing or inadequate in LMICs and hence, successful integration of health systems and HMIS becomes a huge challenge.

Fragmentation has been identified as one of the biggest challenges to strengthen a HMIS which includes a lack of strong harmonization between national stakeholders and divisions of health information and public registration and vital statistics systems (Alwan et al., 2017). As a matter of fact, it is not easy to measure public HMIS, especially when different organizations, groups and programmes are working for healthcare provision within and across ministries. A study in Tanzania, a LMIC, investigated the multifarious challenges observed in the national HMIS identifying fragmented programmes and lack of coordination as key barriers (Smith, Madon, Anifalaje, Lazarro-Malecela, & Michael, 2008).

A weak data collection and reporting system is a bottleneck producing ineffective and low-quality data. According to Alwan and colleagues, poor reporting of casualties, and cause-specific mortality data becomes a constraint in diminishing the quality of data as only 60 out of 131-member countries surveyed had vital registration systems that met acceptable standards of completeness, correctness and timeliness (Alwan et al., 2017).

In general, governments in some cases do not have enough resources or in other cases, do not spend a lot of resources on HMIS strengthening, including their integration. For an integrated HMIS, systems need to shift firstly, from manual to digital, and secondly, from multiple to single reporting of data so that duplications and redundancies are minimized. After the implementation of electronic systems, one crucial challenge is to maintain the systems in the long run, requiring robust approaches to make systems sustainable and scalable (Braa et al., 2004).

Available literature highlights several barriers to integration of HMIS in LMICs. These include financial restraints, a dearth of the acceptability to innovation, lack of data accuracy or consistency among facilities and districts units and the phenomena of 'health data cannot be publicly shared, is owned by the government.' Additionally, limited technical capacity is a huge hurdle, and also limited human resources and poor infrastructure. Lastly, in some countries government policies do not favour open data sharing and hence their policy frameworks need overhaul (Sheikh, McKinstry, Akhlaq, & Muhammad, 2016). Building interoperability is desired to link standalone systems developed distinctly for different purposes to exchange data, guided by standards (Robertson et al., 2010).

In LMICs, one factor that cannot be ignored is the social systems perspective or social-technical mesh (Braa & Sahay, 2012). It is the social context that play a vital role in the success or failure of an integrated HMIS. It involves both computers (which can be relatively fully controlled) and humans (which can only be partially controlled due to different idiosyncrasies). Social system that is inclusive of social subtleties and politics, leads to unintentional consequences that might put the entire program at risk. Furthermore, social systems may affect the process of information usage, i.e., information may be used irrationally such as for political gains or be misrepresented. In some instances, it might be used only for surveillance purposes and not for decision-making to improve care processes. The rational use of information is important, which includes enabling proactive attitudes instead of merely reactive behaviour (Braa & Sahay, 2012).

In conclusion, there are numerous social, technical, institutional and resource challenges that LMICs face to implement an integrated HMIS (Figure 1).

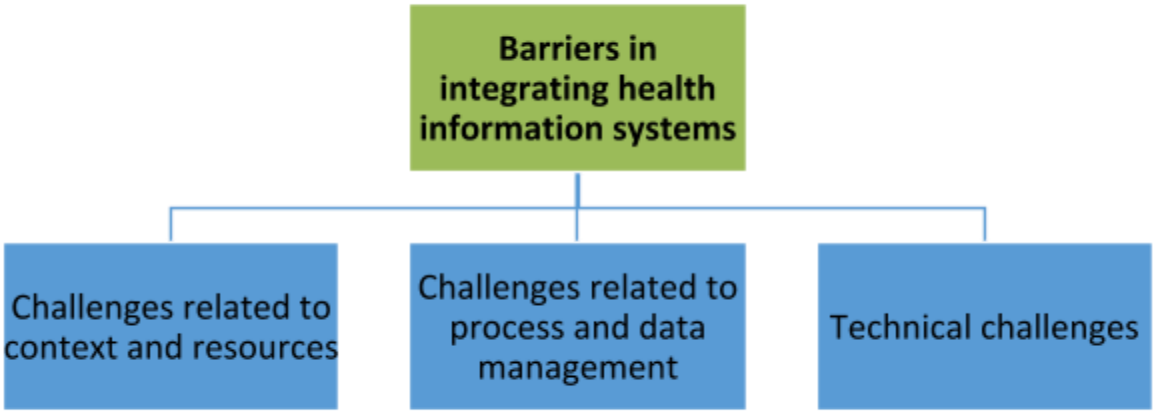


Figure 1 A summary of the barriers in integrating HMIS

2. 4 Theoretical framework

Here I will explain the theoretical foundations on which this study stands, and which helped me in defining the research problem, data collection and its analysis. My theoretical background is predominantly based on Braa and Sahay's ideology of integrated HMIS and standardisation expressed through an inverted triangular model (Braa & Sahay, 2012).

2.4.1 Integrated health information architecture (IHIA)

There are several systems that together make an IHIA. These systems, which include patient health data, technical arrangements, logistics and Human Resource etc., are supported by different kinds of infrastructure (Braa & Sahay, 2012). Similarly, a health information organisation might have several departments and sub departments. These information systems might be vertically fragmented in three architectural layers, i.e., business, application and technology. It is important to integrate these systems

horizontally to create integrated data and to advance decision-making in health sector. This, however, is a challenging goal to achieve (Hasselbring, 2000) due to a number of factors. Despite the global inclination towards uniting all the actors in the health sector of a country for collection and management of health information, two factors that still persist are fragmentation and lack of coordination (Braa & Sahay, 2012).

2.4.2 Elements of HMIS

Nenonen splits the HMIS into five main elements, broadly categorizing it into purely clinical that constitutes clinical patient records and evidence-based decision systems, and administrative/statistical domains. The latter comprises of three parts i.e., business reporting and epidemiological and quality systems. These fragments further have subparts or indicators (Nenonen, 2002). As a result, these parts and subparts makes a HMIS complex, involving intertwining of various actors and departments. A question that arises here is whether the health systems in LMICs comprise of these essential components, and if so, are these components, i.e., clinical and administrative, communicating according to the standards to generate integrated, reliable and timely knowledge. This points towards the use of a social system perspective, which is also termed as 'human activity systems' by Braa and Sahay (2012). According to this approach, HMIS integration becomes difficult to implement and control due to several social elements and dynamics. Countries continuously change in terms of their social, political and technological aspects, hence, development of an integrated HMIS becomes a challenging task (Braa & Sahay, 2012). An IHIA has three levels. Firstly, the social system level (level 1). Then comes the application level (level 2) and lastly, the data level or the technical level (level 3). Figure 2 illustrates the three levels of IHIA.

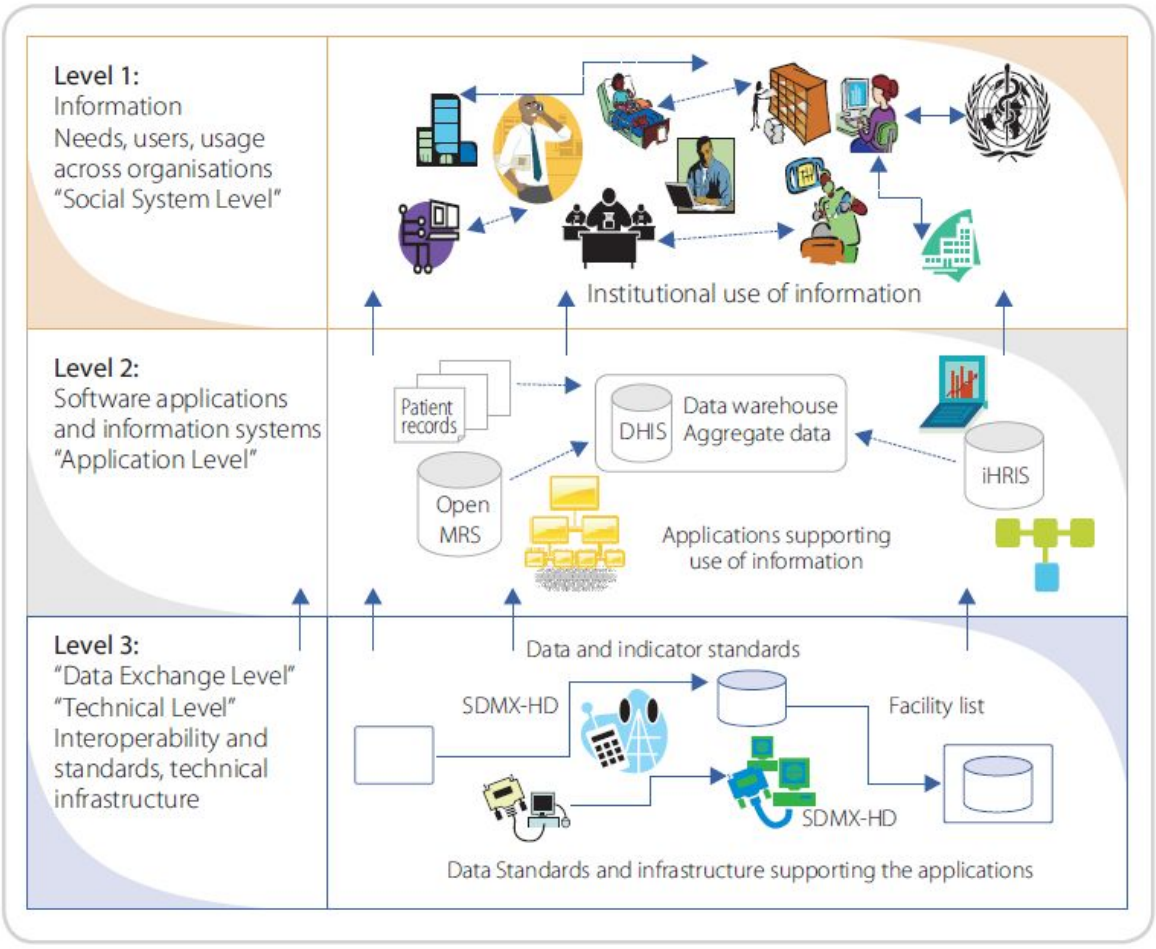


Figure 2 Three levels of IHIA. Source: (Braa & Sahay, 2012)

2.4.3 Integration

According to Braa and Sahay, integration depends on the context, and would mean different for different departments of an organization (Braa & Sahay, 2012). Integration means to take the:

> *"users' needs of the HIS, the purpose of the systems, and the wider organisational perspectives as points of departure, and relate those to goals of better efficiency, effectiveness and co-ordination in organisations and enterprises." (Braa & Sahay, 2012, pg. 59)*

It is not interchangeable with the term interoperability, which is one of the means to attain integration. Integration can be theorized across horizontal and vertical extents. While horizontal encompasses joining

additional business domains, vertical involves hierarchical levels. Figure 3 illustrates the process of integration and interoperability with respect to using integrated data.

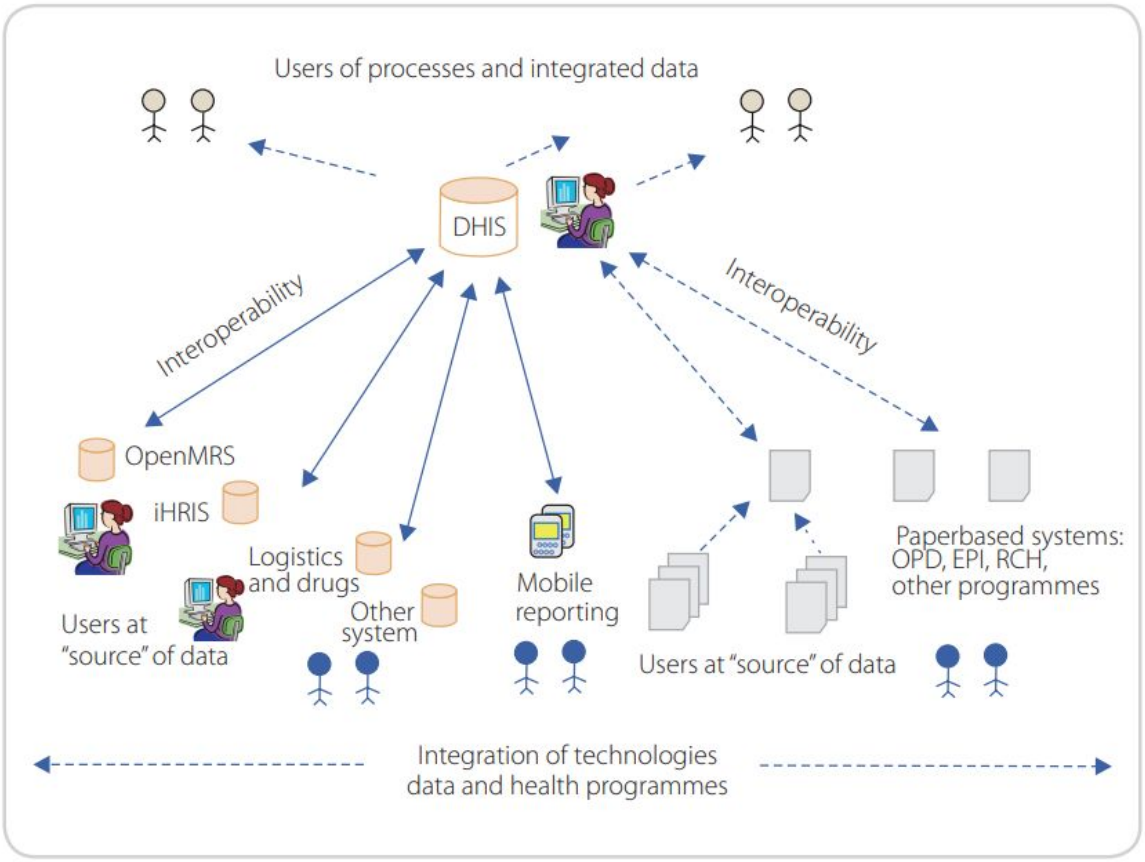


Figure 3 Process of integration and interoperability with respect to using integrated data. Source: (Braa & Sahay, 2012)

2.4.4 Three levels of Standardisation

Measuring health involve a series of predefined indicators and data standards. Crafting such standards in health comprises a series of complicated processes due to the fact that a plethora of different stakeholders are involved. All these stakeholders might have diverging views and interests. According to Braa and Sahay, standardization is important and a requirement for both integration and interoperability. The three levels of standards as described in the European interoperability framework and by Carlile's Integrative

framework are: Organizational, Semantic and Technical/Syntactic. Figure 4 illustrates the three levels of standardization.

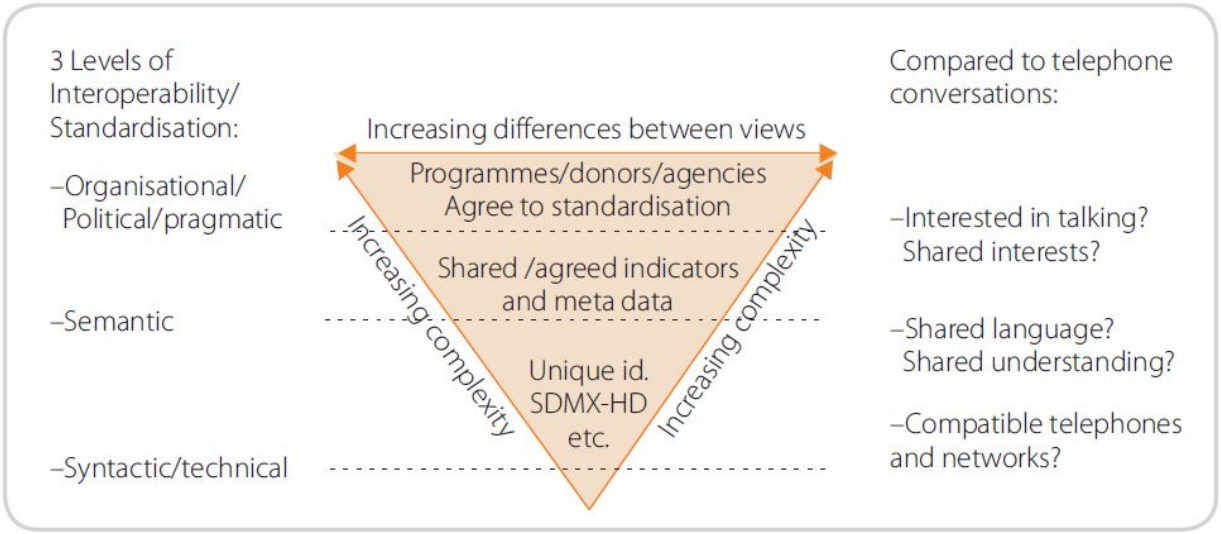


Figure 4 Three levels of standardisation in an inverted triangular model. Source: (Braa & Sahay, 2012)

1. Syntactic-Technical Level

The syntactic-technical level includes all kinds of data collection systems both paper-based or electronic and let the data exchange from one information technology system to another. There is a need to harmonise on the technical tools of data exchange. Mostly notably the format of data exchange so systems involved in interoperability can seamlessly talk to each other.

2. Data-Semantic Level

Data-Semantic level is about *"standards for data and indicators, data dictionaries and metadata",* as standardisation is needed across all levels regarding understanding of the data indicators to be collected and shared. (Braa & Sahay, 2012).

3. Social System – Organizational-Political Level

This is the highest level and the most complex one to achieve standardisation, as it includes policymakers, donors and programmes, and involves decision-making.

I have used this triangle as an initial framework to guide my interview questions, observations and document review. In addition, I have also used it to gather, arrange, and report my findings as per the three levels.

3. Study context and background

This section provides specifics on Pakistan as an Asian country, its healthcare landscape, national health policies, and the health information systems including new ventures taken towards HMIS integration.

3.1 Demographics

Pakistan is a lower-middle income country[1]. It is situated in South Asia and is the sixth most populous country in the world. Its total area is 796,095 km2 and is 33rd largest country in the world. It shares its borders with India, China, Afghanistan, Iran and Arabian Sea. The state is geographically separated into eight administrative units which include 4 provinces: Punjab, Sindh, KPK, Balochistan; 2 federal territories: Islamabad, FATA; and 2 autonomous territories: AJ&K, Gilgit Baltistan (Pakistan Bureau of Statistics, 2018) (Figure 5). In 2017, the total population of Pakistan was estimated to be 207.77 million (Javed, 2017) with an estimated GDP per capita of 1,443.625 US dollars (2016) (King & Cole, 2018). The total population of Pakistan is 218.3 million. The urban and rural distribution is 36.5% and 63.4% respectively (Ministry of National Health Services, 2018).

According to the 'Global Competitiveness Report 2018' released by the World Economic Forum (WEF), Pakistan is ranked 107 among 140 economies (Schwab, 2018). It is ranked 109th in health and 75th in innovation capability, two among twelve pillars of competitiveness. According to the report, Pakistan's,

> *"lowest levels of technological readiness, confirming the challenge for large emerging economies to fully integrate their entire population—especially those living in the most remote areas—into modernization processes" (Schwab, 2018 pg. 34).*

3.2 Administrative tiers

Pakistan is a federal state with three tiers of government: national, provincial and local. The administrative units of the country comprise four provinces, two autonomous territories and one federal territory. Each province has its own provincial government and is segmented into divisions. Each division

[1] Pakistan is a lower middle income. Source: World Bank. Available at: https://data.worldbank.org/country/pakistan

is further subdivided into local tiers, which are districts sectioned into tehsils, which are further subdivided into union councils (Ministry of National Health Services, 2018).

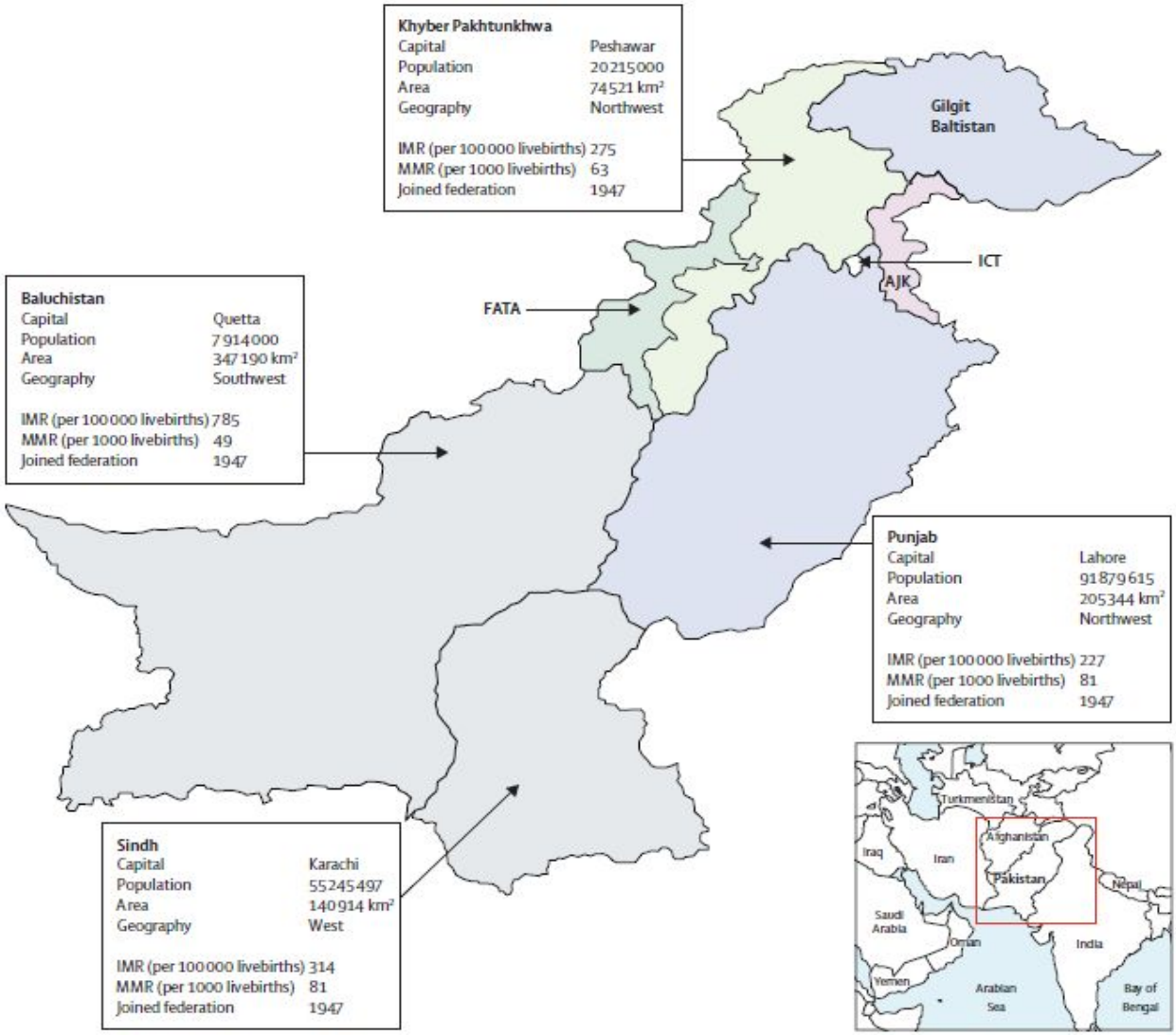


Figure 5 Map of Pakistan showing population density. Source: Nishtar, S., Boerma, T., Amjad, S., Alam, A. Y., Khalid, F., Haq, I. u., & Mirza, Y. A. (2013). Pakistan's health system: performance and prospects after the 18th Constitutional Amendment. The Lancet.

3.3 Health trends and indicators

Although Pakistan has seen an improvement in its overall health landscape, however, the country lags in its efforts to improve healthcare access and equity and to meet internationally accepted requirements. The HMIS in Pakistan has been reported to be non-functional (Nizar & Chagani, 2016). The total expenditure on health as is 2.6% of GDP in 2014, which is low for a populous country like Pakistan. The doctor to patient ratio although shows an improvement is 1:1300 (Nizar & Chagani, 2016). The population rate is very high with a growth rate of 2.04. The population of children under 5 years is 30.5 million and crude birth rate is 27 births per 1000 population. Life expectancy is 68 years (Ministry of National Health Services, 2018). Pakistan is one of the two countries left in the world where Polio myelitis is still present. According to a surveillance study on Maternal and new-born outcomes in Pakistan in 2013, it was reported that delivery and neonatal care is unsatisfactory in the country. In a period of 3 years i.e., from 2010 to 2013, the stillbirth, perinatal mortality and neonatal mortality rates stayed the same (Pasha et al., 2015).

The key health indicators of Pakistan comprise demographic indicators, disease burden and outcome indicators and health expenditure indicators, and emergency and disaster management indicators. The National Health Vision (NHV) 2016-25 offers:

> *"an overarching national vision and agreed upon common direction, harmonizing provincial and federal efforts for achieving the desired SDG3 outcomes and impact. It was designed to represent an aspirational direction and to set ambitious targets to achieve SDGs including universal access to health services."*

In relation to health targets for Sustainable Development Goals 3 (SDG), Pakistan has seen an overall progress. There has been a reduction in maternal mortality rate from 431/100 000 live births in 1990 to 178/100 000 live births in 2015. A rise in skilled birth attendance has been reported from 23% in 2000 to 69% in 2017. Under 5 mortality rates has seen a decline from 139/1000 live births on 1990 to 79.5/1000 live births in 2015; infant and neonatal mortality rate has declined too. The HIV incidence rate is 0.09 % (2015) and TB incidence is 270/100,000 population (2015). The malaria incidence rate is 8.56/1000 (2015) population which has declined significantly from 44.8 in 2000. Hepatitis B incidence is 72/100,000 population (2015). The number of people requiring interventions against neglected tropical diseases is very large i.e., 31056 in 2015. The probability of dying from noncommunicable disease is 24.7 % (2015). Suicide mortality rate is 2.1 % (2015). The coverage of prevention from substance abuse is 10, far from the target 2030 which should be 80. The road traffic mortality rate has seen a small decline from

15/100,000 population in 2000 to 14.2 in 2015. The universal health coverage indicator has seen a progress from 40 in 2015 to 41.4 in 2017 (Ministry of National Health Services, 2018). The General government health expenditure has increased from 9.3 % to 9.7 % of general government expenditure. All these indicators show an improvement in the country's will to meet the health goals for SDG 3. Figure 6 shows an overall picture of the status of SDG 3 indicators in Pakistan highlighting some significant achievements in relation to maternal mortality, skilled birth attendance and malaria.

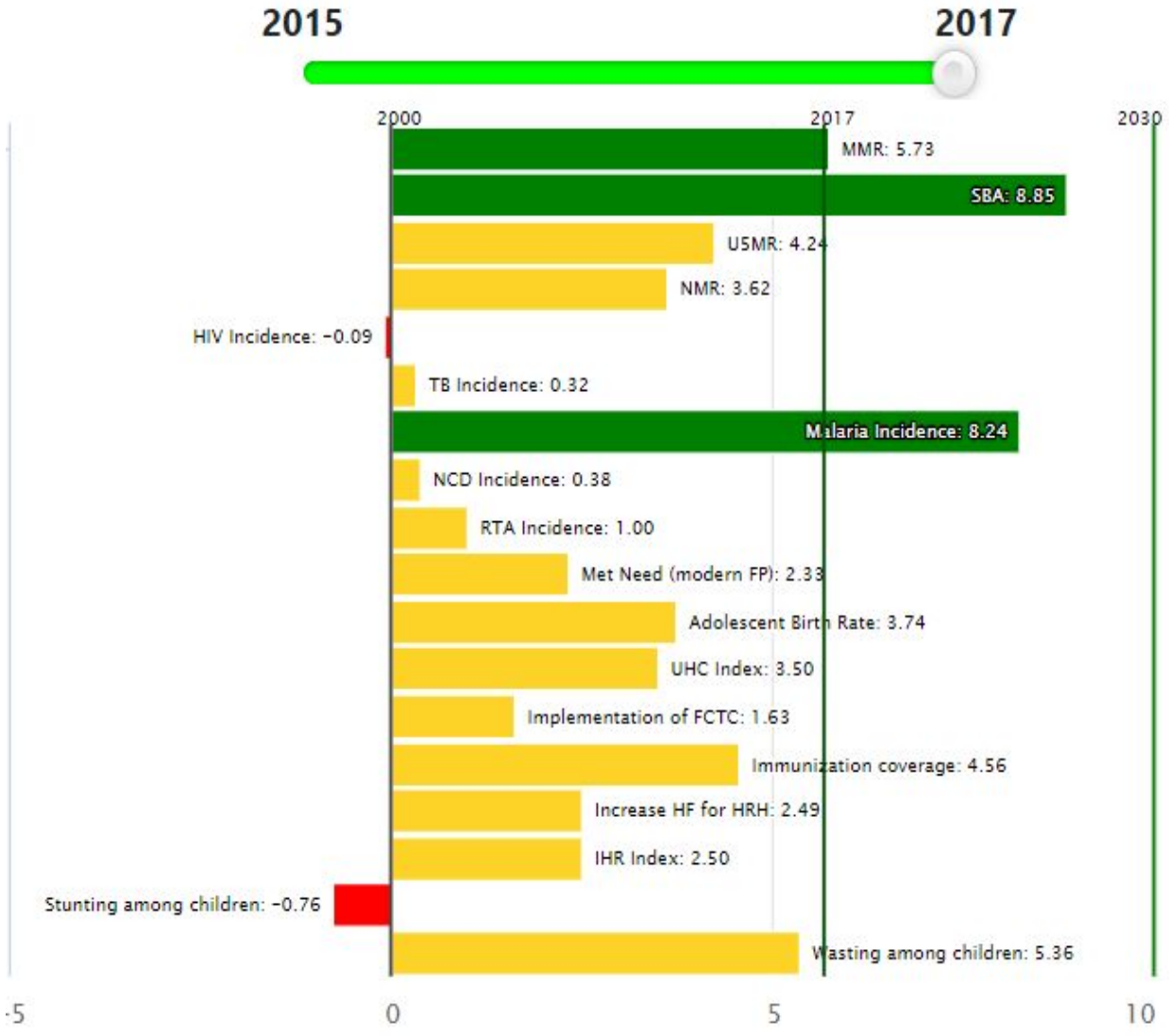


Figure 6 Pakistan SDG 3 indicators status from 2000 to 2020. Notice that the maternal mortality, skilled birth attendance and Malaria incidence are meeting the SDG3 standards. Source: Ministry of National Health Services, R. C. (2018). SDG3 Pakistan.

3.4 Health care system of Pakistan

After its inception, the healthcare system of Pakistan has seen many developments over the years which include many WHO-led projects to combat diseases like malaria, smallpox in the 1950s and 1960s, and abolishment of health ministry under the 18th amendment in 2007 (Nishtar et al., 2013). The efforts to establish a national HMIS initiated in 1990s, however, it lacked efficient management to collect quality data and utilize it for decision-making. This led to the rise of more vertical systems and eventually carved an ecosystem of decision-making that was not evidence-based (Qazi, 2009).

The health care system of Pakistan can be broadly divided into public and private sectors. The public sector includes the federal and the provincial governments. The ministry of National Health Services, Regulations and Coordination (NHSR&C) is under the federal government, which includes National Trust for Population Welfare (NATPOW), National Health Emergency Preparedness & Response Network, (NHEPRN), Drug Regulatory Authority of Pakistan (DRAP), Pakistan Institute of Medical Services (PIMS), Federal Govt. Services Hospital (PolyClinic), National Institute of Health (NIH), Pakistan Council for Nursing, Pharmacy Council of Pakistan, National Council for Homeopathy, National Council for Tibb, Pakistan Medical Research Council, Health Services Academy, National Aids Control Program. It is the responsibility of the policy-makers to develop policies from appraisal of routine reporting systems (DHIS, Vertical Programs, Surveillance Dashboards etc.), as well as periodic Surveys (PDHS, PSLM, MICS, Economic Survey etc.) and assessments undertaken in Health Sector (Reports of Health Development Partners (World Health Organization, 2018). Additionally, the provincial government supervises the district and tertiary health care system (Nishtar et al., 2013).

The public health sector of Pakistan has different levels of health care delivery. The first level is the primary health care provided through basic health units. Next, secondary care is offered through Tehsil and district headquarter hospitals. The tertiary care services are available in big cities and includes teaching hospitals and research centers. The private health sector comprises of many hospitals and health centers throughout the country (Khoumbati, Abbasi, Shah, & Stergioulas, 2018; Nishtar et al., 2013).

The province of Punjab, with an estimated population of over 100 million, is organizationally divided into 36 districts. It has a wide-ranging publicly - and privately-supervised healthcare services system in all districts. The public sector is systematized in the following four levels (Nishtar et al., 2013):

1.Outreach and community-based services focuses on immunization, sanitation, malaria control, maternal and child health, and FP;

2.Primary or first level care, including basic health units and rural health centres;

3.Secondary health care, such as tehsil headquarter hospitals and district headquarter hospitals for in-patient and out-patient care;

4.Tertiary care hospitals, also serving as a teaching facility located in the major cities providing specialized care.

The private sector includes private clinics, hospitals, laboratories and pharmacies.

3.5 Health Care Infrastructure

In 2016, Pakistan took actions towards implementing an integrated health information system in the country with the help from USAID. Spearheaded by the NHSR&C, Health Planning, System Strengthening & Information Analysis Unit (HPSIU), has been established "to provide stewardship for building a well-functioning integrated health information system ensuring the production, analysis, dissemination and use of reliable quality and timely information on health determinants, health performance and health status"(World Health Organization, 2018). HPSIU is an online dashboard that collects health information from provincial health departments, tracing improvement on health indicators. This initiative is meant to fill the void that has previously been reported in the literature to be necessary for health system strengthening. According to Nishtar and colleagues, the health information system of Pakistan has been fragmented, and there is no integrated disease surveillance system in the country. There are many and incomplete information systems for infectious diseases and population-based surveys. There has been no improvement in reporting the cause-of-death in the sample mortality surveillance system. There is only one cancer registry which is internationally authorized and there are no national stroke registries. The donor supported DHIS monitors the public health alone and did not get much- needed support from the government (Nishtar et al., 2013). The data reporting mechanism works in a hierarchical order including collecting data at first and second level primary health facilities. The data is compiled at the district level and managed at the provincial healthcare facility in the provincial level MIS (Figure 8).

Currently, the health information and disease surveillance activities are through several vertical interventions, which include "DHIS/HMIS, Vertical Health Programs (Lady Health Workers (LHW), Maternal, Newborn and Child Health (MNCH), HIV/AIDS, TB, Expanded Programme on Immunization (EPI), Dengue and Malaria), Service Statistics, Logistics, Financial & Human Resource Management

Information Systems, Disease Early Warning System (DEWS)" and numerous surveillance databases functioning provincially and federally (World Health Organization, 2018). HPSIU has developed the provincial health information system dashboard which is coupled to provincial DHIS units and dashboards for data sharing on 78 key indicators (World Health Organization, 2018) (Figure 7).

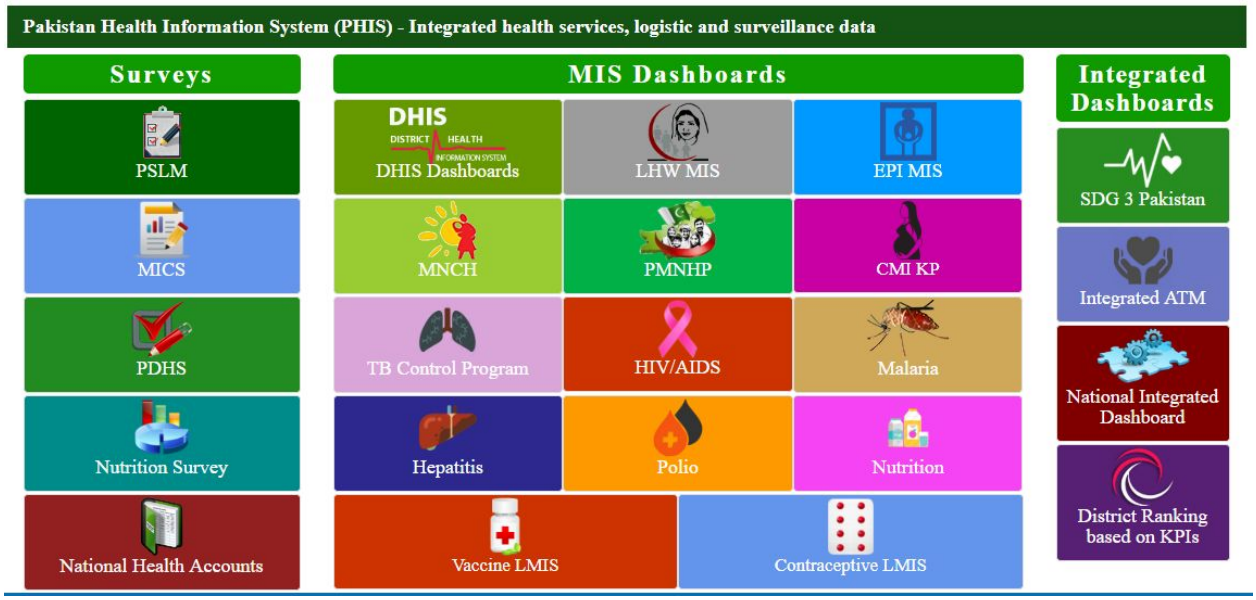
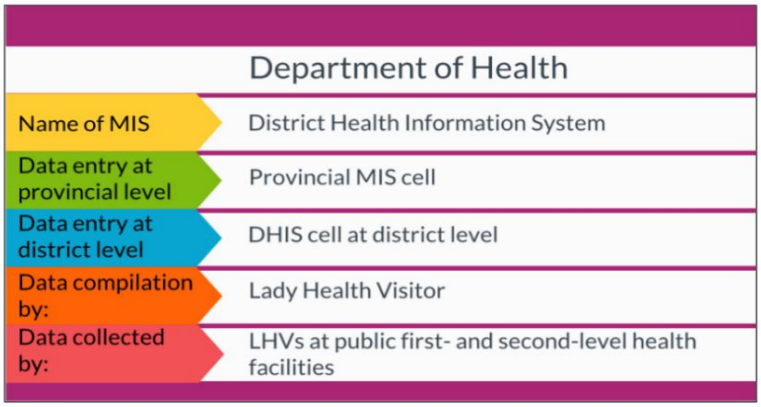


Figure 7 A screenshot of PHIS dashboard that shows different health indicators being captured by the programme. Source: http://nhsrc.pk/

Figure 8 Reporting mechanisms in DHIS



The Government of Pakistan developed their HMIS in 1992 with the support of USAID. After decentralization in 2001, the government felt the need for overhauling the federal IS incorporating only first-level health facilities. With a partnership between the government and Japan International

Cooperation Agency (JICA), a study on Improvement of Management Information Systems in Health Sector (2004-2007) was conducted. This project led to the establishment of DHIS and its associated national action plan for the countrywide implementation and execution of DHIS. According to the DHIS Punjab, it is, “fully implemented and functional in all districts of Punjab province since 2009” (Government of Punjab, 2019).

In conclusion, the current health information landscape of the country is complex yet stands intact in an intricate web of socio-political, institutional and cultural context. The government agenda is towards strengthening evidence-based and transparent data utilization processes. There are many vertical systems in relation to HIV, TB and Malaria and hence, overlapping of data is a huge issue. Many data collection sites are under-resourced. In addition, data quality is questionable too as there is a lack of integration between government and the private sector. My thesis focuses on this complex issue of integration.

4. Methodology

This chapter focuses on the methodology of this study. This study employs the protocol of a case study that involved both primary and secondary data collection through semi-structured interviews with the key stakeholders, and document analysis of the relevant documents and user observations through field visits. First, I have presented the aims and objectives of this study. I obtained the data via in-depth interviews and from the document analysis during a field visit in mid-December till mid- January 2018. In addition, I recorded notes during the field visits. The chapter will further explain the study design and details of data collection and analysis.

Based on my preliminary understanding of the data collected, the HMIS of Pakistan has slowly improved over time, from a national data generation system called HMIS in the 90s to an advanced district health information system (DHIS) in 2006. This system has been upgraded in 2009. Currently, based on the interviews with HIS staff in various departments, they are highly expectant about the potential of DHIS2 to integrate systems and create a unified framework.

4.1 Aims and objectives of the study

The aim of this study is to investigate the challenges in developing and implementing an integrated HMIS for HIV, TB and Malaria in Pakistan and asks the following two research questions:

1) What are the challenges in developing and implementing an integrated HMIS for HIV, TB and Malaria using DHIS2 in Pakistan?

2) What are the opportunities in developing and implementing an integrated HMIS in Pakistan?

3) What are some approaches to tackle these challenges?

4.2 Study design: a case study research

I adopted a case study design incorporating in-depth interviews, document analysis and field visits. In principle, there is no universal approach to a case study research, and I adopt Cassel and Symon definition of case study research as under:

"consists of a detailed investigation, often with data collected over a period of time, of phenomena, within their context." (Cassell & Symon, 2004, ch 26)

According to Crowe and colleagues, a case study *"is a research approach that is used to generate an in-depth, multi-faceted understanding of a complex issue in its real-life context."* (Crowe et al., 2011).

Yin explains that case studies serve as means to explain, describe and explore phenomenon in everyday context,

"A case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident." (Yin, 2009).

Cavaye describes a case study as a research strategy for information systems and describes a case method, as one which, *"does not explicitly control or manipulate variables; studies a phenomenon in its natural context; studies the phenomenon at one of a few sites; - makes use of qualitative tools and techniques for data collection and analysis"* (Cavaye, 1996). Case study research has many sides and can be used to investigate numerous topics, *"from different epistemological standpoints, at various stages of knowledge, using various method"* (Cavaye, 1996). To understand the context and to have an in-depth understanding of the topic under study, collection of qualitative data through interviews and field notes has many strengths (Cavaye, 1996). Since this study was exploratory in nature, I have preferred to choose qualitative methods to discover the holistic picture of the HMIS in Pakistan and to describe the challenges involved in integrating different systems. For the sake of internal validity and rigor, I have applied triangulation in methodology. In-depth interviews, field visits and document reviews are the three sources of data that have been triangulated.

I have followed the steps to perform a case study as illustrated by Hancock and Algozzine (Hancock & Algozzine, 2016), and Cassel and Symon (Cassell & Symon, 2004). Firstly, to set the stage, I have reviewed the available literature on the topic of HMIS in LMICs. Having some contextual knowledge regarding the health systems of Pakistan, it became easy for me to 'determine what we know' and to select the study design. Next, these initial steps are followed by amassing data from the chosen methods, which in this case were interviews field visits and document reviews. Lastly, after analysing the data and synthesising the findings, I have developed a narrative of the case study which is presented in this thesis.

As previously discussed, my thesis investigates the challenges in HMIS integration in Pakistan and explores the opportunities available to implement DHIS2 to overcome some of the existing challenges.

Hence, a case study research is my strategy of choice to answer the research questions under study. It has helped me to understand the context, to observe the phenomenon in its natural settings and systematically collect data on relevant facets of the phenomenon.

4.2.1 Study site

The data collection process lasted from mid-December 2018 to mid-January 2019 in three major cities of Pakistan i.e., Islamabad, Jhelum and Lahore. I had enough time to conduct the interviews and to observe the sites. Before the field visit, I already had designed a semi-structured interview guide with opened-ended questions which I piloted on two colleagues for a better understanding of the interview structure and to make any changes. Based on their feedback after the pilot stage, I made a few changes.

As recommended by Hartley, the best practice to initiate a case study research is to get an overview of the structure and functioning of the case under study (Cassell & Symon, 2004). To accomplish this goal, I started off by retrieving documents and literature related to the health systems of Pakistan. Prior to my official field visit, I paid an initial visit in December 2017 to Karachi, Sindh, which was for another DHIS2 related project but also gave me a chance to get a general overview of the health systems of Pakistan. This visit helped me build the contextual understanding and to plan out my subsequent research methods and to map my potential informants. I collected several reports, presentations and field notes during this visit. This information oriented me towards focused research questions and helped me to design the interview guide.

As part of my second research method of observation, I visited two facilities in Islamabad (CMU for AIDS, Tb & Malaria) and Jhelum (District Health Office) to observe the infrastructure, the software being used and to gain an insight on the organisational setup.

4.2.2 Study methods

4.2.2.1 Interviews

The stakeholders I purposively selected and interviewed belonged to all the facets of HMIS. I interviewed two programme managers, a former monitoring and evaluation (M&E) specialist, a surveillance officer and a researcher. In total, I interviewed five key informants as part of the primary data collection process.

Table 1 provides information related to the informants. The interview process started with an introduction to the study and a description of my designation, purpose of the study and how the data from the interviewees would be used i.e., for the thesis and/or a paper. All the informants were invited to any questions that they might have before or after the interview. Additionally, I asked for their written informed consent before the interview. The informants declined audio recording of the interviews; hence I recorded the data through field notes. Extensive notes were written after every interview. All the interviews took place at the workplaces of the informants and lasted for 45-60 minutes.

The interviews focused on a predesigned interview guide with general questions on the role of the HMIS in work processes, opinions held by users of HMIS, performance/accuracy of the HMIS, problems/issues during implementation. They also focused on the perspectives of those involved with the HMIS at the Ministry of Health, the district level, and the health facilities. I probed the informants on issues that came up during the interviews.

Table 1 List of informants

Informant 1	Researcher, HMIS AIDS, Malaria, TB
Informant 2	Former M&E Surveillance Specialist central medical unit (CMU) for AIDS, TB & Malaria)
Informant 3	Programme Manager M&E CMU for AIDS, TB & Malaria
Informant 4	Programme Manager MICS CMU for AIDS, TB & Malaria
Informant 5	District TB Control and Surveillance Officer

The interview guide consisted of open-ended questions related to the research questions under study (Table 2).

Table 2 Interview Guide

To get an overall understanding of the system	1. How long have you been working in this organization? 2. How does the health information system of Pakistan work? Kindly walk me through the whole process i.e., from the basic health unit to the policymakers/health ministry? 3. Could you describe the current situation of HMIS integration in the Pakistan?

and the situation	4. How does the process work in different parts of the country? information systems, health care industry, classification of stakeholders? 5. How is the health data used at the government level? 6. What health information technology software do you use and why? a. Regarding HIV, TB - has DHIS2 already been implemented on the ground? if yes, how's the experience been so far? 7. Kindly explain the existing HMIS's evaluation systems.
To discuss the research questions	1. In your point of view, what are the key barriers/challenges to integration of health information systems? Why? ● Contextual challenges: socio-political, economic and functions of the various stakeholders etc. *"Context encompasses both outer and inner contexts. Outer context refers to conditions external to the organisation, such as social, economic, political, and competitive environmental factors, whereas inner context refers to conditions internal to the organisation, such as structural, corporate culture, and local internal politics"* ● Behavioural challenges ● Technical challenges ● Organizational challenges: structural quality – organizational support/capacity, hardware, software; functional quality of information logistics – completeness or correctness of data, cost of information processing, user satisfaction, patient privacy, patient satisfaction, diffusion; 2. What is the future road map or vision for integrated health management information system.

Semi-structured interviews were conducted with a diverse range of healthcare staff including decision-makers, implementation teams and information technology staff, and users. The interview questions examined backgrounds and experience, perceived challenges surrounding software and hardware integration and interfacing, implications for organizational functioning and work practices, and potential ways to address identified issues.

4.2.2.2 Document analysis

According to Bowen, *"Document analysis is a systematic procedure for reviewing or evaluating documents—both printed and electronic"* (Bowen, 2009). The process has proven to be a low-cost yet effective method to accumulate empirical data (Bowen, 2009). To support and compare the data obtained from the interviews, I reviewed a list of documents. This process resulted in chunks, excerpts and pieces of data that I later incorporated with the interviews data to *"seek convergence and corroboration"* (Bowen, 2009), i.e., organising under the themes. Most of the documents for this study were provided by the HMIS informants and proved to be valuable sources of data. Table 3 provides details of all the documents I reviewed and analysed.

Table 3 List of documents

Pakistan Health Information System, final report 2017	This report has been produced by WHO for the NHSRC Pakistan and provides an assessment and roadmap of priority actions.
Assessment of health information system used by Pakistan principal recipients for the global fund with a view to HMIS integration for HIV, TB and Malaria – 2016	A report on the current situation of HMIS in Pakistan and to develop a transition plan for merging different MISs into DHIS2.
DHIS Annual report 2017 – Punjab	An analysis of some important health indicators to present the provincial situation followed by division and district wise status.
Primary hospital monthly report	Paper-based form to collect data (Appendix 1)
Secondary hospital monthly report	Paper-based form to collect data (Appendix 2)

Other resources that provided supplementary data included institutional brochures displaying organograms and policies, data entry forms and online resources available on the web pages of DHIS Punjab and KPK.

4.2.2.3 Observations

I conducted observations of two facilities in Islamabad (CMU for AIDS, Tb & Malaria) and Jhelum (District Health Office) to observe the infrastructure, the software being used and to gain an insight on the organisational setup and system use. During the observations, I keenly examined the activities performed by the staff such as chief officer, data entry operators, and if something needed explanation then I asked queries, which were informal, and rather were related to getting clarifications on what was going on in the context by primarily addressing questions of what, why and how. It produced descriptive information of what was taking place in the situation and prompting the system user's own explanations, assessments, and perspectives in the context of use. These tactics and methods for observations facilitated me to gather the data from diverse perspectives that aided a rich understanding of the phenomenon under study.

4.2.3 Data Analysis Process

I followed both the content analysis and the thematic analysis procedures to analyse the data as recommended by Bowen for studies with document analysis as supplementary to interviews (Bowen, 2009). This involved organising the data under categories related to the research questions as well as classifying the codes under specific and emerging themes. I have looked at and classified the barriers at the semantic, syntactic and organisational levels (Fig 4).

I started the data analysis process by carefully skimming, reading and rereading the data collected through field visits, interviews and site observations. This phase included interpretation of the data as well. This resulted in a list of chunks of data that I later organised on an excel sheet. The codes used in interview data were applied to the data extracted from the documents. I reiterated this step several times to enhance rigour in the analysis process. These codes were later classified under overarching themes that captured the research objectives thoroughly and helped me to answer my research questions.

5. Case study and analysis

This section describes findings emerging from my empirical work. At first, I will discuss challenges as per individual health programmes (HIV, TB and Malaria), and then drawing upon my conceptual framework, examine the challenges of integration across these programmes.

5.1 Challenges for AIDS control program

Although the AIDS control data is being collected across the country at almost all the levels of the facilities, it has been reported that the data is not being utilized for evidence-based decision making. The National AIDS Control Programme (NACP) ART (Antiretroviral Treatment) systems are online however, the VCCT (Voluntary Confidential Counselling and Testing) systems are using Excel sheets. There is a lack of integration among all the AIDS control HMISs and a central server to store data is missing too. One of the informants highlighted the dearth of technical staff at district levels to perform the data analysis.

5.2 Challenges for TB control program

The data collection tools in case of TB control vary across the provinces. Manual registers and excel sheets are being used for M&E and surveillance, relating to multidrug resistant TB. However, TB district management information system (DMIS) uses online tools for data collection. There is a need to integrate TB control HMISs as there is a wide array of HMISs being used in TB program, for instance, 3 HMISs are being used in for TB dots surveillance, Multi drug resistance (MDR) surveillance and HIV/TB surveillance, 3 HMISs are working to collect TB Labs data i.e. Lab Information System, Microscopy Networks and Gene Xpert, and 2 logistic systems are collecting data TB stores, i.e. DMIS and warehouse management information system (WMIS).

5.3 Challenges for Malaria control program

Several facilities at the district and provincial levels in 3 provinces are using DHIS2 in case of Malaria HMISs. There are three parallel Malaria HMIS running throughout the country, i.e., FM, G30 and DHIS.

The data from the private sector is not being incorporated with that of the public sector. In general, like the other two programs, the compiled information of Malaria is not being used for policy planning and evidence-based decision making. In case of functionality of the Malaria HMISs, the Global Fund (GF) and non-GF districts do not report on the same format. One informant highlighted the need of laptops and other IT infrastructure at the district levels.

In conclusion, in the case of all three programs, i.e., AIDS control, TB and Malaria, a lack of uniformity in data collection and sharing processes has been reported in the interviews and through document analysis, hence pointing towards the data standardisation challenge. In case of AIDS control program, the province of Punjab has the highest number of ART centres as compared to other provinces. National AIDS Control Program has developed ART HMIS to collect case-based information of HIV/AIDS patients. The ART data is collected online across all the provinces and the VCCT data is collected through registers (manually) and using Excel sheets. VCCT centres are established by provincial authorities with their indigenous funds and report to the provincial AIDS Control Programs only. With respect to TB control program, Punjab province has maximum number of Monitoring and Evaluation surveillance centres, followed by Sindh and KPK. As informed by the managers and found from the reports, most of the centres have human resources available for data entry and have adequate access to IT infrastructure. However, there are certain challenges for all three programs to be fully implemented.

5.4 Organizational structure and data collection system

Before discussing the challenges, it is essential to understand the organisational structure and data collection system that was informed by the interviewees. After interviewing the informants, it was learnt that health policies, regulations, and standards are driven by Federal Ministry of Health (MOH) and its global partners like WHO, Global Fund etc. Once these policies and data standards are finalized then they are communicated to the provincial authorities. It is up to the provinces to opt to go along by implementing these guidelines or to go for their own implementation plan as long as it provides the data according to the standard in compliance with Federal MOH/WHO standards. At the provincial level, they can add more dimensions to the data being collected based on their local requirements but are bound to submit data to Federal MOH. This structure points towards lack of consistent regulations regarding managing HMIS across the country, and discrepancy in same programmes employed in different

provinces. This increases the difference in views at the three levels, i.e., semantic, syntactic and organisational.

At the facility level, patient-level data is being collected using DHIS programme. There are different types of forms designed by DHIS project and they are in place for the last 10 years. For example, in the case of TB, there is a patient registration form to record patient data. Once an entry is done, the patient goes to the doctor for treatment. The doctor has another separate form to record the clinical data of the patient such as conditions, the severity of disease, symptoms etc. Once treated by the doctor, the patient then visits the drug dispenser. The dispenser records the medications prescribed to the TB patient. Such records are made manually at some facilities and electronically at others. At each facility, the data is recorded and collected for a week, after which it is aggregated and presented to the higher level, i.e., at the division or province level. People sitting at the higher levels are responsible for the consolidation of data and generation of weekly and monthly reports. There are authorised standards for these reports, which are incorporated in the DHIS framework.

DHIS is an online platform and is available at the majority of the BHUs (Basic Health Units) in Pakistan. Data is collected using paper forms at facilities where online DHIS is not available. These forms can capture information about patient general information, TB/HIV/Malaria MNCH etc., (Appendix 1&2). However, detailed examination in case of Malaria/TB/HIV is still being maintained in separate vertical HMISs.

5.5 Challenges of interoperability across semantic, syntactic and organisational levels

In Pakistan, the health information ecosystem is a complicated array of data collection, sharing and integration processes, for instance a remote clinic can use its own software solutions to collect, store, and analyse medical data. Data collection methods range from conventional paper-based to electronic means. There is a huge standardisation gap at the semantic and syntactic levels. Hence, to integrate these individual applications with a central data repository and to enable them to communicate with other systems in the healthcare industry, is a real challenge. Healthcare data integration services involves integrating teams, concepts, and technology to create the infrastructure capable of housing big data and using it in a meaningful way, while addressing data accessibility, ownership, and privacy. A major

challenge that the HMIS of Pakistan faces in terms of embracing all the integration services is the availability of limited financial resources as the government's spending on health is inadequate.

After interviewing stakeholders from the health information sector and health ministry, in addition to document analysis and sites observation, several challenges were identified (Table 4).

<table>
<tr><th colspan="3">Barriers</th></tr>
<tr><th>Syntactic/Technical</th><th>Semantic</th><th>Organisational</th></tr>
<tr><td>Non-uniform data standards</td><td rowspan="2">Fragmentation</td><td>Lack of a national regulatory authority has resulted in fragmented HIS</td></tr>
<tr><td rowspan="3">Unorganised and muddled data</td><td>Lack of e- health informatics competence hub</td></tr>
<tr><td rowspan="2">Nonexistence of any data exchange protocol to define data format</td><td>Organisational uncertainty and unrealistic policies</td></tr>
<tr><td>The issue of capacity building</td></tr>
<tr><td rowspan="2">Data completeness and quality</td><td rowspan="2">Prolonged power and internet outages</td></tr>
<tr><td>Data duplication</td></tr>
</table>

Table 4 Barriers classified in accordance with syntactic, semantic and technical levels

5.5.1 Syntactic challenges

These are the technical challenges that the actors face in terms of data integration and interoperability.

5.5.1.1 Non-uniform data standards

Based on my observations and field notes, there is no technical data standardisation in place. There are different data collection standards being used in different health facilities. The systems are mostly paper based. For instance, there is no uniform coding scheme being used for health facilities. Due to the presence of too many data sets, a standard syntactic description of data is missing for the purpose of data transfer among the senders and users of data.

5.5.1.2 Unorganised and muddled data

At some facilities, much of the data is collected and stored in multiple places and formats. There is no standardized data collection process being followed across the HMIS ecosystem. Also, there is no cooperation with the private sector in HMIS activities. In case of Sindh, despite its high portion in health service provision, the private sector has not been considered as a major source of health information.

5.5.1.3 Data duplication

It was informed and observed that the system is unable to handle medical references in a seamless way. If a patient has moved and went to another health facility, then system will register the patient as a new entity. Apart from that in certain cases two systems are collecting similar type of data in the same geographical regions which leads to significant data duplication and inconsistency.

In conclusion, the HMIS of Pakistan faces the challenges of too many data sets and formats and there is no mechanism in place for identification and merging of duplicate records.

5.5.2 Semantic challenges

5.5.2.1 Fragmentation

As informed by the managers, there are numerous management information system (MIS) tools available in the provinces to collect same data, e.g. Malaria has G30 as well as FM (Form Malaria) tools for malaria surveillance. Online ART MIS of Punjab is different than other provinces. Likewise, fragmented MISs are available in each program e.g. TB program has five MISs that do not communicate with each other. In case of Sindh, fragmented and multiple overlapping and/or duplicate sub-HMIS is negatively affecting the overall health services in the province. Different formats, inflexible systems, differences in how data is defined/understood and procedures for the various actors involved, are challenges for building an integrated HMIS. Integration can solve some of the existing challenges of fragmentation, but it will also require negotiations and alignment of interests between the myriad of actors involved. In addition, the logistics management information system (LMIS) is in place in most facilities across the country but has not been integrated with any other system. As a result, it is difficult to merge information coming from different fragmented systems and the information obtained might be inconsistent and contradictory.

Lastly, there are different HR systems in place, for example, LHW but they are working in isolation. There is no such policy that includes the private sector to report their data to the district and/or provincial HMIS.

Another significant challenge highlighted by the informants and in the reports is the presence of various vertical programmes and multiple disparate information sources and repositories. The vertical programmes have been imposing their unilateral data requirements upon their staff, resulting in duplication and wastage of time and resources. In addition to that, multiple systems are involved in collection of similar data in same geographic regions without any collaboration. It was observed during assessment that data sharing across the programs is limited due to lack of standardisation of metadata.

The data of all three diseases i.e., AIDS, TB and Malaria is not standardised at the semantic level, and not captured in one system and there is no integration of HMIS with an external system, for example, LHW or LMIS. An integrated HMIS across the three diseases will be the crucial step to develop coherent and integrated systems. This would be accomplished through integrating AIDS and Malaria into a DHIS2 system and developing it to include services and surveillance data.

5.5.2.2 Data incompleteness and poor quality

Routinely collected facility-based data has known limitations. It does not capture all the cases that exist in a community. Nevertheless, it can inform precisely about the people who have visited health facilities for consultation and health services. In almost all the facilities as reported by the informants, completeness of facility-based routine data is a big problem. Although regular quality checks within the DHIS system based on the Lot Quality Assurance Sampling (LQAS) methodology have been incorporated, with feedback mechanism established between the DHIS provincial cell and the district coordinators managing DHIS data, data are sometimes incomplete in some ways. Several facilities are not sending reports at all and other facilities are not sending reports regularly. Those facilities that are regularly sending reports are not reporting data on each indicator every month and miss out many elements.

According to the annual assessment report 2017, there are no national guidelines on DHIS data entry standards. Therefore, more than 95% of people working on DHIS are left alone with no written guidelines. Moreover, definitions of data elements are not clearly understood by the staff. Consequently, incorrect diagnosis, and entry of wrong fields are commonly observed problems as indicated by the informants. There is a need for a defined set of indicators for regular reporting.

Lastly, I was informed that important prerequisites of data quality are missing at a few facilities. Neither hospitals nor any clinics or vertical programme use any type of data standards, including non-use of ICD (International Classification of Diseases) or ICD-related data coding and terminology or national identification numbers for individuals or for health events.

5.5.2.3 Nonexistence of data exchange guidelines

To employ interoperability and integration of data, a standard data sharing guideline is vital. An underlying cause to lack of harmonization was highlighted by the district officer, who informed that there was a deficiency of a standardised data exchange protocol to guide data transferability and understanding.

In conclusion, several challenges have been observed in relation to interoperate and integrate data at the semantic level. The underlying cause is fragmentation and the presence of too many programs.

5.5.3 Organisational challenges

Due to fragmentation and many vertical programs, there is a shortage of interaction among the actors to execute the data and employ interoperability. Both the technical and semantic challenges depend on the challenges observed at this level. A list of challenges as informed by the informants and found from the documents are listed below:

5.5.3.1 Lack of a national regulatory authority

One of the fundamental underlying reason of ending in a fragmented HMIS is the lack of a national regulatory authority. All the systems fully comply with unilateral short-term requirements but due to non-existence of a national regulatory authority, these systems collect data and keep it with them instead of reporting it at regular intervals to a centralised data repository. Consequently, the data are neither shared nor converted into information for decision making.

5.5.3.2 Lack of E-health competence hub

Though there are many online systems currently in place, until quite recently, there was no government effort to digitize data collection in health services and this has led to the creation of different fragmented

system operating within their boundaries. In addition, no centralized hub could have been established with key domain/technical competencies. An informant from the District Health Office, Jhelum reported that there was an absolute shortage of epidemiologists and statisticians:

"All announced positions for the statistical officers are vacant till date."

5.5.3.3 Organisational uncertainty and unrealistic policies

Besides the pure technical challenges of clinical data integration, there is an issue of the willingness and ability to collaborate among the stakeholders, i.e., among group of actors, healthcare providers and patients. Therefore, data collection, management, integration, and analysis are broken and fragmented processes till date. This points towards the broader challenge of financial deficit and policy uncertainty. One informant from the research department stated that the top-down standard health policies led by the government required an overhaul in terms of accepting more changes based on the local contextual requirements to sustain local service provision.

5.5.3.4 The issue of capacity building

Capacity building issues at facility, data entry and analysis levels were highlighted by various informants. There are inadequate dedicated human resources for data entry and analysis. Infrastructural and technological deficiencies also pose major challenges in achieving timeliness and completeness of data e.g., some facilities do not have internet facility and laptops/desktop computers are not available. Moreover, provincial and national level entities do not have a dedicated server for data storage. With the availability of data from vertical programs, there is a need to recruit trained staff or train existing staff for the data analysis process. According to the annual assessment report 2017,

"There are epidemiology experts at the province, but no strong proof of fairly acceptable routine DHIS data analysis procedure was found. Instances where analysis is done, it is commonly limited to simple frequency tables/bar graphs at provincial level, or month to month side-by side tables."

5.5.3.5 Prolonged power and internet outages

It was reported by the informants that in the power outages was a frequent issue and at most of the facilities internet was not available.

In conclusion, at the organisational level, several barriers are there in terms of interoperating and integrating the health systems in the country.

5.6 Advantageous elements for HMIS Integration

The informants highlighted some enabling factors in relation to HMIS integration in Pakistan.

5.6.1 Improved reporting

One informant highlighted that the reporting system has improved over the years and data was being collected and reported from more than 10,000 facilities.

5.6.2 Acceptive attitudes

All the informants interviewed were generally supportive of the view of integrating all the systems in place to improve the overall reporting system of the health data. Although they voiced several concerns about the practicalities of attaining this goal.

5.6.3 Available vacancies for data analysts and more funding

It was reported that there are many positions available for experts in statistics, epidemiology and data analysis.

6. Discussion and contribution

The findings of this study highlight several challenges across semantic, syntactic and organisational levels that Pakistan is facing in terms of building an integrated HMIS. There is a huge difference of operability amongst actors at all three levels, reflecting the complexity of the challenge. Firstly, fragmentation and lack of co-ordination is a major problem fronting the agreed objective of collecting and executing quality info to improve decision-making in the health sector. The issue of fragmentation has previously been highlighted in the literature (Braa & Sahay, 2012; Kossi, 2016). In Sierra Leone, the HMIS were characterised by presence of many centralised program based HMISs for diseases such HIV/AIDS, with poor data output (Kossi, 2016). A study in Namibia reported the presence of different information sources and warehouses from the 446 health facilities, which was a consequence of various parallel donor agencies working to establish HMIS (Dlodlo, 2017). In principle, data exchange is only possible when the HMIS ecosystem share same technical, semantic and organisation standards. Based on my findings, the data warehouse is missing to interoperate different systems in one place. Every program in the AIDS, TB and Malaria field has its own technical procedures and standards and hence, there is a need to work on formulating rigid technical protocols to move towards integration and interoperability. The problem of fragmentation can be solved by embracing the integrated good design of HMIS, entitled 'enterprise architecture or IHIA' - with interoperability as an integral element - by focusing on 'information uses for management' and standardising it across the systems and enterprises (Braa & Sahay, 2012).

Secondly, at the semantic level, there is no standard protocol that illustrates data sharing guidelines. The data collected from multiple vertical programs and sources is in multitude and data duplication is a huge issue, hence compromising data quality. Moreover, the right use of the data is missing as well. The barriers such as poor data quality, limited human resources and less finances have been previously reported in a study conducted on HMIS of Pakistan (Qazi, 2009). However, this study is relatively old and only included health managers' perspectives. The public health sector and the vertical health programs in Pakistan should invest in and work on reaching a shared understanding on what is necessary to collect and execute information. A dialogue needs to be built among all the actors to collect only what is needed. With standardized data indicators and metadata in place, interoperability of would be easy. This will facilitate integration of AIDS control, TB and Malaria HMISs and would promote a culture of inter-organizational information sharing among the stakeholders. In addition, it is highly essential to inform the policymakers about the usefulness of interlacing the community-level data streams. The data

entry system should be improved too, i.e., by incorporating the computerized national identity card (CNIC)-based data entry.

The creation of a regulatory body that can work on harmonising and regulating the standards and coding schemes among the various health systems, would be an effective step towards gaining integration in HMISs. Once standards have been developed at the organisational level, the complexity issue reduces as we cascade to the technical level. This regulatory body would make sure that key data elements and indicators are being regularly updated and provided to the users.

Thirdly, since the informants expressed that there was a lack of quality reports, measures should be taken to prepare timely and integrated reports to be used for effective decision-making. My recommendation does not attempt to change any of the existing systems and data collection processes, but rather suggests a less radical approach and more incremental planning of adding a new layer "on top" to facilitate data integration and analysis in a structured way. As outlined in the general guidance on building integrated data repositories, the quality of the data in the HMIS is determined by the data collection processes at the lowest levels of the health system. The total burden of data collection at a small health facility will affect the quality of the data collected, which urgently requires harmonisation of data collection across vertical programs and sub-systems.

Fourthly, there is a strong need to enforce these standardisation regulations to the private sector as well. This sector covers health needs of an estimated more than 40 % of the population. Hence, bringing the private market into the mainstream systems would help improve the data quality and overall health information of the country.

Lastly, replacing the existing architecture would be disastrous for a country like Pakistan, where the end users of HMISs have been reluctant to embrace the ever-evolving technology and newer ways to develop an IHIA. A way forward could be to establish a centralised reporting system or warehouse which consumes data from other systems. Once this is achieved, the systems can slowly roll out in phases to adhere to the new data collection and management systems. My rapid assessment of the situation in Pakistan indicates that there is quite a bit of overlap in terms of data collection with multiple systems collecting the same data from the same sites. Hence, in the longer run, a major step to improve the quality of the data in the integrated data repository would be to streamline and standardise different sources of data. Another important aspect of harmonising the data collection is to use common standards across subsystems that are used to collect the same services, but for different parts of the health system, e.g. public vs private or hospitals vs primary level. A process towards more standard-based data collection

across the whole health system will be a key step towards improving data quality and will greatly simplify the process of integrating these multiple data sources in a common repository. The goal should be to develop master lists, protocols or registries for indicators, data elements/variables, and for health facilities with a proper coding scheme and to make these available to all system developers. DHIS2 can help with the structures and functionality to store and disseminate these standards, but this is first an organisational process where multiple programs that are working in isolation to come together and agree on common standards and on a more streamlined and standardised way to collect data without duplication across the health system.

Limitations

Due to limited time and resources, it was not possible to interview more informants and to observe more sites. Additionally, I was unable to retrieve details or reports on contracts between the public and private sector for delivering and implementing the information systems. As a result, it was difficult to develop an all-inclusive understanding of some crucial matters impacting on the overall HMIS. Moreover, the field work was primarily done in the cities of the Punjab province, hence the situation in other provinces might be different. A large-scale study involving more provinces and the private sector to study the HMIS of Pakistan with an objective of policy overhaul is needed.

7. Conclusion

This qualitative study explores the challenges in developing and implementing an integrated HMIS as a strategic resource for HIV, TB and Malaria using DHIS2 in a lower-middle income country i.e., Pakistan. It also looked into the opportunities available to establish such a system and provides recommendations for the decision makers to tackle the challenges. After interviewing some key stakeholders, field visits and document analysis, several key findings have been extracted which includes some of the key administrative, political, sociological and epidemiological issues, deficiencies and weaknesses as well as some enabling factors. The challenges across syntactic level include non-uniform data standards and data to be unorganised and muddled. Moreover, data duplication has been reported. The semantic level illustrates challenges such as fragmentation, nonexistence of any data exchange protocol or guidelines and data incompleteness and poor data quality. The barriers observed at the organisational level include lack of a national regulatory authority, lack of e- health informatics competence hub, organisational uncertainty and unrealistic policies, the issue of capacity building and prolonged power and internet outages. There is no standardization for metadata. There is no data exchange protocol to define data formats. The opportunities include ambitious researchers and staff and available vacancies for talent. There is a need to incrementally standardise data collection and use common standards across systems and programs at all three levels, especially at the semantic level. Also, to establish a centralised reporting system or warehouse which consumes data from other systems. Once this is achieved, the systems can slowly roll out in phases to adhere to the new data collection and management systems. Pakistan shares its HMIS situation with other countries and there is a need for an international benchmarking collaborative effort to standardise the health information collection, management, sharing, and reduce fragmentation to enhance public health data quality.

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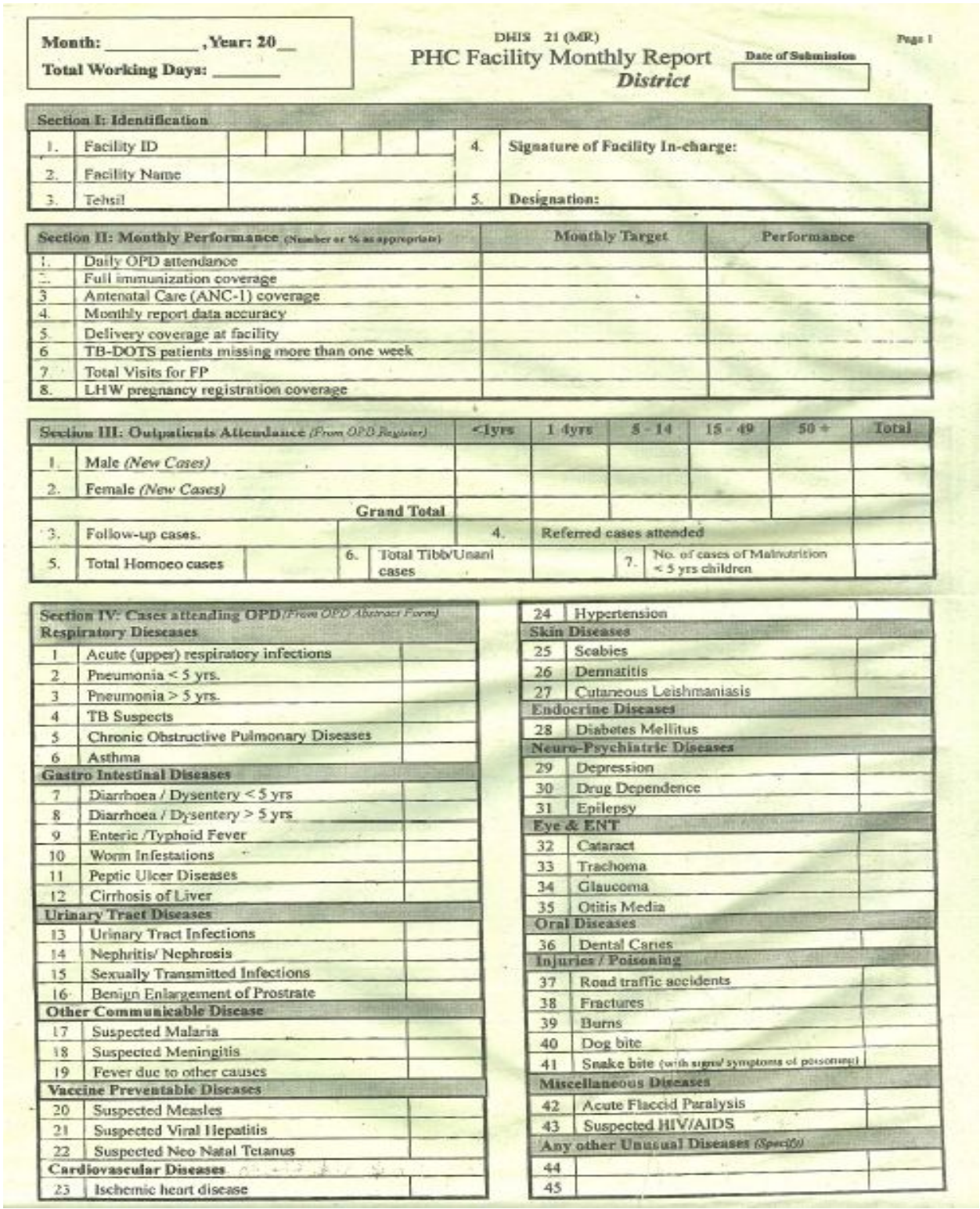
Appendix 1

Primary hospital monthly report



Month: _____, Year: 20__
Total Working Days: _____

DHIS 21 (MR)
PHC Facility Monthly Report
District

Date of Submission

Page 1

Section I: Identification

1.	Facility ID		4.	Signature of Facility In-charge:
2.	Facility Name			
3.	Tehsil		5.	Designation:

Section II: Monthly Performance (Number or % as appropriate)		Monthly Target	Performance
1.	Daily OPD attendance		
2.	Full immunization coverage		
3	Antenatal Care (ANC-1) coverage		
4.	Monthly report data accuracy		
5.	Delivery coverage at facility		
6	TB-DOTS patients missing more than one week		
7	Total Visits for FP		
8.	LHW pregnancy registration coverage		

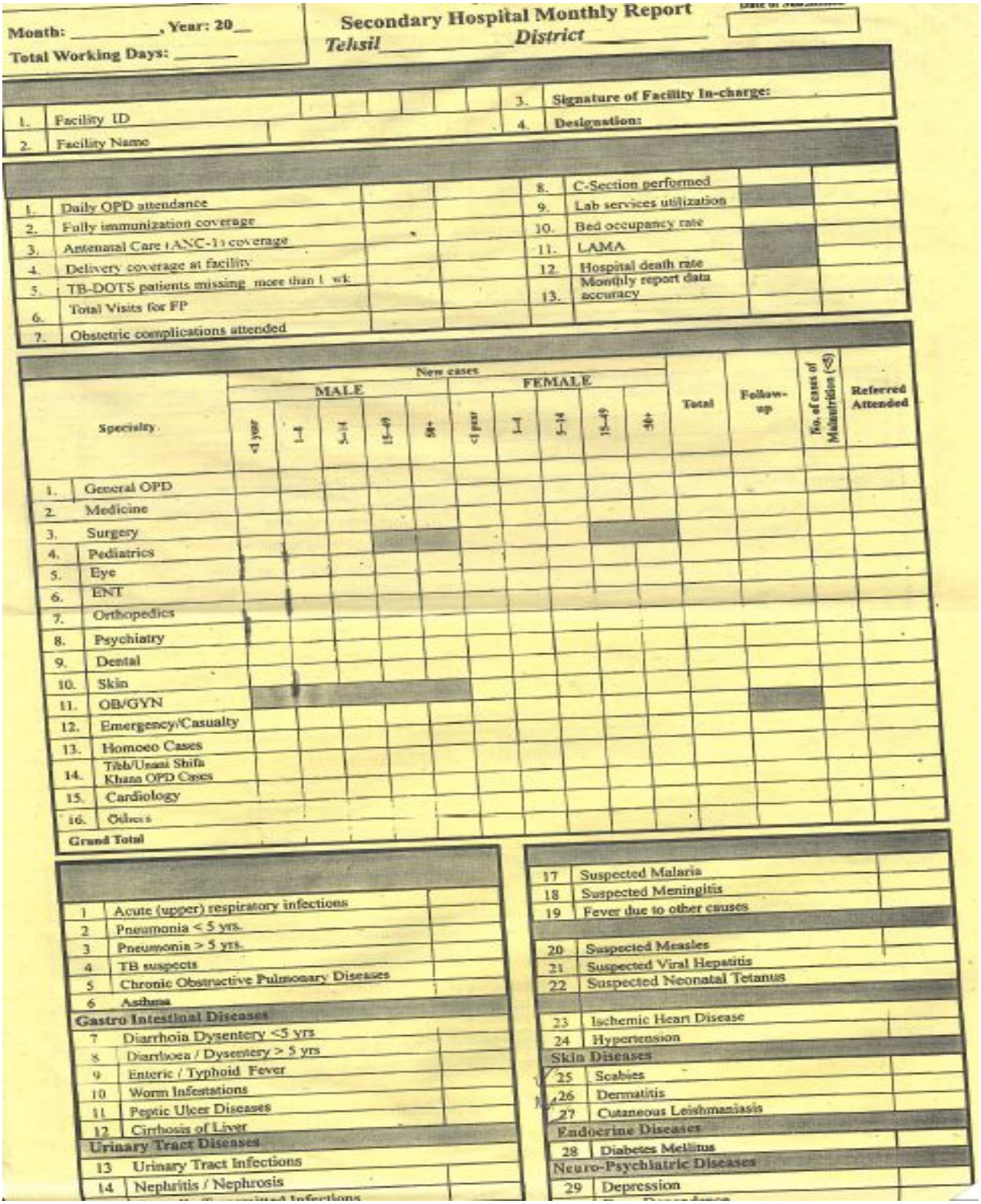
Section III: Outpatients Attendance (From OPD Register)		<1yrs	1-4yrs	5 - 14	15 - 49	50 +	Total
1.	Male *(New Cases)*						
2.	Female *(New Cases)*						
	Grand Total						

3.	Follow-up cases.		4.	Referred cases attended			
5.	Total Homoeo cases		6.	Total Tibb/Unani cases		7.	No. of cases of Malnutrition < 5 yrs children

Section IV: Cases attending OPD (From OPD Abstract Form)		
Respiratory Diseases		
1	Acute (upper) respiratory infections	
2	Pneumonia < 5 yrs.	
3	Pneumonia > 5 yrs.	
4	TB Suspects	
5	Chronic Obstructive Pulmonary Diseases	
6	Asthma	
Gastro Intestinal Diseases		
7	Diarrhoea / Dysentery < 5 yrs	
8	Diarrhoea / Dysentery > 5 yrs	
9	Enteric /Typhoid Fever	
10	Worm Infestations	
11	Peptic Ulcer Diseases	
12	Cirrhosis of Liver	
Urinary Tract Diseases		
13	Urinary Tract Infections	
14	Nephritis/ Nephrosis	
15	Sexually Transmitted Infections	
16	Benign Enlargement of Prostrate	
Other Communicable Disease		
17	Suspected Malaria	
18	Suspected Meningitis	
19	Fever due to other causes	
Vaccine Preventable Diseases		
20	Suspected Measles	
21	Suspected Viral Hepatitis	
22	Suspected Neo Natal Tetanus	
Cardiovascular Diseases		
23	Ischemic heart disease	
24	Hypertension	
Skin Diseases		
25	Scabies	
26	Dermatitis	
27	Cutaneous Leishmaniasis	
Endocrine Diseases		
28	Diabetes Mellitus	
Neuro-Psychiatric Diseases		
29	Depression	
30	Drug Dependence	
31	Epilepsy	
Eye & ENT		
32	Cataract	
33	Trachoma	
34	Glaucoma	
35	Otitis Media	
Oral Diseases		
36	Dental Caries	
Injuries / Poisoning		
37	Road traffic accidents	
38	Fractures	
39	Burns	
40	Dog bite	
41	Snake bite (with signs/ symptoms of poisoning)	
Miscellaneous Diseases		
42	Acute Flaccid Paralysis	
43	Suspected HIV/AIDS	
Any other Unusual Diseases (Specify)		
44		
45		

Appendix 2

Secondary hospital monthly report



Month: _____, Year: 20__
Total Working Days: _____

Secondary Hospital Monthly Report
Tehsil _____ *District* _____

1.	Facility ID	3.	Signature of Facility In-charge:
2.	Facility Name	4.	Designation:

1.	Daily OPD attendance		8.	C-Section performed	
2.	Fully immunization coverage		9.	Lab services utilization	
3.	Antenatal Care (ANC-1) coverage		10.	Bed occupancy rate	
4.	Delivery coverage at facility		11.	LAMA	
5.	TB-DOTS patients missing more than 1 wk		12.	Hospital death rate	
6.	Total Visits for FP		13.	Monthly report data accuracy	
7.	Obstetric complications attended				

Specialty	New cases MALE <1 year	1–4	5–14	15–49	50+	FEMALE <1 year	1–4	5–14	15–49	50+	Total	Follow-up	No. of cases of Malaria/dia (<5)	Referred Attended
1. General OPD														
2. Medicine														
3. Surgery														
4. Pediatrics														
5. Eye														
6. ENT														
7. Orthopedics														
8. Psychiatry														
9. Dental														
10. Skin														
11. OB/GYN														
12. Emergency/Casualty														
13. Homoeo Cases														
14. Tibb/Unani Shifa Khana OPD Cases														
15. Cardiology														
16. Others														
Grand Total														

1	Acute (upper) respiratory infections
2	Pneumonia < 5 yrs.
3	Pneumonia > 5 yrs.
4	TB suspects
5	Chronic Obstructive Pulmonary Diseases
6	Asthma
Gastro Intestinal Diseases	
7	Diarrhoia Dysentery <5 yrs
8	Diarrhoea / Dysentery > 5 yrs
9	Enteric / Typhoid Fever
10	Worm Infestations
11	Peptic Ulcer Diseases
12	Cirrhosis of Liver
Urinary Tract Diseases	
13	Urinary Tract Infections
14	Nephritis / Nephrosis

17	Suspected Malaria
18	Suspected Meningitis
19	Fever due to other causes
20	Suspected Measles
21	Suspected Viral Hepatitis
22	Suspected Neonatal Tetanus
23	Ischemic Heart Disease
24	Hypertension
Skin Diseases	
25	Scabies
26	Dermatitis
27	Cutaneous Leishmaniasis
Endocrine Diseases	
28	Diabetes Mellitus
Neuro-Psychiatric Diseases	
29	Depression