

Mapping feedback loops: Role of ICTs in making invisible voices visible

A Case study from Sri Lanka and Nepal

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making invisible voices visible**

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Abstract

The purpose of this thesis is to explore user participation through user feedback, based on the case of the digital global public good (DGPG) District Health Information System (DHIS2). This research draws on three important contextual conditions: capacity building, maturity of the system and DGPG which impact the feedback process and the creation of quality feedback. It explores field data collected by the authors in the two low- middle income countries (LMIC), Sri Lanka and Nepal. The socio-political conditions of LMICs tend to favour a top-down approach, in which the lower-level users are not considered. Based on this fact, the study incorporates participants from facility level who stated their non-involvement during the system implementation and while the system is running. In order to encourage such users, feedback serves as their voices, which was not heard for a long time and feedback system serves as a bridge between them and stakeholders for a collaborative development process. The intriguing element of this study is that it will contribute to the domain of research on user participation in an operational system. Research on user participation often focuses on user participation during the early design and development process of a new system, but in this case the system is already operational. The research question raised in this thesis is: *What are the available means for users to provide feedback while working with an operational open-source-based Health Information System (HIS), and how effective is this feedback addressed by the developers and implementers?* The study investigates the problem and challenges surrounding the utilisation of user participation, to be more precise the focus of the study is to encourage user participation in a system that is in regular use. As the main approach of user participation this study suggests implementation of a digital feedback system, and the process that must be undergone for a successful feedback system. To do that 1) the capacity needs to be strengthened within the country so that health personnel are knowledgeable and skilled to use the HIS. 2) The government and people must work closely to overcome the economic, political, and geographical challenges, so that the system can mature in a progressive manner. 3) A system producer claiming a system to be DGPG should also consider the users around the globe and encourage awareness about DGPG.

Keywords: *user participation, user feedback, digital global public goods, capacity building, level of maturity, health information System*

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Acronyms

API	Application Programming Interface
ARS	Ayurveda Reporting System
BS	Bikram Sambat
BMI	Biomedical Informatics
CA	Constituent Assembly
DHIS	District Health Information Software
DPT3	Diphtheria, Pertussis, Typhoid, Tetanus
DGHS	Director-General of Health Services
DDG	Deputy Director of General
DIN	Drug Information Network
DDA	The Department of Drug and administration
DoHS	The Department of Health Services
DoAA	The Department of Ayurveda & Alternative Medicine
EHMIS	Electronic Health Management Information System
EWARS	Early warning, Alert and Response System
FMIS	Financial Management Information System
HIE	Health Information Exchange
HISP	Health Information System Program
HIS	Health Information System
HIV	Human Immunodeficiency Virus
HISSL	Health Informatics Society of Sri Lanka
HIIS	Health Infrastructure Information system
HIU	Health Information Unit
HMIS	Health management information system
HuRIS	Human Resource Information System
ICT	Information and Communication Technology
INGOs	International Non-governmental Organisation
IS	Information System
IFRC	The International Federation of Red Cross and Red Crescent Societies
IME	International Management
LMIC	Low-Middle Income Countries
LMIS	Logistics Management Information System

MoH	Medical Office of Health
MO	Medical Officer
MOMCH	Medical Officer - Maternal and Child Health
NGOs	Non-Governmental Organisation
PMMH	Pregnant Mother Maternal Health
PGIM	Postgraduate Institute of Medicine
PMAHCS	Planning and Management of Assets in Health Care System
QDA	Qualitative Data Analysis
RQ	Research Question
SDG	Sustainable Development Goal
SSIS	Senior Strategic Information Specialist
TB	Tuberculosis
TT	Tetanus Vaccine
TIMS	Training Information Management System
UN	United Nation
UNFPA	United Nations Population Fund
UIO	University of Oslo
UNFPA	United Nations Population Fund
UNICEF	United Nation Children's Fund
USAID	United States Agency for International Development
WHO	World Health Organisation

Appendices

Bikram Sambat - national calendar of Nepal which is historically used in the Indian subcontinent.

Disease prevention - procedures were individually, particularly those with risk factors for disease, to be treated to prevent a disease from occurring.

Family Health Bureau - organisation responsible for planning, coordinating, monitoring and evaluating the reproductive, maternal, child, adolescent and Youth Health programme in Sri Lanka.

Health protection - protecting individuals, groups, and populations from single cases of infectious diseases, incidents, and outbreaks.

Health promotion - process of enabling people to increase control over, and to improve their health.

Landlocked - A landlocked country is a country that does not have territory connected to an ocean.

Incharge – highest position in the department.

Information and communication technology - diverse set of communication technologies, and computer applications which can gather, process, store and disseminate information.

Nepal bhasa (Newari) - one of the major languages of Nepal.

Political division - a geographical unit in which a person with authority is elected, so that he/she can represent the division.

Open-source platform - any platform that allows access to its source code to any other users or developers.

Surveillance - action of monitoring behaviour, activities, or information for the purpose of information gathering, managing, or directing.

Social Health Security Development Committees - committee established to provide Health security coverage and ensure access, utilisation of quality health services at an affordable cost for all citizens of Nepal.

Outpatient department - part of a hospital designed for patients that do not need an overnight stay, it is a department where you are treated as an outpatient or day patient

Chapter 1 Introduction

This thesis is a joint effort of two authors titled ‘Mapping feedback loops to make: invisible voices of users visible. A case study from Sri Lanka and Nepal’. It briefly introduces our study area, research objectives, research questions, motivation for this study, and our expected contributions to this field.

1.1 The expanding role of digital health

Over the recent years, there has been an accelerated growth of new Information and Communication Technologies (ICTs) initiatives around the world, and the health sector has been particularly impacted. New and advanced ICTs are evolving, and they are at the forefront of development initiatives, providing unique opportunities for countries to accelerate economic growth and connect citizens to public services and jobs, including within the health sector. In times of crisis, from natural disasters to pandemics such as the one the world experienced with Covid-19, digital technologies are what’s keeping people, governments, and businesses connected (World Bank, 2020). Various research studies have demonstrated that ICTs can make a significant contribution to the health sector in developing countries; no longer it is a matter only of technology, but of how health professionals make better treatment decisions, hospitals provide higher quality and safer care, citizens make informed choices about their health, and governments become more responsive to the health needs of their citizens (World Health organisation, 2005). It is also about creating national and local information systems that support the development of effective, efficient, and equitable health systems. Above all, it is about connecting people to the information and knowledge they need for accessing better health for themselves, their families, and their communities (World Health organisation, 2005).

Health Information Systems (HIS) refer to systems that are designed to manage routine health-related data about the services the government provides to its citizens. This includes both aggregate data of population-based services and individual data about a patient's medical history and treatment services provided.

Not only that, Health Information Systems help manage population-based services and also individual care services within hospitals and other health facilities. HIS is thus a significant tool

for operational management, supporting healthcare policy decisions, and patient-level care services (Brook, 2020).

Many low and middle-income countries (LMICs) are using computer based HIS to manage and strengthen their healthcare services and support the achievement of their Sustainable Development Goals (SDGs). However, they continue to face considerable challenges in using digital data to support the provision of high-quality, affordable, and universally accessible care. In response, policymakers, donors, and program implementers are searching for innovative approaches to eliminate the geographic and financial barriers to health, contributing to mounting interest and acknowledgment of the potential of the digital to strengthen healthcare services (Lewis, et. al., 2012).

Sri Lanka and Nepal, which are the analytical focus of this thesis, are both using the District Health Information System (DHIS2) (DHIS2, 2022) as their national digital platform for various applications, such as routine HMIS (Health Management Information Systems), disease registries, building national health dashboards for monitoring health systems' performance, and in the recent month for tracking and responding to the Covid-19 pandemic.

While there are interesting similarities in both countries in their use of DHIS2, such as the variety of applications and the context of an LMIC, there are also interesting differences, such as their varying levels of maturity in their respective systems, the different varying models of implementation and capacity development and different socio-political and cultural conditions. Examining the implementation processes in both countries, around the same technology, allows for analysing what works well and what does not and their underlying reasons.

This thesis focuses on the analysis of the issue of 'user feedback' which refers to the modes by which users can express their voices around issues they are facing while working with an operational system, and in understanding their experiences in getting effective responses or not to the issues raised.

User feedback is different from participation, as discussed in the literature, as user involvement in the design of new systems since our focus is on an operational system. The issue of user feedback is important for the developers and implementers to gain an understanding of user experiences and be able to address them effectively. Traditionally, user participation studies have focused on understanding users' inputs to the design process while planning for a new

application, but they have not focussed on understanding the inputs into the issues faced with an operational system. Often it is the case that users are given some initial training at the time of initiating a new technology, but then they are left on their own far away in the field once the system is operational. As versions of the software keep changing and the use process becomes more complex, understanding user feedback is crucial, else there is the real danger that users will discontinue the use of the system.

The issue of feedback is particularly relevant to understanding when the HIS is based on an open-source digital platform (like DHIS2), where there is an implicit assumption that users are knowledgeable about the system, have access to the source code, and would have the capabilities to address issues faced locally.

However, this is often not the case, as the platform continues to change and become increasingly complex, magnifying the need for local support based on the lived experiences of the users. With this in mind, the research question addressed in this thesis is:

What are the available means for users to provide feedback while working with an operational open-source-based HIS, and how effective is this feedback addressed by the developers and implementers?

1.1.1 Importance of feedback in user participation

Feedback can have multiple meanings. Oxford dictionary defines feedback as advice, criticism, or information about how good or useful something or someone's work is. In this study, we consider feedback as thoughts, emotions, and perspectives of the end-users about the platform or system they are currently using. It can represent the level of satisfaction or maybe dissatisfaction the end-users have regarding the system they use, it can be good reviews, complaints, or even a feature they request that they feel is missing.

In addition to that, in some cases, there can be situations where the end-users are given a system implemented by a higher level/government agency without the participation of end-users. If this is the case, it becomes important to understand how users perceive the system, whether they think the system they use makes their everyday life easier or does it primarily add to their burden of work.

The importance of the involvement of end-users in the design process of a platform or system as well as of receiving their feedback as they work with an operational system, cannot be emphasised enough. As discussed by Almaliki et. al. (2022), user feedback represents the main source of knowledge to understand how users perceive the role of software in meeting their requirements. Therefore, their feedback is crucial for the system to be better adapted to their everyday needs and build positive changes to the platform or the system. Feedback from end-users serves as a guiding resource for the growth of any type of company, platform, or system (Wellington, 2019).

Having an operational system, which has been developed and designed by a higher level/government agency or through some external agencies with limited involvement or feedback from users about their perspectives, can contribute to users experiencing challenges in its use. Ultimately, the user's satisfaction level is the benchmark for the success of any kind of platform, and if their voices are largely invisible, it will be inherently difficult to see the actual problem areas experienced on the ground and to identify the potential nodes for improvement (Pillai et. al., 2019). If users and their feedback, thoughts, emotions, and perspectives are considered from the beginning of the system development process and throughout its implementation, it will contribute to the platform or system being more user-friendly and providing user satisfaction, as compared to a situation when their voices are not visible.

Ignoring users while designing a system can contribute to users experiencing challenges in its use, as they struggle to voice their concerns, resulting in poor action to resolve their problems. Feedback thus has two key components -- one is the available digital and non-digital means that users have to voice their concerns and feedback. Secondly, the nature of response or action they experience from the developers and implementers on the issues they have raised.

This thesis will examine both these aspects, separately in Nepal and Sri Lanka, analyse the similarities and differences in user experiences, and try to understand the underlying reasons.

1.2 Overview of relevant literature

In this section, we argue why this study is important, what are the gaps in the literature, and where we believe our study can contribute. In addition, we briefly give an understanding of the four important conceptual aspects guiding this research: *User participation through feedback*,

capacity-building models, digital public goods, and the context and maturity of the system. These represent important and relevant concepts for our analysis and will help frame our contributions.

1.2.1 User participation through feedback

User participation refers to the behaviours and activities that the target users or their representatives perform during the processes of information systems (IS) design and development (Barki and Hartwick, 1989). User participation is considered to contribute to IS success, which is often difficult to achieve, only by technical means of improving software quality and software features (Martikainen, et.al., 2020).

Feedback is a major part of the user participation process, as when users are involved in the development process they can contribute to issues regarding their experiences and aspirations with the system by providing their thoughts, emotions, and perspectives. Although there is abundant literature on user participation in the design of new systems, questions related to feedback from users on operational systems have not received as much attention as they should, particularly around questions of the effectiveness of systems to support everyday tasks of data analysis and use.

When there is an operational system in use but designed with a top-down approach as in Sri Lanka (Hewapathirana R. 2017), the users will undoubtedly experience challenges in its use, and will struggle to voice their concerns while being obliged to use the system by the higher-ups. When unable to voice their concerns, they will also receive poor action to resolve their issues, leading to an erosion of their interest in using the system. Understanding these dynamics is distinct from the user participation processes in new system design.

Thus, in our case, we want to study user participation in an already operational system, more precisely feedback on how the users perceive the system, what experiences they have regarding the use of the system, and how and through what channels they can reach out to access for help and raise issues of features they feel they are missing, and the nature of responses they get on the voices they raise.

1.2.2 Digital Public Goods

The issue of digital global public goods (DGPGs) is relevant for our analysis, as DHIS2, which is the platform on which both the Sri Lanka and Nepal HIS are built on, has inbuilt assumptions of user access and control over the software (Sæbø *et.al.*, 2021). Such assumptions marginalise the importance of actively soliciting feedback from the users. Existing literature on DGPGs largely focuses on the ‘supply-side’ of how they are developed and distributed and tends to ignore their actual use of the DGPGs.

DGPGs are often defined as open-source software, which allows users to access the source code without apparent restrictions on who can access it (Digital Public Goods, 2021). In the case of DHIS2, it has the flexibility for local customisation and configuration (DHIS2, 2021), which allows ministries, stakeholders, and other users to access the source code, and configure and customise it according to their needs. This raises the need for local capacity to be able to carry out these operational tasks. However, this local capacity is often not there or is limited in LMICs, particularly when new versions of the software are implemented and distributed, new features and modules are added, and the existing features are changed.

Training users to adapt to these changes comes at high costs and time investments, which are often not affordable by LMIC governments. This lack of training and limited feedback will further contribute to users experiencing struggles to use the system, which raises the need for continuous feedback from the users and their resolution by system implementers. In its absence, the complexity the users must contend with in the use of the system is continuously rising. As users of DGPGs, which by design are always evolving, it is particularly important to have their feedback, perspectives, and understandings of the DGPGs they are using. While there is a lot of focus on DGPGs and their production or development of it, there is far less focus on users, which raises the importance of highlighting this research and practice gap.

There is indeed undoubted potential that DGPGs provide for strengthening public health systems in LMICs, but their potential to date has been largely underutilised. While there are various technical issues to contend with, such as standardisation, interoperability, sharing models of infrastructure for adaptation, capacity building, and international digital cooperation (Nicholson *et. al.*, 2022), arguably the question of user feedback is an important missing piece.

1.2.3 Context and maturity of the system

Several contextual conditions shape the maturity of the HIS, including political, environment, digital and human infrastructure, capacity building, history, and geography. Incorporating the role of context in shaping the perspective on system maturity is relevant to this study as it shapes the capabilities of the users to effectively use the system, have appropriate channels for voicing their concerns, and have the power to ensure that their concerns are addressed. Consequently, the lack of such maturity would contribute to the HIS becoming unsustainable (Mursu et al. 2000). Both the study sites included in this have differing political, economic, and cultural characteristics, and some similarities in the structure of their health systems and the DPG being used, which influence system maturity both positively and negatively.

The majority of care services in Sri Lanka are delivered through the public sector, since the country is a Unitary Government, with the Ministry of Health being largely responsible for the planning and delivery of health services in the country. In contrast, system decision-making in Nepal has been devolved to the federal, provincial, and local governments, as the country has a federal form of government. Thus, decisions are largely based on federal, provincial, and local health needs (Thapa et. al., 2019).

The health workforce shortage is a challenge that is similar for both the study sites, which contributes to difficulties in developing better capacity and infrastructure, adversely impacting the questions of HIS maturity. Nepal is one of the least developed countries globally, with a fragmented health system, insufficient health resources, poor sanitation, and prevention facilities. Public health services initiated by the government are arguably the backbone of the entire health system, but although the country has made notable progress in health outcomes over the past two decades, inequities in access to healthcare are still significant.

According to the Nepal Health Sector Strategy 2015-2020, one of the major barriers is the geographical accessibility for many people (Cao et. al., 2021). Sri Lanka on the other hand has made remarkable progress in its public healthcare system and is one of the few countries in the South Asian region to meet its Millennium Development Goals (MDG) and even some of its Sustainable Development Goals (SDGs). The system offers services on a walk-in basis with no charges at the point of care. Its service delivery has achieved impressive geographical spread with relatively low levels of spending. However, underinvestment in the system has resulted in

widespread shortages in human resources, medical supplies, and services, as well as inequitable service distribution (Kumar, 2018).

Studies show that most ISs implemented in LMICs fail to mature beyond the piloting stage, due to various reasons, including limited donor funding, lack of capacity building and inadequate political will (Neuman & Powers, 2021). When resources are limited, funds are generally diverted away and focus is given to other emerging priorities, and the attention to the HIS often erodes over time (Siribaddana, 2016), implying that the system is not allowed to mature.

Our thesis will examine what conditions shape the maturity of the respective operational HIS in the two countries, and how this influences the processes of user feedback and its effectiveness.

1.2.4 Capacity strengthening

Human, financial, and other resources are a significant part of any organisation to effect a positive change in the community (Leonard, 2018). However, the greatest asset of any organisation is its human resources and capacity.

Capacity, which refers to the ability to realise a certain potential to do something purposeful (Braa & Sahay, 2012, p. 207) for the staff and efficient approaches to continuously build it helps better achieve organisational goals effectively, where “Building capacity requires the competence to identify the problem or tasks to be done, strengthening these competencies, and helping to better realise the potential” (Braa & Sahay, 2012). Capacity is important more broadly to help realise the development goals and contribute to the agenda of better health for all, which fundamentally requires a vibrant and robust health system consisting of well-trained and motivated health forces (Chen et al., 2004).

In many LMICs, IS implementation efforts fail to mature beyond the piloting stage (Wakerman & Humphreys, 2011; Heeks, 2006; Walsham & Sahay, 2006) due to various reasons, but lack of adequate capacity is among the most important (Ash et. al., 2003; Sellitto & Carbone, 2007). While there are many training efforts, fewer initiatives have been taken to build capacity more broadly in higher education, particularly aimed at health professions (Burdick, et. al., 2007). Challenges related to capacity have historically plagued healthcare organisations in LMICs, and this compounds the problem of limited technical capacity and information specialists that exist in most LMICs (Sahay, 2016). Thus, over the past decade, capacity building has become more

and more central in the process of developing health systems in LMICs (Brown, 2003). There are several approaches to achieve the endeavour to solve the capacity challenges, which can be done via training, education and providing guides and manuals.

In the context of HIS, all these approaches are relevant. But in several instances, these approaches, especially in LMICs, seem insufficient for holistic capacity building (Dahal, 2019). New systems, updated modules, and advanced programmes get introduced and implemented from time to time, requiring continuous efforts to keep the workforce stay up to date with the new developments (Dahal, 2019). In Sri Lanka, resources for design and customisation, development, implementation, and training have been led by the Ministry of Health in close collaboration with the national university and an NGO called HISP Sri Lanka (HISP Sri Lanka, 2017). Such a collaborative structure is largely absent in Nepal, which has mainly relied on the training of its health personnel through the Ministry supported by other national and international organisations. Given that both countries have invested in providing training to their health personnel, this thesis will try to discover if these trainings are frequent, effective and are contributing to the sustainable use of HIS.

1.3 Research question

In this study, user participation and feedback are the key terms in focus, which are complementary as feedback can be one of the approaches to user participation that directly and indirectly promotes user involvement. As we briefly mentioned above the research question which will be guiding this thesis is as follows:

What are the available means for users to provide feedback while working with an operational open-source-based HIS, and how effective is this feedback addressed by the developers and implementers?

Drawing on the two terms user participation and feedback, this thesis will explore the degree of involvement of users in an existing system, which is the DHIS2. This study explores the processes of feedback of multiple levels around DHIS2, which they are using on a daily basis, based on their perceptions, needs, and problems. Understanding the users and involving them with the use of an effective feedback system, can potentially have a high impact on strengthening the overall implementation of HIS. An effective feedback system not only helps understand system errors and bugs, but also helps in understanding the experiences of the users. Furthermore,

only generating feedback is not enough, qualitative, and timely analysis and response to feedback are needed for the sustainability of a feedback system.

Understanding the users of HIS and encouraging them to participate via a feedback system helps customise and update a system according to its needs and demands. As the users are heard and involved, there will be fewer chances of developing unnecessary modules and will also contribute to fewer complaints regarding the system and its use. Understanding these issues requires the analysis of:

1. Processes of feedback cycles include collecting and responding to user feedback
2. Promoting user participation through means of effective feedback systems
3. Understanding the gaps inherent between the production and use of DPGs

1.4 Motivation for this study

We are two Master's students writing the thesis in joint authorship. We both started our Bachelor's at University of Oslo(UIO) in Design Use and Interaction together in 2016. While studying together for more than four years, we took several subjects where we worked in groups on group assignments. We took the course IN5320 - Development in Platform Ecosystems in the first semester, where we had our first encounter with DHIS2, an open-source HIS implemented in more than 70 countries (DHIS2, 2022). We were fascinated by the different types of software platforms that existed, and how the DHIS2, developed by the Department of Informatics, University of Oslo, stood out globally.

The course had also a large group project, where we together with other students developed a web application with JavaScript and HTML using the RESTful web API. The project allowed us to work with a real-world use case, and we realised the immense impact that DHIS2 has had on the health sector of many LMICs, including Nepal and Sri Lanka. The choice of working with DHIS2 as a topic for our combined Master's thesis was attractive, as we could potentially contribute to strengthening the health systems in our respective countries, and it could also provide us with a meaningful future career path.

Since both of us had the same aim with such a potential future project, we thought this could be something that we could do together. After researching the subject area and talking to other students and colleagues, there was one topic in particular that we thought might be interesting for us to write about, which was to examine how and has DHIS2 contributed to improved data

use through the available features such as the dashboards and data analytics. However, we realised that there was a big gap between the features being developed and their use, and how there were limited means to hear user feedback.

With this broad idea in mind, we got in touch with the supervisors who are responsible for this project. Discussing this topic with them and looking more into it made us interested not only in learning about the issue of feedback in relation to the use of dashboards primarily, but also more generally about the processes of feedback, as we were interested in learning more about user experiences. As we both have backgrounds in two LMICs, Sri Lanka and Nepal, we concluded that we could look into the use of DHIS2 in both the countries and understand what are the similarities and differences in relation to processes of feedback.

That being said, another interesting aspect of this is that we both are living in Norway and are studying at the University of Oslo, which initiated DHIS2 as a free and open-source platform. So, being born and raised in Norway and having a Norwegian perspective, but in addition to having roots and backgrounds in Sri Lanka and Nepal, we thought it would provide a better understanding from the users' perspective as we arguably have an understanding of both the cultures, which is important to understand the processes of both voicing and receiving responses on user feedback.

1.5 Expected contributions

The expected contributions are both conceptual and practical, these are outlined below.

1.5.1 Conceptual contributions

This study will contribute to the domain of research on user participation in an operational system, which is different from the already existing literature that has a dominant focus on user participation during the design and development process around a new system. By understanding users' perspectives, this study will conceptually contribute to highlighting the challenges of not involving the users in the use process and the adverse consequences of poor feedback systems.

We claim that involving the users during the operation of the system via feedback will strengthen their motivation and satisfaction to make better use of the system, such as the functionalities of

dashboards and data analytics. This will promote a better sense of system ownership as we see their problems and suggestions being heard and addressed.

Apart from user participation, this study will also contribute to the domain of research on DGPGs. By building an understanding of users' perspectives through the lens of feedback, we could try to fill the gap of demand-side conditions (Sahay 2015), representing the actual use of the DGPGs. The concept of understanding users of DGPGs devotes the focus of the intergovernmental organisation, international non-governmental organisations (INGO), non-governmental organisations (NGO), and even the general public towards the importance of understanding the users and their participation. Rather than only focusing on the supply side, it should focus on the process of development, implementation, and operation of DPGs to be sustainable.

This thesis in addition to all this will contribute to understanding the role of context in shaping processes of system maturity, where user feedback is a crucial component. There are several circumstances and factors that affect how the process of the feedback system works: culture, capacity and resources; these are just a few of the factors. By exploring this issue in two different country contexts but using the same digital platform, we will be able to understand what are the enabling and constraining influences of context on the processes of user feedback.

1.5.2 Practical contributions

Through our case study in districts of Sri Lanka and Nepal, this research provides insights into the perspectives and feedback from users of the system from multiple levels in the hierarchy: Facility, district/province, and national levels. We will build an understanding of how users perceive the system if they are included or not in the design and use processes, how feedback is processed, and how they experience the system. These insights are valuable as they can provide important information to global and national teams on possible changes that are needed. To the national level implementers, we will contribute with an understanding of what users think about the feedback process, which will help address the communication gap between users and implementers, for example, to highlight training needs. To the national level developers in respective countries, we will contribute with valuable feedback from multiple levels, which is important for further development and advancement of the system.

To the health ministries in both the countries, we will contribute valuable information on how the feedback process can be improved and can be used towards the development of their training

plans and required budgets. We will highlight the importance of user involvement in realising the potential of HIS to improve health services delivery and improved system ownership. To the global development team, this research will highlight the problems and users' needs in the South Asian countries, which they could consider while developing or providing assistance, and how new developments should be introduced.

Specific areas of contributions include:

1. Designing and making use of the feedback system regularly
2. Conducting periodic surveys of users' problems and their needs
3. Providing training and workshops on empowering the users
4. Involving users through the system lifecycle process.

1.6 Organisation of thesis

Chapter 1: Introduction, gives an overview of our thesis, our study area, research objectives, research question, and the empirical basis of this study. We also discuss our personal motivation for conducting this research.

Chapter 2: Literature and theoretical concepts, intends to go through relevant literature where the first subchapter introduces ICT, HIS, DHIS2, and DHIS2 platform's remarkable evolution through the decades. The next subsection introduces the concept of public goods and digital public goods. Finally, this chapter introduces feedback, why it is important to include feedback on the design process of the health system, and also what connection feedback and user participation have. All these topics will hopefully add background information and context, which will make it easier to understand this case study better.

Chapter 3: Context of the study - Country profiles, this chapter intends to give an overall understanding of both Sri Lanka and Nepal. Background information about the respective countries is important to know so that easier to visualise where they are in the process of building the country. This section gives a deep understanding of the health sector, policies and other relevant information which is needed to understand the overall situation in both the countries.

Chapter 4: Methodology & paradigms, this chapter gives an understanding of all the methods we have used for conducting this research. It will also provide information on the multi-level users that are interviewed, observed, and part of the group discussion in this study.

Chapter 5: Findings, as part of our findings process, we have coded our data and summed up all the responses we have collected from the interviews. Therefore, as we mentioned earlier in this chapter, we have divided all the findings into three levels just to make it easier to understand: Facility, district/province, and national level users.

Chapter 6: Analysis and discussion, this chapter provides an analysis and discussion of the findings we found in Chapter 6. Based on the findings, we have pointed out and categorised the most important issues, and we will provide our analysis and suggestions.

Chapter 7: Conclusion, finally in the last chapter we will address the research question that we identified earlier in this thesis. Based on our findings, we will provide suggestions on how the system can be improved for the better, so that the system is sustainable and future-oriented.

Chapter 2 Relevant Literature and Analytical Concepts

This chapter intends to give a detailed description of the four important concepts of our thesis: i) User participation through feedback; ii) Digital public goods; iii) Maturity of system; iv) Capacity building.

A detailed understanding of these concepts is essential for understanding the content of the other chapters. Introduction wise, we draw on the relevant literature in health and ICT in LMICs and how crucial user participation is in the system development process. In addition, we look at DHIS2 as a digital public good and how the maturity of the system is crucial in the process of providing quality and efficient healthcare services. We discuss the issues around capacity building, and we look at strategies for strengthening the capacity within the country. At the end, we look at an analytical framework which illustrates how all the concepts mentioned above are interconnected and what the outcome of improving these concepts will contribute to.

2.1 Health and ICT

The World Health Organisation (WHO) describes health as a state of complete physical, mental and social well-being and not merely the absence of diseases or infirmity. In addition, WHO affirms: “*The enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, religion, political belief, economic or social condition (WHO, 2022).*” Health is therefore one of the fundamental elements of our well-being. Several initiatives have been taken by countries to develop and improve health standards for individuals and societies. Developed countries are more advanced in providing better health facilities, though for low and middle-income countries (LMIC), the scenario is different. Due to economic, political, social, and environmental issues, LMICs face multiple constraints and cannot provide a similar level of health services. In recent years, there have been several efforts to strengthen the healthcare services in LMICs, including digitisation of care processes.

UN's *Sustainable Development Goal (SDG) 17: Revitalising the Global Partnership for Sustainable Development*, targets capacity-building by increasing technology and innovation in the least developed countries and improving data collection and monitoring systems (UN, 2022). The advent of ICTs has contributed to an immense change in every sector, as it has been a bridge that intends to reduce the gap between humans and technology. For this thesis, ICTs are defined

as tools that facilitate communication and the processing and transmission of information by electronic means.

This definition encompasses the full range of ICTs, from radio and television to telephones, computers, and the internet (McConnell, Shields, Drury, Kumekawa, Louw, Fereday, G., 2006). ICTs play a vital part in every governance structure, including the health sector. ICT in health is mainly based on the development of digital technologies, databases, and other applications that seek to prevent illness, treat diseases, and manage chronic illness (TalkingHealthTech, 2022). ICTs are seen as contributing to improving healthcare for individuals and communities.

2.2 Health information systems in developing countries

WHO describes health systems in terms of six core interconnected components or building blocks: (i) service delivery; (ii) health workforce; (iii) health information systems; (iv) access to essential medicines; (v) financing; and (vi) leadership/governance. In addition, they underline that these components contribute to strengthening the health systems in different ways and are all interconnected with health information systems in different ways (WHO, 2010).

A health information system normally refers to a facility reporting system designed to manage and administer healthcare data. It encompasses acquiring, storing, delivering, and analysing health data, made available in formats that meet the needs of multiple users such as policymakers, planners, managers, healthcare providers, communities, and individuals. In the health sector, the collection and distribution of information and reports are supported by robust health information systems (*J.Hosp. Med.*, 2010). The health sector consumes a lot of data, particularly related to individual patients and health facilities and thus has a significant impact on the health of the population.

Another implication of HIS is on costs, as digital platforms contribute to saving cost. Patients often need treatment from different healthcare providers, by sharing health information using health information exchange (HIE), health facilities can access health-related data about patients from a common platform. This potentially can reduce the cost both for the patients and the facility (Camara, et.al., 2007) and reduce the risk of misunderstandings between the doctors and the patients. While acknowledging the benefits of HIS and regardless of its growing availability, LMICs are facing huge challenges in implementing and using the systems, building capacity within the country, and most importantly, making the system sustainable over a longer period.

LMICs are dependent upon global funds and donors, subject to the use of economical and affordable systems, most likely global digital public goods. While digital public goods are more

focused on the supply side of their development and dissemination, they often ignore the actual users' needs and demands throughout the processes of system development, implementation, and use.

2.2 User participation in information systems

To encourage users of a system to get engaged in the system implementation and use, user participation is crucial. User participation “*refers to the various activities that users perform during information system (IS) development, user participation is considered to contribute to IS success, which is difficult to achieve, by improving software quality and increasing satisfaction*” (Martikainen et.al., 2020). Barki and Hartwick defined user participation “*as the extent to which users or their representatives carry out assignments and perform various activities and behaviours during information system development (ISD) and conceptualised it along with four dimensions, users’ hands-on performance of activities, responsibility, relations with IS, and communication with IS staff and senior management*” (Barki and Hartwick, 2001). Active user participation has a hugely positive psychological impact on the users, it contributes to positive behavioural and attitude changes, and users develop the belief that systems are important, helpful, and relevant for them and the society (Barki and Hartwick, 1994).

User participation can be practised using several approaches such as user-centric design, participatory design, ethnography, and contextual design or by a combination of two or more approaches. These approaches have different principles and with different degrees of involvement of users. For example, participatory design promotes the active involvement of users and in other approaches, users are used as objects for observation and are involved to provide information, suggestions, communicate problems, and their needs (Kujala, 2003). There have been several studies that promote and describe the benefits of user participation. Many studies focus on the participation and involvement of users at an early stage of system development or before the implementation of a system, meanwhile studies on user participation and involvement in an already existing and operational system is unexplored. This is the focus of this study, to build a better understanding of the processes of user feedback and how it can be more effectively promoted.

Historically, the involvement of users in system development was discussed back in the 1960s in Scandinavia. At that time, it was generally agreed that industry should promote general democratic principles in the society and that opportunities for increased individual engagement should be created as means to increase productivity and efficiency (Bjerknes & Bratteteig, 1995).

The approach was later included in several projects where the objective was to involve workers in the design of a computer-based planning and control system for their workplace. They included workers' knowledge, arranged working groups to discuss and find solutions through action programmes, and did assessments of the existing information system. This provided information that could improve the effectiveness and quality of the system. Today, participatory design is a methodology used in several disciplines such as urban planning, architecture, and sustainable development.

The Health Information Systems Program (HISP), the focus of this study, is a participatory design project, where the FOSS DHIS software was developed. The project started in South Africa but has since developed into a global network of participating countries and institutions (Velden, et.al., 2014). The core developers started the project with a very intimate relationship with the users and the context, though this is not the case anymore. Now, the meaning of participation has changed significantly by involving global teams in a network (Braa and Sahay, 2012). HISP was one of Norway's highest-ranked international development projects between 1999 and 2000 because of its success in promoting self-sustainable grassroots implementations following principles of participatory design and development. Braa and Hedberg acknowledge the early Scandinavian participatory design project as a source of inspiration for HISP and the development of DHIS (Gregory, 2003).

2.2.1 User feedback

User feedback has not been studied on its own right in studies on participatory design, which we want to highlight through this study. We conceptualise feedback as thoughts, emotions, and perspectives from users about the platform or system they are currently using (Følstad, 2017). The thoughts could be the level of satisfaction or dissatisfaction, feature requests they wish for, or even good/bad reviews about the system they have been able to convey. It can also be considered descriptive information regarding a learner's performance in a given activity, intended to guide future performance. There are several advantages for system implementers/developers of receiving user feedback;

1. It provides an outlet where users can express their concerns and frustrations
2. Users are the main consumers of the HIS that is being used, so they are attuned to the challenges they face which need to be elaborated upon.

User feedback and user involvement are crucial for software organisations, as they help system implementers/developers in understanding the users' needs and democratically extending the HIS (Kujala, 2003). This kind of feedback is not only crucial for system implementers, but also for the developers, stakeholders and other related people who can benefit from it (Pagano et.al., 2013), as it will provide the basis for future improvements to the system (Kimaro et.al., 2013). There are different ways to provide feedback that can be developed through group meetings, emails, direct calls, and social media (Viber, WhatsApp).

Providing feedback on an operational HIS in an LMIC context may be difficult, as the priorities of the system providers lie in providing an optimal HIS rather than involving users in the development process or getting their feedback. Additionally, due to lack of economic resources, LMICs often try to meet the short-term demands of their constituencies rather than thinking of sustainable systems. Likewise, bureaucracy, a top-down and rule-driven approach to functioning, and the belief that users are unaware of user participation and feedback systems are the other reasons that resist the implementation of the effective feedback system. With the advantages that user feedback provides, it is important to incorporate user participation and feedback processes. However, they need to be appropriate methods and approaches which are different from the traditional methods of user participation (Teka et.al., 2017).

Challenges in having an effective feedback system

Many operational systems in LMICs are designed with a top-down approach where health ministries, other national level authorities, and major donors are the main decision-makers. When planning and executing important projects such as the implementation of HIS, the grass-roots level users are normally not involved in the development, customisation, or implementation process. The users are therefore obliged to use a system that is implemented by the higher-ups. In this way, it might be difficult or take time to obtain the trust in the system from the users as they must be willing to cooperate in using the new initiatives.

Trust is identified as an important factor in the HIS success -- if the end-users have trust in the system and are willing to use it, it is a big step toward developing a successful HIS (Hewapathirana R. 2017). Implementing an HIS without users' participation has its disadvantages as they are obliged to use it without any proper knowledge or education about the system. They will further experience challenges in its use as most of the users in LMICs have never

encountered or used such systems before. When experiencing challenges, it will be difficult to voice their concerns, problems, or issues they face regarding the system. Some of them even think of it as an addition to their regular work and lose interest in using the system.

Involving the users and getting their feedback on a system is usually done in the development process, but in this context, the system is already operational, in that way it can be difficult to get user feedback without an explicit feedback system. Having said that, some strategies could be implemented to strengthen such feedback processes.

2.3 Participatory design within HISP network

As briefly discussed in the previous subchapter, HISP is considered a participatory design project, the key focus of the application of participatory design (PD) techniques has been around the design and development of the DHIS software. The growth and impact of HISP and its software DHIS have grown immensely through the decade. In the HISP community, PD has been used as an approach to target a diverse range of users within multiple levels of the health system to develop better health for marginalised communities in developing countries. A problem that often occurs in developing countries as Castell (1997) discusses, is exclusion from the network society. Developing countries do not have the same opportunities to access modern technologies as other developed countries.

Developing countries being excluded from society leads to a higher risk of being marginalised, which again leads to a lack of further development. Thus, the PD approach in developing countries through HISP has helped foster decentralisation and empowerment of local users in terms of control, access, and use. As an example, users who previously had to write reports by hand and send them to other institutions by post can now access their data quickly on their desktops, and institutions that are to receive the reports can receive them shortly after they are submitted.

Users at the grass-roots level and district/province level have for the first-time online access to data in their administrative areas, which makes their everyday tasks easier (Braa & Sahay, 2012). Braa and Sahay (2012) discuss four different interconnected cyclic development processes which are important for PD in HISP.

1. Developing the software - PD and development of the DHIS software application have involved rapid and exploratory cyclic prototyping in cooperation with users,

representing a practical way to both get the requirements right and develop the software accordingly.

2. Developing the information system - the participatory and cyclic development of essential data and indicator sets are used in the DHIS application as a prototyping tool. This helped get the generic data models right -or building the LEGO bricks - while also using the DHIS as a PD tool for prototyping to get the wider information system right, such as the datasets and the hierarchy of standards - the LEGO bricks were to build the system.
3. Developing the information for the action cycle - this represents the cyclical approach to turn the data collected into indicators which further needs to be converted into action to make improvements in the health services.
4. Developing the action research cycle: The action research cycle enables the development of the other cycles - building the software, the information system, and also that information for action. This cycle involves collaborative action between the health system and HISP, to identify required interventions, their implementation, and evaluation, based on which the next round of interactions in the cycle is made and thereby constantly generating a changing environment.

In this way, these four interconnected cycles provide the substance and content of PD processes within HISP. Each of the cycles comprises multiple techniques such as agile prototyping, workshop, meetings, database development, data analysis, capacity building, research, and education to be able to reach the end goal. The HISP PD effort is a rich and complex endeavour, though in practice it can be difficult to have a multi-level engagement of users as it requires technologies, capacity, interventions, and support. The aspect of having a multi-level engagement of users in the development process is an important point of view that needs to be addressed by the developing countries that are in the process of redeveloping their HISs.

Russpatrick et. al. discusses in their article that in an ongoing PD project in Rwanda, there were challenges related to local app development. The research further reported that it should be provided an approach and analysis of multi-levelled PD and interaction across local sites, country, and global levels. Practically, this could contribute to easing the tension between slow global responses to generic platform features and local needs through local app development (Russpatrick et.al., 2021).

Several developing countries already have an operational HIS, but as discussed earlier, the common for these countries is that the system is implemented with a top-down approach where involving users hasn't been a high priority as it should be. Therefore, action needs to be taken to involve all types of users in the development process, to achieve user satisfaction and a more sustainable HIS.

Strategies for involving users in an operational system

Bratteteig and Joshi (2016) discuss the importance of two processes in participatory design: Mutual learning and co-construction. Mutual learning suggests that designers learn about the use context and users' activities and that they need to observe and interview users in situ themselves. The users on their side need to learn about the technical possibilities so that they can imagine new solutions as well as the new practices that these solutions can bring about. The ultimate result of mutual learning is to learn about each other's practices and share competencies (Joshi & Bratteteig, 2016). In co-construction processes, users and designers work together on making concrete design representations and prototypes and collaboratively evaluate the design results (Brandt et.al., 2012).

The *co-construction* process can be combined with a mutual learning activity where a design idea is concretised and discussed among designers and users of the system (Joshi & Bratteteig, 2016). These processes can be implemented in an operational system, where designers and users work together, discuss, and evaluate the system to understand the problem areas, and solve the issues faced by the users.

Another strategy that could be initiated is arranging monthly surveys from all users about the system to help them provide feedback on what they would like to be configured, modified or changed.

2.4 Free and open-source software (FOSS) as a public good

FOSS is largely being used as an HIS platform in LMICs (Hewapathirana, 2017). FOSS is defined as a software that is freely licensed to use, copy, study, and change in any way, and the source code is openly shared so that people are encouraged to voluntarily improve the design of the software (UiO, 2020). The potential of FOSS enables LMICs to manage their information economy, by advancing knowledge more quickly and avoiding being held hostage to proprietary software (Câmara & Fonseca, 2007). FOSS is considered as an example of a digital public good (DigitalPublicGoods, 2022).

Public goods are those goods whose benefits cannot be confined to a single or a set of buyers. Yet, once they are provided, many can enjoy them for free. Without a mechanism for collective action, these goods can be underproduced (Rich et.al., 1997). The theory of public goods originates from the economics discipline based on two foundational principles of non-rivalry and non-exclusion (Ostrom et.al., 1977; Samuelson, 1954). Non-rivalry means when one individual makes use of a good, it does not depreciate the availability of others. And non-exclusive means there are no restrictions for the use of such goods for any individual or a group of individuals. For example, clean air -- one individual using clean air will not deplete the stock of clean air for others and will be available for everyone. We cannot exclude an individual from consuming it if it exists.

“Global public goods (GPDs) are goods of those kinds whose benefits cross borders and are global in scope” (Smith, et.al., 2003). GPDs are those public goods that are widely accepted as fundamental for socio-economic development with global relevance (Birdsall et.al., 2012). For example, the reduction of carbon in the air will benefit all people around the globe, and the discovery of vaccination of any infectious disease would prevent the spreading of the disease. There has been the invention of several GPDs that have provided benefits to people regardless of whether it is an LMIC or a developed country. They play a crucial role in safeguarding the social, economic, and political progress of countries. They are fundamental to managing global risks such as climate change, infectious diseases, and financial crises that can harm LMICs disproportionately (Birdsall et.al., 2012).

2.4.1 Digital Global Public Good

The term goods might give the interpretation of a commodity or a tangible thing like rice and oil, but the term goods also refer to non-tangible goods such as software and services. Thus, digital goods are those intangible goods that have a digital format, it could be a video, photo, programming codes, software, or system.

Digital public goods are those goods that have all the essence of global public goods and can be defined as re-programmable, modularised, and recombinable public goods, which are non-rivalrous and non-excludable. *The UN Secretary General’s High-level Roadmap for Digital Cooperation defines digital public goods as “open-source software, open data, open artificial intelligence models, open standards and open content that adhere to privacy and other applicable international and domestic laws, standards and best practices and do no harm” (United Nations, 2020, p. 35; Sæbo, et.al., 2021).*

In recent years, the use of FOSS-based HIS has significantly increased in the public health context of various LMICs. Prominent in them include DHIS2 being used in nearly 80 countries, the OpenMRS (Open Medical Record System) being used as an electronic medical record (EMR) in various contexts, and the iHRIS (Integrated Human Resources System) being used for health workforce management. The growth and impact of DHIS2 globally have been significant, making it a de-facto standard for HIS development representing the largest global footprint in terms of national HIS (Sahay, 2019).

District Health Information system (DHIS2)

DHIS2 is a FOSS platform used as a data warehouse that provides better data management, and visualisation and makes it possible for data users and policymakers to analyse live data in real-time (DHIS2, 2022). The core of DHIS2 was developed to fulfil the general requirements which are relevant for different geographical settings, but the flexibility of the platform allows for customization in accordance with local needs.

Today DHIS2 is used as a module-based open-source platform using Java frameworks, which enable the exchange of information such as reporting, analysis, and dissemination of health-related data. DHIS2 has a layer-based architecture which allows it to be more flexible in terms of user adaptations or modifications. The platform consists of a generic core where the software, APIs, and data models reside.

Third-party apps or custom apps can be developed by anyone and run on the DHIS2 platform. The apps that are developed can be tailored to a specific district or clinic's needs (DHIS, 2022). An example is the DHIS2 Covid-tracker, which is an instance developed specifically for COVID-19 surveillance in Sri Lanka. At the request of the Sri Lankan Health Ministry, this instance was developed to register and track incoming travellers from areas with a high risk of COVID-19 infection (DHIS2, 2020). As another example, the government of Nepal has now upgraded its old paper-based Health Information System (HMIS) into a digital system using the DHIS2 aggregate version, which replicates the prior paper-based system.

The generic core of DHIS2 is developed by members of the HISP team in Oslo, and when it comes to software localisation, it is managed by multiple local HISP teams in different countries. DHIS2 as an ecosystem provides a network that makes it easy to collaborate and contribute with capacity building, support, DHIS2 academies, DHIS2 development, and implementation.

According to HISP Sri Lanka and members of the Health Ministry in Nepal, there is a lot of collaboration across local HISP teams, but also with the core development team at UIO. To date, the DHIS2 platform is running on version 2.38 with a version released on May 5, 2022. The module-based open-source system DHIS2 points towards the accomplishment of DGPG status by being non-rivalrous and non-excludable. Non-rivalrous because when a person uses the system, it does not prevent others from using it, and non-excludable because it does not exclude a certain individual or group from using it (CFI team, 2021).

The platform architecture of DHIS2 allows local expertise to implement, develop and customise the system. In addition, it allows them to provide new requirements, use cases, and innovations that can contribute to changes in the system. The system is re-programmable, modularised, and re-combinable, this has been made evident by various organisations such as Ministries of Health, NGOs, MSF, and PEPFAR implementing the HIS. Even though DHIS2 corresponds to the definition of a DGPG, there are still complex situations and challenges that occur. Firstly, funding for the project is majorly reliant on donors, NGOs, and other agencies (Sæbø et.al., 2021). Secondly, tensions between scaling and striving to be relevant globally and locally, while still being able to serve the needs of an increasingly diverse user base, challenge relevance (Nicholson et al., 2019).

2.5 Context and maturity of the system

The maturity of the healthcare domain is affected by several contextual conditions which is a barrier to providing quality and efficient healthcare services (Tarhan, et.al., 2020). These conditions restrict them from being able to grow rapidly and develop their healthcare system further. The quality of public healthcare in LMICs has been neglected and attention is only given to technical aspects rather than for example interpersonal and institutional components. For example, the economic aspects of healthcare in LMICs have always been a crucial issue, catastrophic health expenditure poses a threat to the household's financial situation which causes problems in maintaining their basic needs (Bali, 2018).

The difficulty of LMICs being able to grow rapidly and achieve universal health coverage (UHC) lies in the design of policy initiatives that are often unable to tackle the root cause of the political, economic, and geographical differences (O'Donnell, 2014). The political aspects of LMICs are mostly unstable, and there tend to be fewer opportunities to make democratic choices. Political instability, multi-party involvement, and unfair and unethical practices result in frequent protests and the mindset of the majority of people always feels insufficiency and instability. Elected

political leaders are those who are responsible for taking major decisions and budget allocations and prioritising health sectors equally, but due to demands and objections from different parties, it becomes a challenge. In addition, a culture of non-transparency, corruption, and consumption of public resources by the private sector results in poor health delivery (Ranabhat et.al., 2020).

Economically in LMICs, there is stagnation due to the Gross National Income (GNI), formerly known as Gross National Product, being low. GNI is defined as the total value of all finished goods and services produced by a country’s citizens and businesses in a financial year and is one of the most important economic indicators (BusinessStandard, 2022; Ranabhat et.al., 2020). Due to low per capita income and low GNI, LMICs are also given the tag of least developed countries and are not able to invest sufficiently even in fundamental development needs including health.

The World Bank considers low-income economies as those that have GNI per capita between \$1,046 and \$4,095, upper middle-income economies as those that have GNI per capita between \$4,096 and \$12,695, and high-income economies as those with GNI over \$12,695 per capita (WorldBank, 2022). The table below presents GNI per capita in dollars of selected countries. According to this statistic, Norway, the United States, France, and China are the countries with the highest GNI and are considered high-income countries. Iraq is considered an upper-middle-income country. Sri Lanka, India, Nepal, Eritrea, and Sierra Leone are considered low-income countries (WorldBank, 2020).

Country	GNI per capita in \$
United states	\$64,140
China	\$10,550
France	\$39,500
Norway	\$78,290
India	\$1,920
Iraq	\$4,680
Sri Lanka	\$3,720
Nepal	\$1,190
Eritrea	\$600
Sierra Leone	\$510

Source: World Bank 2020

Table 2.1: Total GNI of selected LMICs and developed countries

A major barrier to the health services that are provided in LMICs is the implementation of high patient fees, i.e., privatisation, which has a negative economic effect on the individuals and families that have to pay to get the fundamental health services they need. LMICs are highly dependent on funds and donor support to achieve improvements, typically there are multiple donors aimed at particular disease-specific programs which are responsible for the development of HIS in LMICs. Thus, historically, such types of development have not been sustainable as the funding is normally short-term based, there is an inability to mobilise national support, there is a top-down approach, and it lacks building of the local capacity. Therefore, this kind of initiative ends up as incomplete or as a partial failure (Kimaro, et. al., 2005).

Geographical aspects are one of those factors that are identified as the most challenging, as this is hard to overcome even if there is the availability of good governance and a strong economy. The geography of a place hinders the availability of services, affordability, and acceptability. Especially in LMICs, several communities face difficulties in accessing even some basic health services, due to the distance from community to health facility and the cost of transport (Ranabhat et.al., 2020). The Nepal Living Standards Survey reports that 41 per cent of rural households do not have access to a health post or sub-health post and that 79.6 percent do not have access to a public hospital within 30 minutes of their home.

Overall, Nepal's rural population takes a mean of 135 minutes to access a health post or sub-health post. As geographically diverse as Nepal is by being a landlocked country with three ecological zones -- lowland, hills, and mountains -- it might be more time-consuming to provide healthcare in certain areas with more difficult roads and longer distances to where most of the health posts are located. Therefore, access and utilisation of healthcare become difficult. In Nepal, it is especially difficult to distribute simple needs such as vaccines. The picture below illustrates porters carrying COVID-19 vaccines to health facilities in mountainous areas.

Since there is less opportunity for transportation in such areas, the vaccines need to be carried by people on foot all the way up to the needed areas (Wang, et.al, 2019). Understanding these accessibility issues allows for the re-development of healthcare deployment in Nepal and similar nations.



Source: UNICEF/UN0431118/LPNgakhusi

Figure 2.1: Porters carrying covid-19 vaccines to health facilities in Jumla District in far-western Nepal, in March 2021.

Another important aspect of the maturity of the system is governance. Governance refers to ensuring the existence of the policy and strategic frameworks in combination with oversight, regulation, coalition, and accountability. As discussed earlier in this chapter, priorities lie differently in LMICs, where the public system governance mostly focuses on the delivery of public sector services. Public healthcare in LMICs differs from that in high-income countries in terms of resource mobilisation, coverage, access, and governance. In the case of governance, high-income countries rely on available technologies such as HIS to ensure good governance, which is expensive and generally rare in the LMICs.

These different conceptual aspects have varying levels of influence in shaping the maturity of HIS, and its evolution over time. The spiralling cost of healthcare, geographical boundaries which limit access to healthcare services, and the lack of political patronage are just some of the factors that restrict the healthcare domain in LMICs from being able to mature. There are conditions that restrict the maturing of HIS. This lack of maturity also has adverse influences on the ability of the users to work with the HIS and provide relevant feedback for improvement (Ur-Rahman, et.al., 2019)

2.6 Significance of capacity strengthening

HIS' capacity strengthening within LMIC settings is a considerable challenge. Personnel working in the health sector play a vital role in providing health-related information and medical care to the population (Siribaddana et. al., 2019). Therefore, it becomes important to continuously provide support so that they can develop their knowledge.

A major issue in LMICs is limited access to technical capacity, which encompasses multiple aspects of governance, technical skills, training, and data use (Siribaddana et. al., 2019). Aspects which constrain LMICs from being able to incorporate the technology are multiple including economic, political, social, and environmental, and in its absence design-reality gaps are created which impede the maturing of the HIS.

2.6.1 Limited workforce resources

With the convoluted threat of infectious diseases that briskly spreads around the world, the importance of a sustainable health workforce becomes crucial. The workforce is not only healthcare professionals like doctors, nurses, and physicians, but includes community health workers, mid-level workers, public midwives, and others who all play important roles in strengthening health service delivery in any country.

Due to the global crisis in the health workforce, where there is an acute shortage and maldistribution of health workers geographically and professionally, strengthening the capacity becomes a real problem (Bangdiwala, et. al., 2010), which is magnified in the LMIC context because of the problems of access, particularly in the rural areas. The staff who are needed for data collection, reporting and analysis are overburdened with other responsibilities and therefore detract from their primary role of care provision (Dal Poz et al., 2009). WHO indicates that by 2030, it needs around 18 million health workers, mostly in LMICs, to fill the shortage of workforce in the health sector (WHO, 2022).

To understand the problem area, we have examined WHO's statistics on health workforce per 10,000 population in some countries in the Asian region. According to these statistics, four of these countries have less than 20 nurses/midwives per 10,000 population and eight of these countries listed below have less than 10 medical doctors per 10,000 population.

Asian Region	Year	Nurses/midwives	Medical doctors
Bangladesh	2020	4.89	6.67
Bhutan	2020	20.78	4.99
Maldives	2019	46.61	20.53
India	2020	17.48	7.35
Indonesia	2019	39.54	6.23
Myanmar	2019	10.82	7.37
Nepal	2020	33.42	8.52
Sri Lanka	2020	24.95	12.29
Thailand	2020	31.52	9.5
Timor-Leste	2020	17.48	7.56

Source: Global health workforce statistics database, WHO.

Table 2.2: Health workforce per 10.000 population in Asian Region

Comparing the findings above with the findings below, where we can see a table of health workforce per 10.000 population in the European region, we can see a significant difference in the number of health workers per 10.000 population as indicated in the table below.

Asian Region	Year	Nurses/midwives	Medical doctors
Norway	2020	184.2	50.47
Germany	2020	141.9	44.35
Denmark	2018	105.4	42.25
Belgium	2020	200.8	60.79
Croatia	2019	81.22	34.65
France	2019	117.8	32.74
Ireland	2020	179.8	34.9
Netherlands	2020	116.4	40.79

Poland	2020	68.66	37.71
Romania	2020	73.89	29.81

Source: Global health workforce statistics database, WHO

Table 2.3: Health workforce per 10.000 population in the European region

WHO's development of norms, standards, and guidelines to promote quality assurance for pharmaceuticals is an integral part of WHO's constitution. One of the eight global standards defined by WHO defines the level of quality in the delivery of services. An example of such a standard is accordingly:

Standard 3 - Appropriate package of services: The health facility provides a package of information, counselling, diagnostic, treatment, and care services that fulfil the needs of all adolescents. Services are provided in the facility and through referral linkages and outreach (WHO, 2015).

Thus, to be able to provide quality health services according to WHO's norms, standards, and guidelines there need to be available staff that could provide such services. The importance of strengthening capacity becomes crucial in such a situation. Aspects that leverage the lack of a healthy workforce are both economic, political, social, and environmental. Countries with poor economies are likely to be those with the most inadequate human resources and the least means to strengthen capacity. Not merely that, it also requires a strong action coalition across all stakeholders with diverse interests to be able to achieve the goal of national health, which is available for every citizen in the country, and an environment where the workforce can be supported and valued (Bangdiwala, 2010).

2.6.2 Knowledge gaps

The knowledge gap in health informatics is particularly wide in LMICs as they often experience challenges in providing training, knowledge, and education to create sustainable local expertise (Siribaddana, 2016). The workforce typically has extensive knowledge and experience in domains such as nursing, medicine, and community care, but has limited health IT skills. Hence, they need proper training and continuous training and knowledge to improve their understanding of HISs and the strategic value it provides (Dahal, 2018). The Health Information System Program (HISP) has adopted several approaches in an attempt to narrow the knowledge gap.

Training and capacity building has been some of the interventions for filling these knowledge gaps. An example of such an approach is establishing local higher education institutions, where local experts can obtain both master's and doctoral degrees in health informatics.

Sri Lanka is a positive example in this regard as they have established a Master's degree in Biomedical Informatics at the University of Colombo in Sri Lanka. The effects of the establishment have greatly contributed to adopting technology in the process of improving the health system in the country. Similarly, Diploma, Master's, and Ph.D. courses in Public Health are provided at the University of the Western Cape in South Africa. These programs were initiated in developing a sustainable institutional base for the training scheme and became a centre of excellence in health information (Braa and Sahay, 2012). Likewise, during the eHealth Asia 2015 conference held in Colombo, there was signed a memorandum of understanding that there will be provided resources and technical assistance to establish a master's degree program in health informatics at Kathmandu University in Nepal (health information society of Sri Lanka, 2015). As per our site visit to Kathmandu University, there is now an ongoing process of establishing the Master's Program in health informatics where the aim is to strengthen the capacity and provide proper education in HIS.

2.6.3 Strategies for capacity strengthening

Building and strengthening the capacity within health informatics on LMICs require multiple modes, including

1. Establishing formal education in Public Health Informatics
2. Short-term specialised courses for In-service
3. In-house Training
4. Support through global, regional, and national networks
5. Hand holding and support - learning by doing in context over time
6. Supporting capacity development through toolkits
7. Remote training

Establishing formal education is one thing, but the already existing health staff should also be able to build and develop their knowledge. An effort that should be initiated is short-term specialised courses so that they could improve their knowledge and skills and get an understanding of the HIS in use. As new modules of the system are introduced rapidly it is

important to arrange such courses rapidly so that the process will be sustainable. Likewise, it is important to have workshops and engage the users in the development process of the existing system. Development in this study denotes the customization, updating versions, making changes, educating, and training users, customization, testing, and problem-solving in an operating system. Two examples of education that are provided in developing countries are the MD programme at the postgraduate institute of Medicine in Sri Lanka and the school of public health part of the University of Western Cape which supports the establishment of the district health system in the new democratic South Africa.

2.7 Analytical framework

In this section, we illustrate a basic analytical framework that helps to identify key challenges and approaches to strengthen user feedback systems for operational HISs in developing countries. This framework is generated by the overall understanding of the empirical data which will be further discussed in the analysis chapter. The phenomenon discussed in this study is mainly user participation through feedback, the mechanisms, mediums, and technologies involved in generating feedback, and the perception of users on the feedback system. Capacity building, maturity of the system, and DPGs are conditions that can influence user participation and quality of feedback. These conditions are applied and implied in different manners with the different situations due to the problems that can be material, nonmaterial, organisational, social, and technical.

To address all these problems, we have proposed the mechanism of an effective feedback system within HIS. This mechanism is supposed to be the inbuilt system that helps users at all levels communicate their feedback, where a team of dedicated feedback managers is available to identify the feedback systematically and scientifically, prioritise and voice the concerns and issues to the related parties, departments, governmental bodies, or international/global teams. Effective feedback implication is not only limited to IS, but it has also been used as a universal strategy for better performance and effective results (Farooq and Khan, 2011, Huxham, 2007).

Planned, dedicated, and routine practice of user participation creates effective feedback that helps solve the problems, in addition, expands the outcomes, and paves the path for the sustainability of the system. In the case of user participation, feedback helps in prioritising users that contribute to positive behaviour, and attitude changes and improve users' satisfaction. Similarly, in the case of FOSS via feedback awareness about digital public goods is promoted. Likewise in the case of

Maturity and the context of the system, effective feedback helps to understand all the political, geographical, and social aspects which in return helps to continuously operate the system with minimal errors. Lastly, in the case of Capacity Building, feedback is essential as capacity building is linked to educating the users, and feedback is vital for all the parties- users, stakeholders, and system developers to evaluate the performance and the results of all the parties.

This framework shows that all the categories and conditions mentioned are somehow overlapped and interlinked with each other. User participation encourages users to be involved with the system, where they can provide valuable opinions about the system for the betterment of the system. It eases the use of the system itself for the users as they can provide feedback which can make a positive impact on the development of the system. The collection of opinions is one of the mechanisms of feedback, thus user participation directly or indirectly promotes feedback. Likewise, the maturity and context of the system are concerned with the existence and survival of the system complying with political, geographical, and social aspects, which require a series of communication to improve and maintain a balance between these aspects. Maturity deals with the growth of the system based on its lifecycle, a matured system has a more organised technique and procedure to manipulate the feedback compared to a less mature system, thus a more mature system denotes a better feedback system.

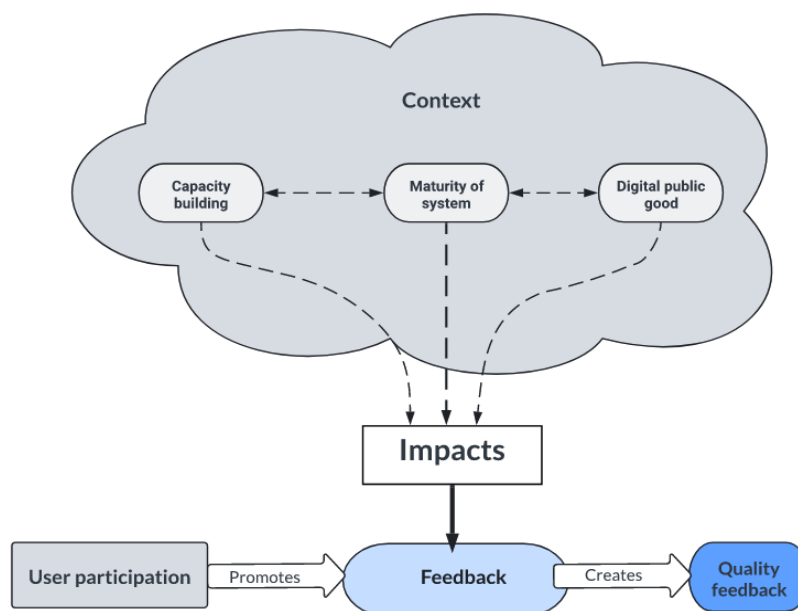


Figure 2.2: Analytical framework

Likewise, DPGs are platforms that have a global application and a huge group of users. In addition, DPGs are free open-source software that allows users to customise the system according to their needs which promotes user participation and provides opportunities to generate feedback from all its users. In addition, making users aware of the free and open-source systems (DPGs) and their implications contribute to skill development which ultimately affects the capacity building. Capacity building is educating the users about the system, making users aware and responsible for the system helps in discovering the problems that are concerned, and sometimes finding the better solution that needs to be communicated, thus capacity building also elevates quality feedback. In conclusion, the figure 2.2 above illustrates the framework that capacity building, maturity of the system, and DPGs are conditions that influence the feedback, the outcome of its influence is quality feedback from users which can contribute to system development.

Chapter 3 Context of the study - country profiles

This chapter will provide background information such as history, health services and other relevant information about our case study sites, Sri Lanka and Nepal, which is needed to gain insights as a context for the study. This chapter also gives an overview of the different districts and provinces where we conducted our data collection. This information is relevant as it provides a sense of internal capacity in the countries and gives an understanding of the maturity of the digital system. It is also relevant for the analysis of feedback capacities.

3.1 Introduction: Sri Lanka

Sri Lanka, formerly known as Ceylon (officially Democratic Socialist Republic of Sri Lanka), is an island nation located in South Asia with an area of 65, 610 sq. km, Sri Lanka is one of the 40 largest islands in the world. Sri Lanka shares a maritime border with India and the Maldives, making them the closest neighbouring countries. The country is divided into nine administrative provinces, which are further subdivided into 25 districts, and the districts are again divided into 331 divisional secretariats. The divisional secretariats are further divided into Grama Niladhari Divisions (GNDs). In total, there are 14,022 GNDs all over the country.



Source: Ministry of Health, Sri Lanka (2018)

Figure 3.1: District map of Sri Lanka.

The capital of Sri Lanka today is Sri Jayawardenepura Kotte and Colombo, which represent the two largest urban areas in the country. Sri Jayawardenepura is the administrative capital of the National Legislature of Sri Lanka, while Colombo is the chief economic and commercial centre of Sri Lanka. Despite being a small island, it houses around 21 million people, which according to the World Atlas makes Sri Lanka one of the most populated islands in the world (Migiro G., 2019). The country consists of a multi-ethnic and multi-religious society with approximately 74 percent being Sinhalese, 17 percent Tamils, and 8 percent Moors. Buddhism is the main religion in Sri Lanka with around 70 percent of the population belonging to it, followed by 12 percent Hindus, around 9 percent Muslims, and 7 percent Christians (Department of Census and Statistics, 2021).

3.1.1 Governmental structure

At present, Sri Lanka is a unitary democratic republic with three levels of government -- national, provincial, and local. It is unitary in the sense that the government has supremacy, and that departments and units work under its administration. The head of the government is the President, who is elected through national elections and serves as the head of the government for five-year terms twice. Further, the President chooses a Prime Minister, who is the leader of the majority party in the Parliament. Together with the Prime Minister, the President designates a Cabinet of members who are going to be part of the Parliament (Commonwealth Local Government forum, 2017).

- **National level:** Cabinet of ministers which comprise the central government in Sri Lanka, President and Prime Minister are part of the Cabinet where the President is the head.
- **Provincial level:** Responsible for following internal law and order, provincial economic plans, education, housing, and agriculture.
- **Local level:** Responsible for providing public services, including roads, sanitation, housing, public parks, and drains. Local levels are again divided into different groups such as municipal councils, urban councils, and divisional councils.

3.1.2 Historical evolution

To get a perspective on the history of Sri Lanka, we have to go back to 1505 when Sri Lanka was occupied by the Portuguese, the occupation marks the beginning of European interest in Sri Lanka. From 1658 to 1796, Sri Lanka was occupied by Dutch forces who established control

over the whole island except for the city of Kandy. From 1796 until 1931, the island was under the control of Britain. Finally in 1948, the island got full independence (BBC, 2019). Despite attaining independence in 1948, antagonism between two ethnic groups increased, and the clash between the two groups led to a nearly three-decade long civil war that culminated in 2009 (Fuglerud Ø., 2021).

3.1.3 Rehabilitation post-conflict era

As a result of the long civil war, there arose several problems related to social, infrastructural, political, and personal health issues, which were very difficult to prioritise. Firstly, due to several years of brutal conflict, many people suffered conspicuous physical injuries. In an Asian country where mental health issues carry a harmful social stigma, it was hard to provide treatment to those affected. Post-traumatic stress disorder and somatization disorder became common among the population.

Despite failures in the initial phase after the war, the need for improving the health infrastructure was prioritised by the government. Now, it has been over a decade since the civil war ended, and Sri Lanka has made remarkable development in the health and social sectors. The reason might be that they have not experienced major disease outbreaks following disasters and emergencies during the past decade. Its impressive health indicators include a maternal mortality rate of 33.8 per 100,000 live births, an infant mortality rate of 9 per 1,000 live births while life expectancy at birth is 75.3 years.

The country has a surveillance system, and all vaccine-preventable diseases are an integral part of the communicable disease surveillance system. In addition, the network of public health units and hospitals is spread across the island where hospitals in general are well-staffed and equipped to meet the growing curative health demands of the population, contributing to a well-established health system (Hewpathirana R., 2017). As a result of these achievements, for more than 30 years, Sri Lanka has been recognised as a strong performer in global health index (Athukorala K., 2022). The government has also built strong partnerships with non-governmental organisations (NGOs), such as the International Federation of Red Cross and Red Crescent Societies (IFRC), to implement programs to rebuild the country (Muraleetharan O., 2016).

3.1.4 Health status: Sri Lanka

Today, Sri Lanka is providing a high-level of health services while still being a low-middle-income country. Sri Lanka's primary healthcare is provided both in the form of a public and

private sector. The public sector health services are provided free of cost at the point of consumption and are delivered through two distinctive forms – curative and preventive.

The private sector provision is based on market demands (Ministry of Health, Nutrition and Indigenous Medicine, 2018). The preventive services, also known as community health services, are divided into geographic subdivisions known as Medical Officer of Health (MOH) units, each covering around 60,000 to 100,000 people. An MOH unit can be described as the smallest administrative division in the public health system in Sri Lanka. These MOHs focus mainly on preventing illness, disease control and arranging prevention programs. According to WHO's review of Sri Lanka's health system, there are around 354 MOHs in Sri Lanka.

The success behind achieving impressive health outcomes is due to appointing MOH as the in-charge of a specific geographical area, and according to people's residence, one gets assigned to an MOH. When it comes to the organisation of the MOH, a Medical Officer of Health, which is a medical doctor, is appointed as a manager of each unit. In addition, they are supported by a team of public health staff such as Public Health Midwives (PHM), Public Health Nurses (PHN) and Public Health Inspectors (PHI) (Rajapaksa L. et al., 2021). Administrative and supervisory staff members are located in the MOH office, but the team of PHM, PHN, PHI, school dental therapists, and staff related to disease control programs are located in the field.

Medical doctors, who represent national units such as the epidemiology unit, family health bureau, non-communicable diseases unit, and other respective health programs are responsible for guiding technical operations. The MOHs in Sri Lanka play a key role in the public health system, as they have responsibilities related to surveillance, monitoring preparedness for response, health protection, health promotion, and disease prevention. In 2020, when the WHO declared the outbreak of Covid as a pandemic, the MOHs played a key role in controlling and management phase as they were responsible for preventing it from spreading within and outside its geographical area. They are the backbones of the public healthcare system at the grass-roots level (Adikari et.al, 2020).

The curative care services, also known as patient care services, are delivered through a network of hospitals ranging from divisional hospitals to teaching hospitals and primary medical care units at the lowest level. At present, there are around 19 teaching hospitals, including the national hospital in Sri Lanka, 22 general hospitals, 74 base hospitals, and 479 divisional hospitals engaged in curative services for the public sector (Ministry of Health, Nutrition, and Indigenous Medicine, 2018), (Adikari et.al., 2020).

3.1.4.1 Health information systems

The catastrophic tsunami and decade-long war that had wreaked havoc in Sri Lanka led to most of the manual records being destroyed (Kumar J., 2011). Therefore, the country needed to rebuild the system so that it could manage its health-related data using digital technologies. The process of digitising the health system in Sri Lanka started in 1998 when the Health Informatics Society of Sri Lanka (HISSL) launched the idea of promoting the use of computers and IT in teaching, learning, research, and delivery of care in the health sector (Health Information Society of Sri Lanka, 2018).

In 2009, a master's program in Biomedical Informatics (BMI) at the Postgraduate Institute of Medicine (PGIM) was established with the driving force of HISSL, and with financial and technical support from UIO and Norad. This program had an aim to produce medical specialists with a background within BMI, meaning a degree that combines both IT and health-related subjects, which could contribute to developing national sustainable capacity.

The collaboration with UIO, which already had a world-leading health information systems program, helped educate the BMI students within modern informatics, in addition to learning about the DHIS2 platform. Through this program, students-built expertise on how to apply the DHIS2 platform in different problem contexts, such as TB and malaria management (Amarakoon et.al., 2021).

In 2011, with this knowledge and expertise they slowly started implementing DHIS2 in pilot programs to serve as a HIS for the country. Today, DHIS2 is used as a national information system in Sri Lanka. In addition, the graduates from the BMI program returned to MOH areas and started working there entitled as "*Medical Officers in Health Informatics*", where they mainly got responsible for health policies, system design, development, implementations, capacity building, and training. With their expertise within medicine and informatics, they are now crucial both technical and administrative experts to push the national health information system forward (Amarakoon et.al., 2021).

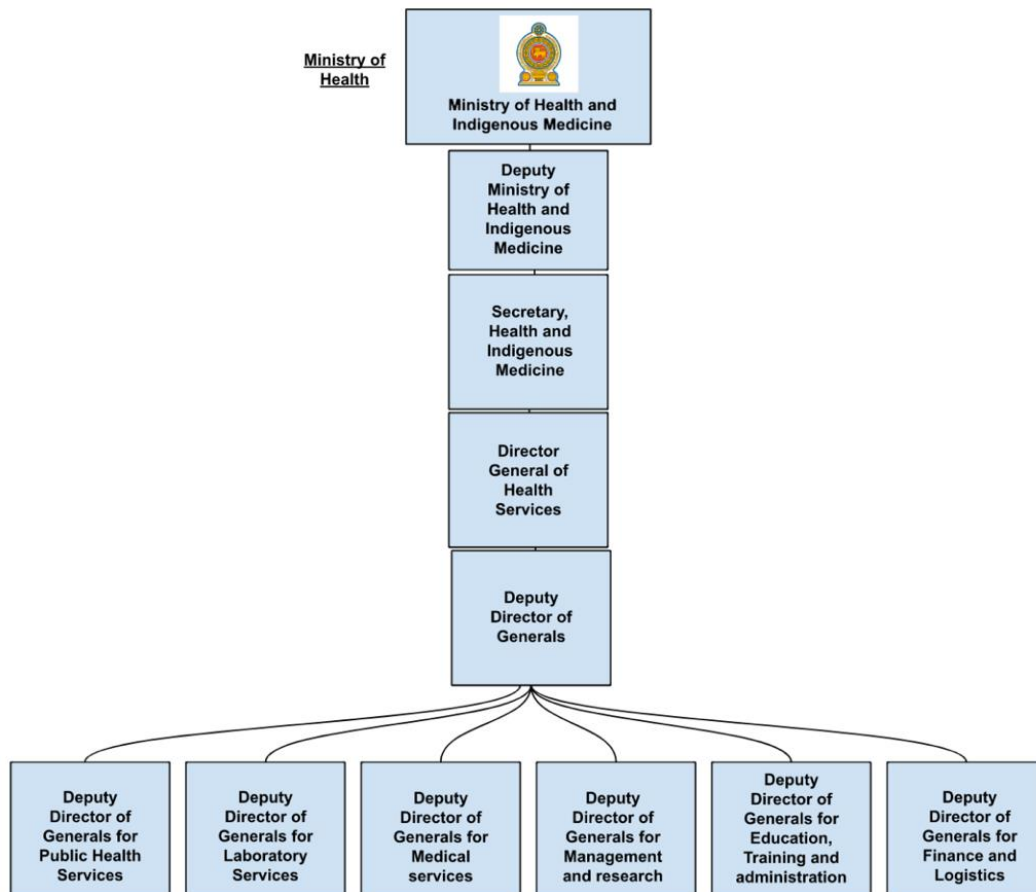
DHIS2 implementation in Sri Lanka

Several initiatives have been aimed at the implementation of DHIS2 in Sri Lanka. The initiatives can mainly be divided into two categories:

1. DHIS2 is being used by several M.Sc. graduates in Sri Lanka. The use of this system in their research projects proclaimed that the implementation of this system was feasible, but it needed customisation to adapt to their needs.
2. DHIS2 was already being used in several projects in the Ministry of Health, Sri Lanka. The projects exhibit that the system was largely scalable in Sri Lanka. However, due to some reasons, the projects had to be stopped or were progressing slowly (Manoj et al., 2012).

3.1.4.2 Health Organisational structure

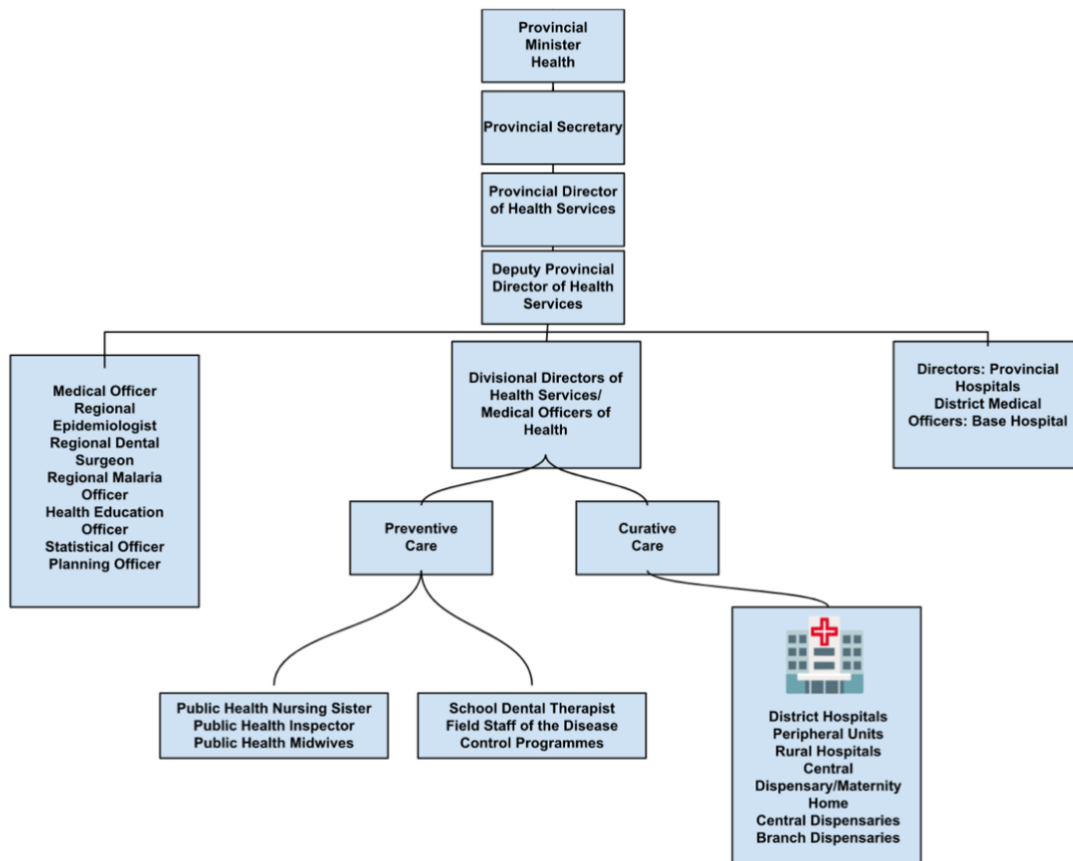
The Ministry of Health is predominantly responsible for health services in the public sector. They plan and deliver health services and are headed by the Director-General of Health Services (DGHS). In addition to that, the Ministry of Health provides training for healthcare personnel, except the medical officers who get their training through the Ministry of Higher Education. The DGHS and the department are accountable for setting policy guidelines, training health personnel, management of teaching and specialised medical institutions, and bulk purchase of medical requisites. Under the DGHS, the Deputy Director of General (DDG) is divided into six sections, and each section is responsible for different fields. DDG for public health is responsible for all the preventive health programs like disease control programs for malaria, filariasis, leprosy, and sexually transmitted diseases. The DDG for medical services is responsible for all institutional services. The described information can roughly be summarised in an organisation chart (Fernando D., 2000):



Source: Fernando D., 2000

Figure 3.2: The organisational structure of the Ministry of Health Sri Lanka

Further, each province has its provincial council, which is responsible for healthcare delivery at the provincial level, and these provincial councils are assisted by directors of health services who are responsible at the district level for planning and implementation of healthcare programs. Years later, Medical Officers of Health (MOHs) were established to provide preventive healthcare to a geographically assigned population. The services are provided by medical officers and other health personnel like public health nursing sisters, public health inspectors, and public health midwives. The described information can roughly be summarised in an organisational chart (Fernando D., 2000):

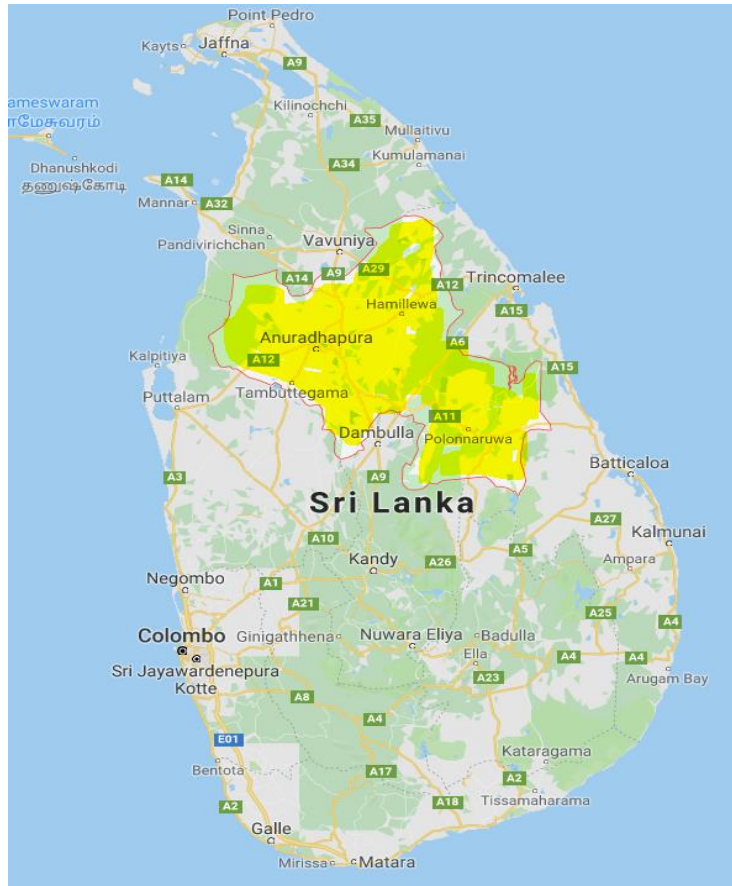


Source: Fernando D., 2000

Figure 3.3: The organisational structure at the provincial level

3.2 North-central and the northern province

The following sub-chapters are important for this study as they provide background information on the provinces, we conducted our data collection in. The North-Central province is one of the nine provinces of Sri Lanka. The province is divided into two districts -- Polonnaruwa and Anuradhapura -- and each district is again divided into divisional secretariats which in total is 29 divisional secretariats for the North-Central province. Both districts have existed for a long time and are known for their ancient Kingdoms. The North-Central province covers an area of 10,714 km, which makes it the largest province in the whole country. But even though it is the largest province, it is the least populated province with a total population of 1,386,000 (Brinkhoff T., 2012).



Source: Genuine Lanka Holiday & Tours PVT(LTD)

Figure 3.4: North-central province of Sri Lanka

The northern province is located right over the North-Central province, and it consists of five districts -- Jaffna, Kilinochchi, Mannar, Mullaitivu and Vavuniya. The northern province covers around 8,890.07 sq. km. As of December 2019, the population of the Northern Province was 1.254 million, with 81.3 percent of the population living in rural areas and 18.6 percent in urban areas (Department of Census and Statistics, 2021).

3.2.1 Polonnaruwa district

Polonnaruwa district (Map, figure 3.5) is divided into seven divisional secretariats where each divisional secretariat has its own MoH. Polonnaruwa is situated in a plain valley of Mahaweli river in the North-Central Province of Sri Lanka. For our field visit, we visited the Hingurakgoda divisional secretariat MOH area. In 2012, the division was populated with 63,000 people (Hingurakgoda Divisional Secretariat, 2021).

POLONNARUWA DISTRICT.



Figure 3.5: The seven divisional secretariats in Polonnaruwa

3.2.2 Anuradhapura district

Anuradhapura is a major city in Sri Lanka which is located in the North-Central province near Polonnaruwa district. Anuradhapura is divided into 23 divisional secretariats and has 22 MOH areas in the district. The district houses a total of 8,60,575 people (Brinkhoff T., 2012).



Figure 3.6: The divisional secretariats in the Anuradhapura district

3.2.3 Jaffna district

Jaffna district is located at the end of the Northern province of Sri Lanka. The total land of the district is around 1,012.01 sq. km, where the area is divided into 14 divisional secretariats and has around 12 MOH divisions located around the district. The Jaffna Teaching Hospital is the main medical institution for the residents of the Northern Province. The teaching hospital is also used for teaching medical students at the University of Jaffna, including nursing and midwife students.



Source: Northern Provincial Government, 2022.

Figure 3.7: Five districts of the northern province, with the Jaffna district located at the top

3.3 Summary of Sri Lanka

Sri Lanka is an island nation located right under India surrounded by the Indian Ocean. The country is divided into nine provinces, those nine provinces are subdivided into 25 districts and the districts are divided into a total of 331 divisional secretariats. Sri Lanka's path to a modern, independent, and developed nation has been marred by continual political violence (Major J., 2022). The country has suffered due to civil war and natural disaster. Years after the culmination of the long civil war, it has seen rebuilding of the country from the major damages and losses, both socially, health-wise, infrastructure-wise and community-wise. In the process of rebuilding the country, health-related data has been made available through digital technologies where IT

and computers have been a central part of teaching, research, and delivery of care services in the health sector.

Today, Sri Lanka is known for providing a high-level of health services while still being a low-middle-income country. The success behind the achievement of high levels of health services comes from a range of long-term interventions, including providing education and healthcare free of charge, training healthcare workers, developing health infrastructures in rural areas, and adopting steps to improve sanitation, nutrition, and immunisation coverage. In this case study, we have collected data from three different districts in the country -- Polonnaruwa, Anuradhapura and Jaffna.

3.4 Introduction: Nepal

Nepal, officially named the Federal Democratic Republic of Nepal, is a landlocked country in South Asia, sharing its borders with India in the east, west and south, and with China in the north. Nepal is divided into three main geographical regions: The Himalayan region, the mid-hill region, and the Terai region. The highest point in the country is Mount Everest, while the lowest point is in the Terai. Similarly, Nepal is divided into three regions topographically which consist of flat and plain lands in the south, hills in the middle, and the Himalayas in the north. For administrative purposes, Nepal is divided into seven provinces and 77 districts. Districts have further been divided into six metro cities, 11 sub-metro cities, 276 municipalities, and 460 rural municipalities.

These metro cities and municipalities are further subdivided into small working areas, which are known as wards, depending upon the area and size of the population. A municipality might have a minimum of 5 to 33 wards. The total area of Nepal covers 147,516 sq. km (56,956 sq. miles) with a population of 28,095,614 as per the 2011 Census, with a population density of 180 persons per sq. km. Kathmandu is the capital city of Nepal, which is also the largest city with the biggest population. With diversity in geography, Nepal is also socially, ethnically, and religiously rich - it is a multi-religious, multi-lingual, and multi-ethnic country.

Nepal is a secular state where an individual is free to follow any religion. But since it is a Hindu kingdom, the majority of the population are Hindus -- about 81 percent, followed by 9 percent Buddhists and others. Nepali is the official language and is spoken all over the country. In addition, more than 122 languages are spoken, and the majority population can also speak Hindi, Maithili, Bhojpuri, and Nepal bhasa (Newari), depending upon the area.

Today, Nepal uses a different calendar than the Gregorian calendar – the Nepali calendar is based on Bikram Sambat, which is approximately 56 years and 8 months ahead of the Gregorian calendar. The main occupation of Nepal is agriculture, with more than 70 percent of the population engaged in it, whereas the important source of income for the country is remittance and tourism. Being a landlocked country, they are highly dependent upon imported products. Essential commodities such as oil, gold, iron, steel, clothes, cement, electronic appliances, food, and vehicles are imported from other countries (Karan P. P., 2021).

Though being an LMIC, Nepal is gradually progressing. Over the last decade, the average annual per capita GDP growth rate was 9.2 percent. Per capita GDP in the fiscal year 2019/20 was \$1126

(Rs 130,957), which is estimated to increase by 7.5 percent in the fiscal year 2020/21 (Economic Survey, Ministry of Finance, 2020/21).



Source: Electoral Constituency Delineation Commission (2011)

Figure 3.8: Map of Nepal with provinces and districts

3.4.1 Governmental structure

At present, the governmental structure that is being practised in Nepal is a federal democratic republic system, where the President is the Head of State, and a Prime Minister heads the government. The power is divided into three levels of government: The federal level, seven provinces, and 753 local governments.

Federal level: The federal level consists of the National Assembly and the House of Representatives as a parallel house. The National Assembly has 59 members, and the House of Representatives has 275 members who are responsible for national policymaking, leading different departments, making national strategy, inter-governmental fiscal policies, and setting and implementing guidelines.

Province level: As mentioned earlier, Nepal is divided into seven provinces, which are governed by a provincial government which includes legislature, provincial treasury, local government, and human settlements. They are responsible for setting provincial laws within the system set by

the federal framework and are mainly responsible for social services like education, health, and social developments, and economic functions related to agriculture and roads (Department: National Treasury Republic of South Africa, 2014).

Local level: The local level in Nepal is the municipality and wards. Each municipality/local body is responsible for budget formulation, law-making, planning and policy formulation, implementation, and delivering local public services in their territories.

They should keep the inventory records of their regions and ought to send the records of resources and reports to the provincial and federal government.

3.4.2 Historical evolution

The important historical aspects of Nepal can be traced back to the 18th century when the Gurkha Shah family established the country's capital in Kathmandu. Further, in the 19th century, Nepal was ruled by the Ranas and the Shahs became puppet rulers (Education Encyclopedia - StateUniversity, 2022). Though Nepal has been a sovereign country, in 1860, the British government had the guiding power in Nepal. The British empire recruited Nepal's famous Gurkhas into its army to assist in suppressing Indian revolts, World War I, and World War II. The Rana and British autocracy ended in the 1950s, and after that Nepal has undergone several political changes from a government headed by parties to a party less Panchayat system and constitutional monarchy in the 1990s. The country went through a 10-year-long Nepalese civil war from 1996 to 2006 led by Maoists, while in between a Royal massacre took place in June 2001, led against the democratic country under a Royal monarchy. After the mass political movement in 2006, election to the Constituent Assembly (CA) was held in 2008. On May 28, 2008, the newly elected CA declared Nepal as a Federal Democratic Republic, abolishing the 240-year-old monarchy (Government of Nepal - Ministry of Foreign Affairs, 2019). The first CA ended without giving a constitution to the country though it had worked out a lot in the constitutional writing process, but the second election of CA was again held in 2013 and was successful to pass the new Constitution in 2015.

3.4.3 Health status: Nepal

Health status, in general, is measured by the factors such as life expectancy rate, infant mortality, maternal mortality, and mortality of children under 5 in a country. In this section, we will present a brief on the overall health facilities that are provided, including health system, plans, and policies.

Health facility providers in Nepal can be public, private, semi-government, or community driven. In this study, we will focus more on public health facility providers and national plans. In Nepal, there are 4,863 public health facilities, including 125 hospitals, 192 primary health care centres, 3,808 health posts, 374 urban health centres, 299 community health programs, and 59 other health facilities (Government of Nepal, 2017).

Nepal has made immense progress in raising the health status of its citizens. According to the World Bank in 2020, Nepal had a life expectancy ratio of 71.7, with an infant mortality rate of 23.6 per 1,000 live births and a mortality rate of under 5 of 28.20 per 1,000 live births. As per World Bank data, in 2017 maternal mortality rate was 186 per 100,000 live births. During a period of 20 years, under five-year-old mortality has been reduced by 67 percent and infant mortality has been reduced by 59 percent. Similarly, maternal mortality has been reduced significantly by 56 percent between the period of 1996 and 2016. Immunisation coverage since 2011 has consistently remained above 90 percent for DPT3 and Polio. But even though Nepal has achieved respectable growth, the country faces significant vulnerabilities. The three main factors which have a negative impact on the state of health in Nepal are high rates of poverty, illiteracy, and its physical geography (World Health organisation, 2018).

Physical geography is one of the challenging factors for the growth of health services in Nepal, as mentioned in the introductory section. The nation is divided into three parts -- mountains in the north, hills in the middle, and flatlands in the south. Every year due to heavy rains and flooding in the southern part, the infrastructure and physical structures get destroyed or flooded, obstructing the path of better health services. Similarly, the middle part of the country is remote due to the presence of higher hills, which stands in the way of developing basic infrastructure like building roads and installing electricity poles and networks.

Likewise, in the mountainous region, there are still several places which are not connected by roads, nor do they have power connection. Development of such areas takes a huge amount of

budget and manpower. Thus, the physical geography of Nepal is taken as a huge problem for its effective development. Most of the better facilities are available only in the urban areas, metro cities and sub-metro cities like Kathmandu, Pokhara and Chitwan. Providing quality health for all areas in Nepal is difficult due to the topography, which is also one of the main obstacles that need to be conquered. The sub-metro cities such as Kathmandu have been provided with better infrastructure like roads, electricity, and hospitals. However, this has led to other areas being neglected. To conquer this, there have been health policies and Social Health Security Development Committees which have a goal to increase the accessibility of healthcare to all areas, including the marginalised communities.

National health policies 1991 - 2014

Health policies have largely underscored the priorities of health information systems in Nepal. The health sector in Nepal consists of many sub-sectors such as management, surveillance, logistics, training, drug balance, and infrastructure. To be able to handle and improve these as a whole, a National Health Policy was implemented in 1991. Its main goal was to improve the health of the Nepalese people, but also to provide health facilities (Bam K., 2011). The main purpose of this initiative was to expand primary healthcare services and provide better health services in the rural areas. Despite poverty and conflicts during the implementation of this policy, Nepal achieved considerable success in the health sector.

In 2014, the health policy was improved to a new version, and the main purpose of this new policy was to establish health as a fundamental right of people, to provide quality health services for all, including the elderly, physically and mentally disabled, single woman, poor, marginalised and at-risk communities. Now, the newest policy implemented in 2019 aims to develop and expand the health system for all citizens in the federal structure based on social justice and good governance and ensure access to and utilisation of quality health services. In addition, this policy has heightened upon the implementation of a health management information system that is modern, qualitative, and technology-friendly, including the development of an integrated health information system (Government of Nepal, 2019). Policies from 2019 that aim to strengthen the health information system in Nepal are mentioned below.

Nepal health policies 2019

In the National health policy 2019, point 6.15 states the brief plan for the development of HIMS in the country, while the sub-points state how it could be done.

6.15 The health management information system shall be made modern, qualitative, and technology-friendly, and an integrated health information system shall be developed.

6.15.1 HIMS of all levels as per federal structure shall be developed and managed in an integrated manner

6.15.2 HIMS shall be made integrated, technology-friendly, contemporary, and regular and the capacity of all levels shall be enhanced to use the information

6.15.3 The fact and information obtained from the HIMS shall be used in monitoring, evaluation, policy formulation, programme development, and decision-making process at various levels.

6.15.4 Security of HIMS shall be ensured and HI of beneficiaries shall be maintained in the e-recording system.

6.15.5 Existing surveillance systems in the health sector shall be strengthened and an integrated surveillance system shall be developed and implemented.

3.4.3.1 Health information system

With the support of the United Nations Population Fund (UNFPA) and USAID, the Ministry of Health and Population developed its first HMIS in 1993. This system collected health information from the public and private sectors and supported decision-making to improve access to and use of quality health services, enhance evidence-based planning and management, and monitor and improve the performance of the health sector at large. In 2013, online entry of data started in each health facility, and in 2014 web-based software DHIS2 was implemented, in the process of integration with other system systems like HIMS and Early Warning, Alert and Response System (EWARS) was migrated to DHIS2 in 2016. Today Nepal uses DHIS2 version 2.30 for the aggregate data collection, whereas they have been using DHIS2 application; *DHIS2 tracker* as an individual data recording only for HIV patients. In addition to that they are using several other HIS to manage health related data.

There are 10 major health information systems under the Ministry of Health and Population today which manage all the health-related data.

1. Health Management Information System (HMIS)
2. Financial Management Information System (FMIS)
3. Logistics Management Information System (LMIS)
4. Health Infrastructure Information system (HIIS)
5. Planning and Management of Assets in Health Care System (PMAHCS)
6. Human Resource Information System (HuRIS)

7. Training Information Management System (TIMS)
8. Ayurveda Reporting System (ARS)
9. Drug Information Network (DIN)
10. Early Warning Alert and Response System (EWARS)

3.4.3.2 Health organisational structure

The structure of the health system in Nepal is now divided into federal, provincial, and local levels. This leads to as mentioned earlier that the President is the Head of State, and the Prime Minister heads the government. However, since there is a federal government in place, the power is divided between all three levels. The healthcare system of Nepal is managed by the Ministry of Health and Population, which is responsible for making policies, rules, and arrangements for being able to deliver effective healthcare to the population. This hierarchy is mainly developed to ensure that the population receives and can easily access public health services. The Health Ministry is divided into three departments and the departments are further divided into divisions and sections:

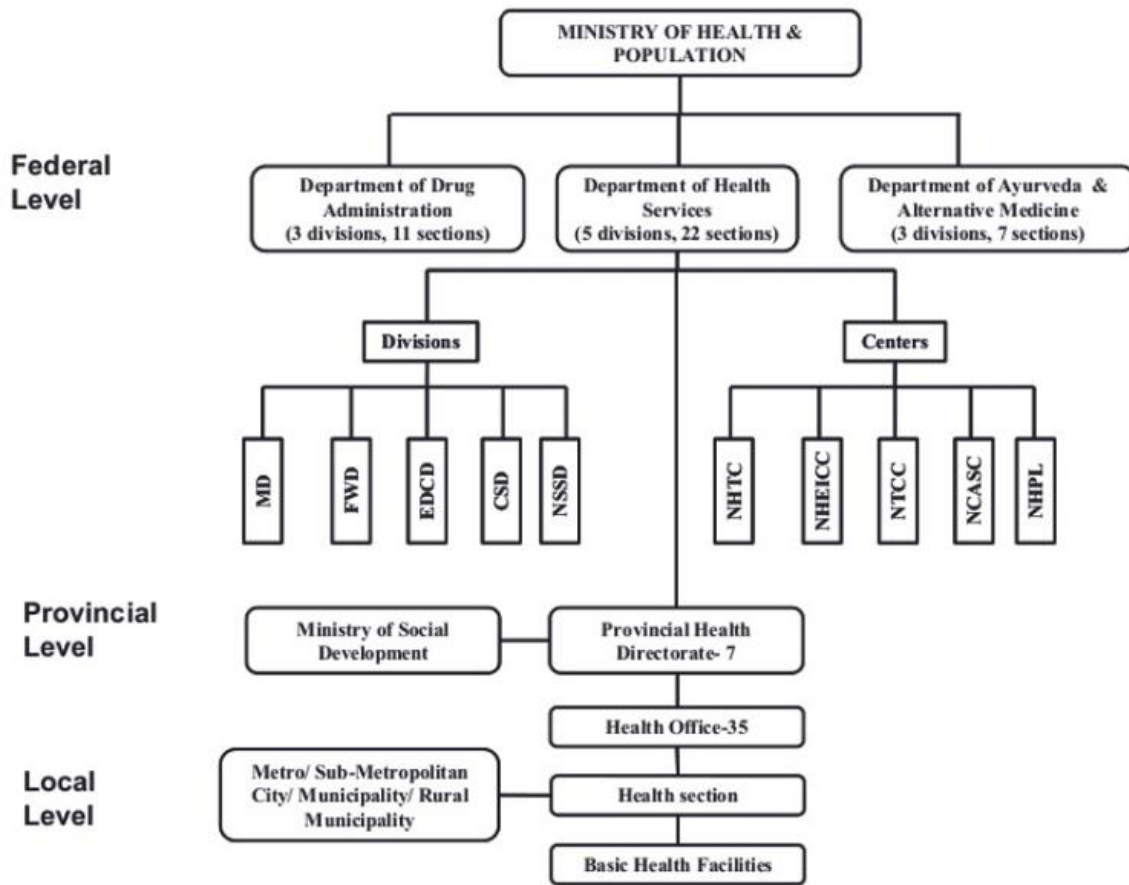
The Department of Drug and administration (DDA) is responsible for regulating all functions related to modern, veterinary, and traditional medicine, efficacious and quality medicine to the general public by controlling production, marketing, distribution, sale, export-import, storage and use of medicine.

The Department of Health Services (DoHS) is responsible for delivering preventive, promotive, diagnostic, and curative health services.

The Department of Ayurveda & Alternative Medicine (DoAA) is responsible for delivering Ayurveda and alternative medicine services and promoting a healthy lifestyle through its network facilities across the country.

At the federal level, we have the provincial level with seven provincial health directorates for each province, which are responsible for providing backstopping and program monitoring to the district health systems, which come under the Ministry of Social Development of Province. Furthermore, it has established health offices in 77 districts which are located under the provincial health directorate. They are responsible for the delivery of preventive and curative health services in the districts. Under the provincial level, we have the local level, which is responsible for providing basic health services such as check-ups of newborns and children, vaccination, and basic medication services. These local-level institutions are normally called

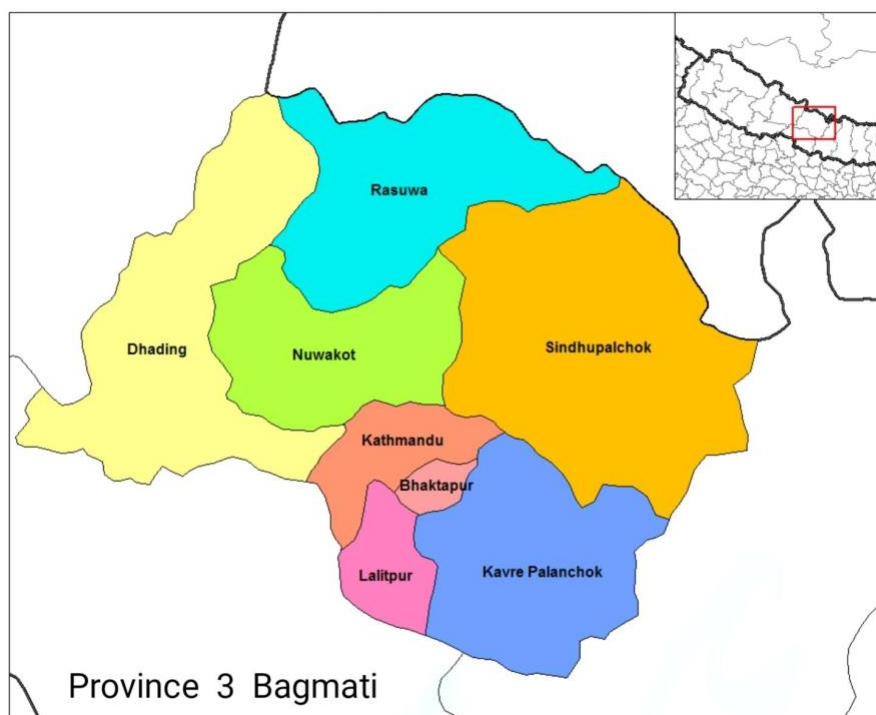
health posts and are the first institutional contact points for basic health services (Government of Nepal, 2017/18). The organisational structure of the Health System in Nepal, looks as followed:



Source: Adhikari B.(2021)
Figure 3.9: organisational structure of the Health System in Nepal

3.5 Bagmati Province

Bagmati Province is one of the seven provinces, which is also known as province number 3 with its capital at Hetauda, covering a total area of 20,300 square kilometres. It is the most populated province with a total population of 5,529,452(Udhyami B., 2011), including the country’s capital and highest populated city, Kathmandu (Wikipedia, 2017). It comprises 13 districts, which include 119 local administrative units in the province which include 3 metropolitan cities, 1 sub-metropolitan city, 41 urban municipalities, and 74 rural municipalities. Kathmandu, Hetauda, Bhaktapur, Bharatpur, and Lalitpur are the major cities in this province.



Source: Wikipedia, 2006

Figure 3.10: Map of Bagmati province with districts

There are in total 934 public health facilities that include 33 hospitals, 43 primary health care centres, 640 health posts, 110 urban health centres, 90 community health units, 18 other health facilities, and 1386 non-public health facilities.

3.5.1 Mahalaxmi municipality

Mahalaxmi Municipality is situated in the north-eastern part of the Lalitpur district and the southern part of Kathmandu. The municipality occupies 26.5 square km stretching from east to west with a total population of 62,172. This municipality is further divided into 10 working areas which are known as wards which is the smallest unit or geographical political division in the hierarchy.

3.5.2 Chandragiri Municipality

Chandragiri municipality is one of the largest urban municipalities in the Kathmandu district situated in the north-western part of Kathmandu. This municipality was declared a municipality in December 2014 merging 11 village development committees. In the meantime, it is further divided into 15 wards.



Source: Nunneman F. (Unknown). Kathmandu valley temples
 Figure 3.11: Map of Chandragiri Municipality and its wards

3.6 Summary of Nepal

Nepal is a landlocked country in South Asia, with borders to India in the east, west, and south, and China in the north. The country is divided into three regions with flat and plain lands in the south, hills in the middle, and the Himalayas in the north. The government in Nepal is a federal system where the chief of the state is the president, and the president and the head of the government is the prime minister. Apart from the ecological divisions, administratively Nepal is divided into seven provinces and 77 districts. Districts have been divided into 6 metro cities, 11 sub-metro cities, 276 municipalities, and 460 rural municipalities. Today Nepal remains a poor country, but it is in constant development. In the process of developing the HISs and digitising the health sector in Nepal, there has been immense progress. Health policies have a large impact on building the health information system in Nepal, as the policies that have been outlined in the past decades have been focusing on building the HIS in the country. Today several HISs manage the health-related data in the country. In this study, we have collected information from two municipalities; Mahalaxmi and Chandragiri that we visited during our site visit in February.

Chapter 4 Methodology

In this chapter, we present details of our empirical engagement which has helped in inductively developing an understanding of these concepts and enabling their conversations with theory.

The chapter has four main sections. Firstly, we describe our role in the research, and the underlying ethical dilemmas that we have experienced and engaged with. In the second section, we discuss overall research design including the philosophical basis, research approach, case study method, and the multi-level engagement. In the third section, we discuss the overall approach to data collection, which is followed by data analysis in the concluding section.

Section One: Positionality and ethical dilemmas

4.1 Our role in the research

In this research, we have played the roles of researchers, where we have studied the use of a digital public good in the health domain. Additionally, having roots to the respective countries where the case study was conducted made this research a more valuable and purposeful project. One of us is originally from Sri Lanka but was born and raised in Norway, while the other is originally from Nepal and has been living in Norway for the last seven years. As we both are aware of the current digital system in Sri Lanka and Nepal, as well as in Norway, it helped develop a deeper understanding of how things work in both countries. Having said that, we had no prior experience with the health sector before this project and lacked an understanding how the health system functions and manages public health data in either of the two countries. Thus, in the course of this research, we have gained a lot of knowledge and a deep understanding of how the data and information within the health sector are collected, managed, analysed, and used.

Having roots connected to these respective countries helped us understand the cultural context, background, and even the local language, which was relevant for us in conducting this research. This was advantageous in the sense that it helped in establishing closer relations and gaining trust from local teams, which further pushed us to see the problem areas from their perspective. Before our site visit, we thought that having the background that we have may affect the outcome of our data collection, meaning data might be biased. For example, participants can answer differently than what they actually feel because they want to satisfy us as researchers. Thus, investigating

the problem area by triangulating several data collection methods has helped us in collecting credible and valid data. Andrew Gary Darwin Holmes discusses in his article about researchers' positionality: *“Some aspects of positionality are culturally ascribed or generally regarded as being fixed, for example, gender, race, skin colour, nationality”* (Holmes A.G.D, 2020). Holmes comes with a specimen where he says that for example, if a black African American becomes a member of a white, conservative, right-wing, racist, supremacy group, you will automatically think that such a group would not accept the African American member. In the same way, we thought that by having the same cultural background we could easily make assumptions about topics since we could see ourselves from their perspective. Therefore, we always reminded each other that we should not make any assumptions about others' perspectives and views based on our experience or perception.

4.1.1 Ethical Considerations

There is no doubt that in every study there will arise questions that any step we take or any decision you make is either good or bad and how it would affect others in your surroundings. Since the field of this study is associated with government offices, and hospitals there are several ethical considerations. There are a number of interactions and conversations, interviews and observations, where we were respectful of people's privacy, and where we had to treat everyone equally. We have been well aware that not everyone will be equally open to sharing things, and we have respected and accepted that. We have tried our best not to be an interruption or intervention into participants' daily routines. In addition, since we collected data from different levels – national, district, and facility – we have followed all instructions and rules at each level. Prior to the field visit, we sent a letter for approval to our local supervisors working in the ministries. The permission letter was sent to all levels we visited so that we were allowed into the facilities we visited.

Prior to the interviews and observations, we gave a consent form to all the participants, which informed the respondents their rights and responsibilities, including who has access to the data. Few of the participants signed the consent forms without reading them thoroughly, and in such cases we as researchers tried to clarify the important issues, they had to be aware of. Conducting research in LMICs requires heightened awareness of unique ethical issues (Daley, et.al, 2013) and protecting the respondents from being exploited (Khowaja-Punjwani, 2016). The research is ethically obliged to provide positive value for the subjects about whom data is collected (The Norwegian National Research Ethics Committees, 2021). Practically, our aim was to give

feedback on results to the national and global HISP teams, to bring in improvements in software and methods, ultimately improving the experience of the end-users.

4.2 Establishment of the project

At the early stage, in December 2020, when the topic of our research was finalised, we had plans of visiting Sri Lanka and Nepal for data collection and to establish relationships with the local HISP teams to strengthen our research access. We started with video meetings on Zoom in the presence of our supervisor, who requested us to establish local supervisors in the respective countries to support our local access and understanding. Local supervisors were to arrange and provide guidance throughout the field visit, suggesting names of relevant persons for us to meet and the units, hospitals, and government personnel to focus on.

In our virtual meetings we discussed the purpose of the study, the data required for the research, travel, and logistics details etc. However, due to the changing rules and travel restrictions arising from the Covid pandemic, it was difficult to decide a fixed time for travel. In such uncertain situations, we had to try to approach our study in new ways. So, we shifted our approach to being partially remote as we hadn't given up the thoughts of being able to conduct the fieldwork.

Through informal and formal meetings with members of the HISP team in Sri Lanka and employees at the Health Ministry of Nepal we got to know more about how the situation was in both the countries and also some information about how the HIS was developed, maintained, and customised in-country. From August to November 2021, we managed to have several Zoom and Google meetings with different users and stakeholders relevant for the HIS. During December, the pandemic situation improved a little, which allowed us to travel to the two co countries in January 2022 for data collection.

Section two: Key elements of the study

4.3 Research Design

In this section, we present the research design across four key elements: i) philosophical underpinning of interpretivism; ii) comparative case study analysis; iii) timeline.
iv) Multi-level engagement.

4.3.1 Interpretivism

Given that feedback is a subjective concept, we adopted an interpretive approach that allows multiple interpretations of the truth, rather than a “single truth” emphasised by positivist approaches. Interpretivism implies that the researcher sees the world as socially constructed (Orlikowski & Baroudi, 1991), based on subjective interpretations.

In our research, we have tried to derive meaning from our empirical work, based on others’ interpretations of the situation and happenings, and how processes of inter-subjectivity were developed during our empirical work. In order to fulfil this, we have interacted with multiple individuals who shared divergent views on the same system and process, as implied by interpretive approaches (Walsham, 1993), based on their cultural, social, and educational backgrounds and experiences.

The consequence of adopting an interpretive perspective is that, while different individuals share divergent views of the same system, we as researchers create meaning of these views based on our own background and experiences, which further influence how we see the world. Hence, this research is not value-neutral, but rather value-laden as it is influenced by our own worldviews.

For instance, while working on understanding the process of user participation through feedback in Sri Lanka and Nepal, we interacted with grassroot level workers such as medical officers, development officers and regional epidemiologists (RE) - to try to understand the contents and means of feedback. The responses in the two different countries were divergent and for varying reasons.

In making sense of these multiplicities of views, we must admit that we were influenced by our own views on how we thought technology could support their work. We believe that ICTs have

the potential to empower staff, which made us constantly juxtapose the views we were gaining from the fieldwork, with those of our own coming from our background of being of Asian origin, women, living in Norway, and our childhood experiences where we saw the value of the technology being used in our everyday life, and various socio-cultural influences.

We realise that our interpretations would always be unique and different from others. A point emphasised by Walsham:

Interpretive methods of research start from the position that our knowledge of reality including the domain of human action is a social construction by human actors and that this applies equally to researchers. Thus, there is no objective reality that can be discovered by researchers and replicated by others (Walsham, 1993, p. 376).

This viewpoint is also reinforced by Orlikowski and Baroudi:

Interpretive studies assume that people create and associate their own subjective and intersubjective meanings as they interact with the world around them. Interpretive researchers thus attempt to understand phenomena through accessing the meaning participants assign to them (Orlikowski & Baroudi, 1991, p.5).

Throughout our site visits, we have seen the strength of interpretive research, which offered us the space to understand and reflect on the complex and multifaceted phenomenon of feedback and public goods, without being locked in a certain viewpoint. This multiplicity was especially important for us as feedback is understood differently by people, shaped by similar and different structures, power relations, their own agency, willingness, and space to participate, and users' relation with technology. These multiplicities give rise to multiple value-oriented perspectives on the problem areas which interpretivism makes building understandings of them much more nuanced (Mukherjee, 2017).

4.3.2 Comparative case study

A case study allows the in-depth examination of a phenomenon within a situated context and allows the examination of a phenomenon and gain insight into how users interact with a system in their natural setting (Benbasat, et.al., 2022; Yin, et. al. 1984). In our study, we have followed a comparative case study strategy to help study the phenomenon of feedback in two specific case contexts around the same platform used for respective national HIS. This enabled us to compare and contrast across the cases to help discern how processes of feedback are shaped (or not). In each of the cases, the unit of analysis was the individual system users, for e.g., health workers or

medical doctors, and their subjective meanings were captured by interviews, observations, and group discussions, shaped by contextual conditions. In the table below, we have briefly outlined our case studies and some of their differences and similarities.

Research facets	Case study 1	Case study 2
Nature of Technology	FOSS operated in Polonnaruwa, Anuradhapura, and Jaffna district in Sri Lanka	FOSS operated at Bagmati province in Nepal
Unit of Analysis	Individuals are mainly; health workers such as development officers, army officers, MoH incharge, medical officers, seniors' registrars, and regional epidemiologists (RE).	Individuals are mainly; health assistants, Health information officers (HIO), directors, and incharge of health posts.
Contextual conditions	Sri Lanka is a country with progressive expansion in improving the health domain in the country.	Nepal is a health domain that is highly dependent on funds, donors, and global partners.

Table 4.1: Case study context

4.2.3 Timeline of research

The HIS used in this case study has been implemented in both countries for over a decade, and in our research, we studied the initiation and evolution of the system over time. We had regular meetings with different stakeholders and users of the system in both countries over a year, which helped to build a better relationship with users of the system and get their perspectives on feedback. In addition, this engagement has helped us understand the system background, the purpose of use, requirements, and user support. Due to the distance, expenses, and covid restrictions we managed to travel to Sri Lanka and Nepal only once, which provided us the opportunity to physically meet the users in their work context. Before and after this field visit, we have consistently had Zoom meetings.



Figure 4.1: Timeline of important milestones of our research

4.3.4 Multi-level and stakeholder engagement

Our research across the cases has spanned multiple levels of the global, national, province/district, and facility to understand the process of the feedback and user perception towards the system across levels. We engaged with different stakeholders, including the global HISP teams, Health Ministry staff, national-level teams, administrators, and facility-level employees (medical officers, development officers, health supervisors, etc.).

The primary unit of analysis for our research is the individual system users within the health domain in both countries. Processes of user feedback are shaped by users interacting with the system and staff, across levels and functional areas. Our study assumption is that without engaging with these different levels and stakeholder groups, we could not build a holistic and interpretive understanding of feedback processes. The tables below describe all the facilities we visited and engaged with during our research.

District	Location	Facility
North Central province	Anuradhapura, Sri Lanka	Provincial Health training center, North Central province
North Central province	Anuradhapura, Sri Lanka	Office of Regional director of Health Services, Anuradhapura
North Central province	Hingurakgoda, Polonnaruwa, Sri Lanka	Medical officer of Health Office, Hingurakgoda
North province	Jaffna, Sri Lanka	Jaffna Teaching Hospital
Colombo	Colombo, Sri Lanka	Health Information Unit, Ministry of Health & Indigenous Medical Services, Colombo
Colombo	Colombo, Sri Lanka	World Health organisation, Sri Lanka

Source: Field Visit, 2022

Table 4.2: List of all facilities and units we collaborated with in Sri Lanka

District	Location	Facility
Lalitpur	Mahalaxmi metropolitan city, Kathmandu	Mahalaxmi metropolitan city office, health department
Kathmandu	Balambu , Chandragiri metropolitan city	Municipality Office,
Kathmandu	Thankot, Chandragiri metropolitan city, ward no.3	Thankot Health post,
Kathmandu	Tinthan, Chandragiri metropolitan city, ward no.15	Tinthan healthpost,
Kathmandu	Teku, Kathmandu,	Health Information Office, Health ministry Department
Kathmandu	Teku, Kathmandu	Save the children's office, Health ministry Department

Source: Field visit, 2022

Table 4.3: List of all facilities and units we collaborated with in Nepal

Section three: Data collection and data analysis

4.4 Data collection

Empirically, data collection was done through semi-structured interviews, observations, group discussions, and document analysis (see table below).

Methods	Description	Learning goals
Observation	Observing users while using the system in the natural setting	Understanding the surroundings and environment of workplaces, how efficient are they at using the system.
Interview	Semi-structured, open-ended conversation with users of DHIS2 at different levels.	Deep understanding of user's perspectives about the system, and their problems
Group Discussion	More than two people were interviewed at the same time	Deep understanding of users' perspective about the system, and their problems.
Document analysis	Documents that provide information on DHIS2 and paper-based data collection systems.	Understanding from others perspective on DHIS2 and other related topics.

Table 4.4: Data collection methods used in this study

4.4.1 Observations

The initial phase of our data collection process started with a participation observation session in the office of a Medical office of a Health officer in Sri Lanka. Further, during our field visits, we had the opportunity to conduct observations at both Anuradhapura district, Mahalaxmi and Chandragiri metropolitan city in Kathmandu. Before our field visits, we planned to do several observations, both individual and group observations. Though, due to the global situation of the pandemic, there wasn't as much opportunity to observe health workers in their natural setting as we wanted to. Even though we managed to have just a few observations it was a good experience, in addition, we think it will provide a valuable and solid foundation for our data collection.

Moreover, the observations we did gave us a good insight into the environment, behaviours, activities, and ongoing processes.

Observations usually allow you to get a sense of reality and work through the complexities of interactions. O’Leary defines observation as a method of data collection that relies on a researcher's ability to gather data through his or her senses. Observation allows the researchers to see, hear and even smell the surroundings, but not only that it also allows them to observe how the participants behave around the objects (O’Leary, 2017). Having this insight we got the opportunity to learn, understand and increase our understanding of how the process of implementation was, their daily routines and the problems they encountered in their daily lives (Driscoll L. D., 2011). Observation is one of the important data collection methods for this study as this method provides an opportunity to evaluate a situation or a task from a different perspective than when one is interviewed where one gives their own perspective. Besides, during observation, we are able to observe the participants in their natural settings, where they are interacting with the system. From this, we can directly gain data with higher accuracy and reliability. In this study, the observation of users using DHIS2 for data entry has provided insights into their behaviour, problems, and perceptions.

In our observation, we requested our participants to integrate with the DHIS2 system as they do on a daily basis, which was different in different field areas. During the observation at the MoH level at Polonnaruwa district and Anuradhapura in Sri Lanka, we observed how an Air-force officer *uses an entry form within DHIS* to enter the data of vaccinated persons from *logging in till he finished entering data for a person*. The registration process started with the collection of a consent form from a person who wants a vaccine. The form must include name, address, contact number, and *national Id number**. For those who are getting a vaccine for the first time, they need to register every single data as per the requirement of the entry form, but he also mentioned that they can use a national ID number to retrieve the person's data without bothering to type every single detail. But the downside is age, as the person under 18 does not have a national id number and those under 16 must have consent signed by their parent or guardian.

The observation was an informal *observation*, as the participants were not only showing us how they used the system but also highlighting the different circumstances and situations that may occur and how they could unfold and tackle them. For example, in the cases like using an id number in vaccination registration - which is not valid for all ages and registration for those who

have got vaccines in a foreign land, even if they are vaccinated for a second time, it will be registered as 1st dose, due to some technical issues. The observation was focused on how they use the system and what kind of problems they might face while using the system. Since participants were predominantly using the system for the last 2 years after the covid-19 breakout, they seem very confident and quick at using the system.

The observation took place at the vaccination centre where people were visiting for vaccine doses and filling the forms, we can see health personnel giving vaccinations. Two air force officers were responsible for entering the data, using a small-sized laptop and were accompanied by four other health personnel who were responsible for collecting the physical consent form from the people and reading out information to the air force officers so that they could save some time and contribute to rapid data entry.

4.4.2 Interview

The primary source of data collection in this study is interviews. As a data collection method interviews provide in-depth, rich, and non-verbal data (O'Leary & Zina, 2017). Interviews give access to interpretations that participants have regarding the actions and events which have or are taking place, and the views and aspirations of themselves and other participants (Walsham G., 1995). Interviews can generally be divided into three types: structured, semi-structured, and unstructured (Oates et.al., 2005). Interview is the most relevant source of data collection, our decided approach to interviewing was semi-structured interviews. A semi-structured interview is referred to as a qualitative approach where the interview has some structure in terms of theory but is not completely structured in the sense it allows you to go out of a structured plan and ask follow-up questions related to the conversation (Ann Blandford, 2013). Before the interviews, we created a pre-fixed list of open-ended questions. We mostly stuck to this list but using a semi-structured interview method was advantageous for us as it allowed us to be more flexible and explore and interrogate any topics, we found interesting and informative during the interview.

Broad topics	Focus
Previous system	History, problems
Current system and use	Understanding, implementation, roles and responsibility, problems, and satisfaction.
Feedback system and communication	Problems and use

Table 4.5: Important topics throughout the interviews

All interviews were conducted in the fields and were arranged by members of HISP Sri Lanka and representatives working at the health ministry in Nepal. Prior to our field visits, we got a detailed plan from members of HISP Sri Lanka on which entities and facilities we should visit and whom we should interview. Detailed plans can be found in the appendix.

We conducted several rounds of interviews, where most of which were individual interviews and around 1 to 3 group discussions in each country. A carefully constructed interview plan can be found in the appendix.



Figure 4.2: Pictures of Interviews with different participants

4.4.3 Group discussion

As a way to collect data from several people that share the common experiences, we used group discussion as a data collection method. Being able to gather people that share the same experience also concentrates on their shared meaning which makes them discuss the topics we ask about. It was a great way to collect data as it made the participants discuss, and we could just be there to observe and take notes. We managed to arrange a group discussion at the training centre in Anuradhapura, Sri Lanka, and the Save the Children's office in Kathmandu, Nepal. At the training centre we had a group discussion with army officers, and at the Save the children office we had a group discussion with developers.



Figure 4.3: Group discussion at the Health Information Management Unit, Kathmandu and Hingurakgoda MOH

4.4.4 Document analysis

A good way of understanding how the actual process works, we have examined articles, reports, and other relevant information. At the phase where we were uncertain if we would be able to travel or not, we had meetings with members closely associated with the HISs development projects in both countries. At these remote meetings, we got introduced to several documents that we went through. Members of HISP Sri Lanka recommended some articles that would be helpful in the process of understanding the health and HIS in Sri Lanka. The recommended articles have helped us understand the process of building national health informatics capacity in Sri Lanka and how they have designed and implemented the Covid-19 IS response rapidly.

On Nepal's part, we have been introduced to a document named the National Roadmap enunciated by the Ministry of Health and Population, Nepal. This document gave us an insight

into the importance of digitising health information, policies, plans, and the development process of HISs. Other than that, the former UIO students master thesis on Capacity Building in Nepal has given us rich data and background information on the study area. DHIS2s official website has also been helpful for us in understanding DHIS2 as a platform and what it offers. As both countries are in the initial phase of digitising the health system, we must say that there are few relevant documents related to user participation and feedback.

4.4.5 Tools being used

This section briefly explains all the tools that we have been using to collect the data during our data collection period.

Recordings

Interacting and facilitating a research interview can be hard work, and it is generally difficult to write down responses while maintaining eye contact, listening, providing encouragement, and planning the prompt, probe, or link to the next topic of interest. To get accurate and reliable data we took audio-recording of all the interviews, beforehand we informed all the participants that the interviews will be recorded and the purposes of the research, and what we were going to use the data for. There is always a possibility that the interview object prefers not to be recorded and, in some cultures, it can even seem like a threatening request (Green, J., & Thorogood, N., 2018). As lucky as we were, all the participants allowed us to make an audio recording of the interviews. Another concern that we had during our sessions, was that being aware that they are recorded, the interview object might change their opinion.

Field visit notes and photos

Both under observation and interviews sessions we collected field notes from all municipalities, districts, and entities we visited. As we did an interview, we took notes of the answers they gave to the questions we asked. During the observations we did, we took notes of topics participants highlighted as problematic, we also took notes of how the environment was and the reactions of the health staff when they were working in their natural settings. As a way to document the data collection process we took pictures of every step during our data gathering. In addition to being memories that we can look back at, they will also provide valuable data for our research.

4.4.6 Pre, during, and post-field visit

Sri Lanka: Pre-arrival

As mentioned in this subchapter we had introductory meetings on zoom to establish relationships with members working with DHIS2 in the respective countries. Prior to our arrival as early as April 2021 we had an arranged meeting with one of the HISP team member working within the HISP Sri Lanka team. At this meeting, our supervisor was also present as she took the initiative to arrange the meeting and she already knew as he previously took his degree of Ph.D. at the University of Oslo. At this meeting, we got a brief introduction to DHIS2 and how they have utilised its potential according to their needs at the initial phase of the pandemic. Later on, in December 2021, we got introduced to two other members who are also part of the HISP Sri Lanka team and who also took their degrees at the UIO. After having these short zoom meetings, all the HISP members took initiative to make a tentative plan that we could follow during our stay in Sri Lanka, the plan contained information regarding who we should visit, the venue for where we should meet up, and a detailed time frame of where we should be when. This plan could be found in our appendix. Since we got introduced to all important members and we got this tentative plan prior to the visit it made it easier for us to execute the field visit.

Sri Lanka: During the stay

Following this plan, we got prior to our visit made it easier for us to plan our trip to Sri Lanka. We started our journey with a meeting at the Postgraduate Institute of Medicine with Dr. Pandula and Dr. Roshan whom we already had a zoom meeting prior to our visit. During this meeting, we got some more information about the work that they do building and digitising the health sector in the country. In addition to this, we must say that we got treated well with good Sri Lankan sweets and tea. After this meeting, our next stop on our schedule was the WHO office, in Sri Lanka, where we met Dr. Priyanga Senanayaka, Dr. Wedika Madanga, and Dr. Ruvinda Jayawardena, who were all working in the health ministry. Here we got a presentation about the work they do at WHO and projects they are working on such as issuing corona certificates through the system. At this meeting, Dr. Wedika was appointed as our local supervisor. As per the schedule, we have suggested dates and two provinces for the field visit. The following day we travelled to Anuradhapura from Colombo which took 5 hours. We stayed for a night in Anuradhapura, the next day we travelled to Polonnaruwa for a visit to the Hingurakgoda MoH. After finishing all the interviews, we travelled back to Anuradhapura, next we visited the Provincial Health training centre - North central province in Anuradhapura. After finishing our

site visit at Anuradhapura, we travelled back to Colombo, all these travels were well assisted by our local supervisor Dr. Wedika who was also born and raised in Anuradhapura. Since personnel working at both Hingurakgoda MoH and Provincial Health training centre - North central province had a good relationship with Dr. Wedika, it was easier for us to interact with people at both places. He also helped us as a communicator when the interviewee preferred the Sinhala language. After some days we had the final meeting at the HIU Sri Lanka, where we again met Dr. Ruvinda, Dr. Manjula, and Dr. Buddhika Aryaratna for a walkthrough of the DHIS2 Dashboard and interviews.

Sri Lanka: Post field visit

Post our field visit, we did feel that we missed out on conducting site visits to Jaffna District as one of us has a background in this district. The reason why we missed conducting data collection in this district is mainly due to limited time. As we were in contact with our local supervisor from Sri Lanka, we managed to arrange a meeting on zoom. At this meeting, we got introduced to several employees at the Teaching Hospital in Jaffna, so this meeting became more of a group discussion. As the employees were comfortable talking in the language Tamil, we did our question round in Tamil.

Nepal: Pre-arrival

The process of pre-arrival to Nepal was similar to Sri Lanka, all the exchanges of emails and meetings were carried out parallelly. Our first point of introduction was with Mr. Bir Rawal on 15th November 2021 who was a former Strategic Information Officer within the health ministry. We had a couple of meetings with him where he shared his roles and responsibilities, the implementation process of HIS in Nepal, how he uses dhis2, and more. We also formed one chat group in an application called *WhatsApp* for instant sharing of messages. We also consulted with a former master's student at UIO in December 2021 who has also written his thesis on “Analysis of Capacity Levels around Health Information Use: District Level Case Study from Nepal”.

Nepal: During the stay

Right upon our arrival in Nepal Mr. Bir Rawal got affected by covid, in addition, he got transferred to another department. As there was a problem in contacting him for a week, we were clueless on how to go further. Thus, our supervisor from Oslo contacted one of the professors at Kathmandu University who also happened to be a colleague of the former UIO student and arranged a meeting with them at Kathmandu University at Dhulikhel. In this meeting, we got to

know the future plans on adding and building a new course for capacity development within the health information system and he also contacted the department of health information system and arranged our meeting with the senior department official. The next day we had a meeting with a senior development officer at the department of a health information system at the Ministry of National Health department, Teku. There we visited several departments to get an approval letter for data collection. After the letter was approved with stamps and signatures of officers responsible for the daily operation, we got a letter that suggested us to visit two of the health department offices in two different municipalities and contact details of the persons from respective municipalities from the department of health information system. With the help of the contact details, we called them and arranged the date and time for the meeting which were suitable for them. First, we visited the health department at Mahalaxmi Municipality and held an interview with the section officer and health assistant present on that day. Then with the permission of the Section Officer of the health department at Chandragiri Municipality, we arranged a meeting with health assistants working in health posts at Thankot and Tinthana. Our last meeting was with the Section Officer of the health department at Chandragiri Municipality Mrs. Jagadiswori Awasthi a day prior to our departure date.

Nepal: post field visit

After our field visit, we needed additional data and perspectives on Digital Public Goods. Since we were in touch with a Senior Strategic Information Specialist working at the Save the Children's office, we contacted him to request another interview, he was very much willing to participate. Interview questions for this interview can be found in the appendix.

Regarding the workarounds and how they untangle or are going to untangle calendar issues, we wanted to talk with someone that had better insights. That is the reason we had a zoom meeting with a member of HISP India working as a Lead Health System, who was also working closely with the implementation of DHIS2 in Nepal. The interview guide for this interview can be found in the appendix.

Case	Location	Setting	Data collection methods and tools
Covid-19 tracker module	Hingurakgoda, Polonnaruwa	System use	Observation, field notes
Covid-19 tracker module	Hingurakgoda, Polonnaruwa	Feedback process, problem areas, communication channels, capacity building and user involvement	Individual interviews, field notes, pictures and audio recordings
Covid-19 tracker module	Provincial Health training center- North central province, Anuradhapura	System use	Observation, field notes
Covid-19 tracker module	Provincial Health training center - North Central province, Anuradhapura	Feedback process, problem areas, communication channels, capacity building and user involvement	Individual interviews, field notes, pictures and audio recordings
Covid-19 tracker module	Office of Regional director of Health Services, Anuradhapura	Feedback process, problem areas, communication channels, capacity building and user involvement	Individual interview, field notes, pictures and audio recordings Individual interview
Covid-19 tracker module	Teaching hospital, Jaffna	Feedback process, problem areas, communication channels, capacity building and user involvement	Group discussion, field notes and pictures
Covid-19 tracker module	Health Information Unit, Colombo	System use	Observation, field notes
Covid-19 tracker module	Health Information Unit, Colombo	Feedback process, problem areas, communication channels, capacity building and user involvement	Individual interviews, field notes, pictures and audio recordings

Covid-19 tracker module	Health Information Unit, Colombo	Feedback process, problem areas, communication channels, capacity building and user involvement	Group discussion, field notes and pictures
Calendar issues and overall system	WHO office, Colombo	Feedback process, problem areas, communication channels, capacity building and user involvement	Group discussion, field notes and pictures
Calendar issues and overall system	Health Information Unit, Kathmandu	System use	Observation, field notes
Calendar issues and overall system	Mahalaxmi metropolitan city, Kathmandu	Feedback process, problem areas, communication channels, capacity building and user involvement	Individual interview, field notes, pictures and audio recordings
Calendar issues and overall system	Chandragiri metropolitan city, Kathmandu	Feedback process, problem areas, communication channels, capacity building and user involvement	Individual interview, field notes, pictures and audio recordings
Calendar issues and overall system	Thankot Health post, ward no:3, Bagmati province	Feedback process, problem areas, communication channels, capacity building and user involvement	Individual interview, field notes, pictures and audio recordings
Calendar issues and overall system	Tinthan healthpost, Bagmati province	Feedback process, problem areas, communication channels, capacity building and user involvement	Individual interview, field notes, pictures and audio recordings
Calendar issues and	Ministry of Health and population Office, Kathmandu	Feedback process, problem areas, communication	Individual interview, field notes, pictures and audio recordings

overall system		channels, capacity building and user involvement	
Calendar issues and overall system	Save the Children Office, Kathmandu	Feedback process, problem areas, communication channels, capacity building and user involvement	Group discussion, field notes and pictures
Calendar issues and overall system	Interview object: Save the children Office, Kathmandu Researchers: University of Oslo	Feedback process, problem areas, communication channels, capacity building and user involvement	Individual interview, notes, pictures and audio recordings
General	Interview object: HISP India headquarters, New Delhi Researchers: University of Oslo	Feedback process, problem areas, communication channels, capacity building and user involvement	Individual interview, notes, pictures and audio recordings

Table 4.6: Data collection from field visit

4.5 Data analysis

Our data analysis process can be broadly described as being inductive, where the empirical insights have helped to inform the development of our theoretical concepts. However, this inductive analysis is not similar to a grounded theory kind of approach where we have started from a blank slate. Prior to the case studies, we had insights into some starting concepts around development, feedback, and participation. These are further revised as we carried out our empirical analysis. In this sense, our analysis process can be described as a process of a conversation between our concepts and empirical work, where each informs and is shaped by the other.

The initial phase of our analysis process started with the transcription of the audio recordings of the interviews and group discussion, and the field notes were refined. The next step in the process was to use Qualitative Data Analysis (QDA), to interpret the data that we have gathered through interviews, group discussion, and observations during our case studies in Sri Lanka and Nepal (Malterrud, 2012; Miles, et.al., 2018). The QDA process has been divided into four steps:

1. Becoming familiar with our data
2. Coding the data into themes
3. Searching for patterns and connections
4. Interpretation of the data

The technique that has been used to reduce the data and group them into categories is content analysis. This technique has helped us to interpret meaning from collected text data and thus identify important aspects of the content (Valcheva, 2022).

The next step in this analysing process was to code all the data. *Coding* means assigning categories and descriptors to blocks of text (Lazar, et. al., 2017), so we can make comparisons between data, derive concepts, and develop concepts easier (Corbin and Strauss, 2014). Our coding sessions mainly consisted of three main steps:

1. Look for specific items
2. Ask questions constantly about data
3. Making comparisons constantly at various levels

4.6 Limitations

There have been some limitations that have impacted our process of conducting our research. The main limitation of this study is the limited time that was spent in both the study sites, Sri Lanka, and Nepal. Since we could only spend 2 weeks in each country, we got to interview and observe a limited number of users in only one province. If we had stayed longer, this could have contributed to richer and more reliable data, as we would have been able to interview more users and had conducted several participants observations and be able to travel to different provinces. This would have provided a superior understanding of the context.

Language barriers have been an important aspect of our limitations. In Sri Lanka some of the army officers and development officers had trouble speaking and understanding English, our local supervisor, who knew the Sinhalese language, was able to interpret our questions into Sinhalese so that they would understand. He then interpreted their answers into English so that we would understand what they answered to our questions. In Nepal, there were similar problems but since one of us was fluent in the national language in Nepal and the interview object preferred to be interviewed in their mother tongue, thus most of the interviews in Nepal were done in the Nepali language.

Similarly, the Covid pandemic situation between the years 2020 and 2021 AD has impacted worldwide. As covid-19 is a highly communicable disease and had a higher infection rate, there were several restrictions related to the use of masks, distance maintenance, and especially travel. Due to this pandemic situation, we were not able to travel on our estimated date and were compelled to postpone our travel date, which gave us a little time to focus on writing than estimated.

Though the study revolves around the health information system and users of HIS affiliated with the health sector, having limited knowledge related to health acted as one of the additional limitations. Having some knowledge related to health might have provided insight and understanding of users of HIS from the perspective of health personnel.

Chapter 5 Findings

This chapter reflects and sums up all the responses we collected from the interviewees, their points of view, and issues that are encountered in Sri Lanka and Nepal. Based on our data analysis process we have done a thematic analysis where we have mapped all our data into smaller categories/themes which will mainly guide this chapter. Based on the qualitative research method we are conducting content analysis where all the information and data from the research participants are grouped and categorised. The categorisations are done based on our literature review and the research questions so that it could contribute towards the discussion and analysis in the next chapter. In this chapter, all the major categories which are called themes are explained and the table below gives a brief about the theme and what they are concerned with.

Theme	Explanation
Involvement during implementation & customization	If users have been involved in the process of implementation, could be at any point of the implementation or customization process.
Capacity building	How the users gained the knowledge about DHIS2, training, guidance, observation, and learnings
Resources and infrastructure	Available resources and physical tools, and problems associated with lack of resources and infrastructure
Feedback	How users communicate the feedback back to other levels, how they communicate to solve issues they encounter, and the media they use for communicating.
Problem areas and feature that is lacking	Problem areas participants encountered and features they wished they had or thought are missing. Since there is an issue regarding the Nepali calendar in DHIS2 we see that as a problem area for the future development of the system.
Maturity of system	Conditions that restrict or help the system develop.

Theme	Explanation
Involvement during implementation & customization	If users have been involved in the process of implementation, could be at any point of the implementation or customization process.
Capacity building	How the users gained the knowledge about DHIS2, training, guidance, observation, and learnings
Perception on DGPs	Understanding of DGPs, interpretation of DHIS2 as one of the DGPs, and their expectation from DGPs

Table: Categorization of Findings

5.1 Involvement during development, implementation & customization

The research participants we interviewed were mostly not involved in the implementation process. The main reason behind this was job rotation within the ministry, as they get transferred to different places or to different departments every 2 years.

“There is alot of job transfers because either there is less human resources in a facility so they need to shift to other facilities that have less people or the decision to make a job transfer of employees is decided by higher ups.” ~ Senior registrar in Health informatics Unit, Colombo

According to the Regional Epidemiologist (RE) at Polonnaruwa, Sri Lanka - he was not involved in the process of implementation, as he was only responsible for the regional set of services. However, he was the first person that got training in DHIS2 in 2018 at Colombo which was organised by Health Information Unit (HIU) which is a department under the health ministry that deals with health information and data. He was further involved in giving training to other health personnel. He mentioned the following:

"Actually, I'm responsible for the regional set of services. But he (referring to another guy) is responsible for policies. He makes the tactical plans. He is the one that ordered to implement this so we arranged the training programmes and we do the monitoring and evaluation." `

"Yeah, we did not have alot of knowledge regarding the information system, i mean the IT-sight. In my university and school time i didn't get any training in IT. We can handle the MS office, that's it. Now every person in Sri Lanka are getting involved with IT subjects which is good."

According to the medical doctors at Jaffna teaching hospital, they were also not involved in the implementation process. At the MoH Hingurakgoda and medical training centre in North-central province only one development officer was involved in the implementation or the development process. The development officer we interviewed worked at the medical training centre in Anuradhapura, she was one of the main supporters of the COVID-19-19 surveillance system and was part of the development team. She was the only exception otherwise all development officers were not involved in the development or the implementation process.

In Sri Lanka the system was mainly implemented by top levels, and users at facility and district level had to attend training sessions and read one-page guidelines to be able to use the system. The one development officer that was also involved in the development process got informal training from the former colleague and senior officers on how to use the system, and then she was later on also responsible to help teach others and support in technical difficulties. The development officer, who also works within the development team, could directly call the immediate medical officer at WHO, to get advice or inform anything. She mentioned the following:

“Working with development so don't use system so much as a development officer for reporting but working to maintain how the system works.”

“Coordinate, everyday meeting. Developing website/customization (3 members in the development team). As a development officer I usually have to enter data into the system but because of COVID-19 i got other roles. I also help the operational and give training to people”

“Working with development so don't use system so much as a development officer for reporting but working to maintain how the system works.”

According to the Senior Strategic Information Specialist (SSIS) working to develop the HIV tracker module in DHIS2 under the supervision of Save the Children in Kathmandu, Nepal has been involved in the process of planning, implementing, and customising the HIV aids module in DHIS2. He mentioned the following:

“Our daily routine revolves around Program monitoring, evaluation, surveillance, research related to HIV and support day to day operation, information system strengthened”

He further denotes that the development process lacks involvement of users and that involving them will be beneficial as we can get to know the issues of people working in the remote areas.

“In the DHIS2 conference they should include health workers from grassroot level, if the real users are not involved in the developing process, how are we going to know the situation of people in remote areas? Its lacking involvement of real users.”

~ Senior Strategic Information Specialist, Save the Children Kathmandu

The health information officers were also a part of the development and customization process and were not involved from the start. The senior Strategic information specialist wished that grassroot-level users were involved in the process so that they could be aware of users' needs. Due to the practice of employee rotation, transfer from one department or from one place to another is most common, thus it was difficult to find employees that had been involved in the installation or implementation from the beginning. Job rotation is a common process in Nepal, and due to this rotation, our interviewees had only worked in the present position for approximately four years in total before moving to another position.

At the health post that we visited, none of the grass-root level workers were involved during the implementation process. So, the system was implemented by the top levels, and they had to adapt according to it and participate in the training sessions when made available so that they could learn how to use the system.

5.2 Capacity Building

Capacity building is different from country to country, and it also depends on how the capacity model is developed within the country to build the knowledge of the health workers for digitization. The most common methods for capacity building are via educating users or providing training. In the context of Sri Lanka most of both the methods were applied, whereas in Nepal the method of providing training was in effect. All of the interviewees from the national level in Sri Lanka had studied (Bachelor in Medicine and Bachelor in Surgery) MBBS and have a graduate degree in MSc (Master's of Science) in Biomedical Informatics (BMI). Through the BMI program, they get introduced to several HIS tools and software including DHIS2. As the highest level in the hierarchy, the national level is responsible for arranging, coordinating, and planning training to build capacity in the country. Training can be arranged in different methods

depending upon the situation and requirements, there were mainly provided hands-on, online and blended training.

"Acting consultant in health informatics I have MBBS as a medical doctor and MSC in biomedical informatics in 2002 MD health informatics in 2019. Responsibility: mainly to support the functions of the health information unit but we have divided into five Consultants actually they are acting consultant and Associate Consultants what we do is we have divided workload. To support the cloud HIMS for in NCD and a national COVID-19-19 health information system, coordination of COVID-19-19 immunisation tracker"

Some of the training mentioned during the interview was training related to basic computer skills, internet and email, office packages, Geographical information system (GIS) applications and the most recent was COVID-19 immunisation training within DHIS2.

"We use Blended training methods we have Hands-On training, online training sometimes Blended so we when I was working in southern Province we have E-learning platform using module so that is how we did the training."

During these interviews, a common issue several people, including employees at the national level mentioned is the amount of training that is given. In an interview with the senior registrar at the national level, he mentioned the following: *"To cover the basic functions yes, but not for additional functionalities like how to generate reports"*. In other words, he meant that the training that is given is enough to cover the basic functions such as entering data, but other more difficult functionalities are not given training in.

When it comes to capacity building in the district/provincial RE at Hingurakgoda, Polonnaruwa was the first one to get training, and trained other health workers accordingly. The RE mentioned that they didn't have a lot of knowledge regarding information systems or IT sight before going into these training sessions. During his university or school time, he didn't get training in IT, so before going into this he only knew the simple things like MS office packages and such things. He further mentioned that nowadays everyone is getting involved in IT, so it is easier to learn.

"Yeah, we didnt have alot of knowledge regarding the information system, i mean the IT-sight. In my university and school time i didn't get any training in IT. We can handle the MS office thats it. Now every person in Sri Lanka har getting involved with IT subjects which is good."

The medical officer at the Outpatient Department in Sri Lanka, since she worked within the family health-related sector and got introduced to the system by FHB, after getting training sessions by them they had to guide others in their unit. As a consequence of the pandemic the training was mainly given in zoom, there was some physical training, and they also got these one-page guidelines which helped them. The medical doctor at Jaffna teaching hospital mentioned that he was the one from their unit who travelled to Colombo to get training sessions and further taught other employees at the teaching hospital. Further, the medical doctor at the Teaching Hospital Jaffna mentioned that employees often get rotated, so new personnel that come in had to be trained by someone that already has the competence. All participants had different opinions on the training that was given:

"More training and in a simple way so it is easier to understand how to use system".

~ RE, Anuradhapura

"We had to use zoom, it was not very difficult, but the thing is we used the free zoom version which caused some issues but otherwise it was no problem. It was very easy to understand. He shared his screen so it was very easy to learn".

~ RE, Polonnaruwa

"We had special training from PD officers on zoom. It was easy to understand since we had the one-page guidelines and also videos it was easier for us.

~ Medical officer, ORDHS

In case of a COVID-19 pandemic all the health assistants and army personnel responsible for using the COVID-19 tracker system were provided with one-page guidelines with brief steps and pictures. Since they could not meet physically and arrange training, all the users were trained online which was about 1-day long training, they were also given a one-page guideline which could help them in the learning process.

In the case of the HI Officer at HMIS department who joined the department in 2019, did not have the chance to attend any kind of training sessions for DHIS2.

"I was not able to get any training due to COVID-19, I learned about the system myself, going through systems and documents"

~HI Officer at HMIS department”

“I got introduced to DHIS when I joined this team, there was one book and we had four thousand dollar to strengthen information system, I found it quite interesting the name DHIS2 and since my colleague had already participated in one of the training organised by HISP India and the National health was also using DHIS2, my colleagues were familiar but I was read the book that was bought from conference Goa”

~ Senior Information strategic Specialist, Kathmandu

In the group interview with developers, the SSIS at the Save the Children's office conveyed that he read about DHIS2 and started learning himself while working in this position. Further, they informed us about how DHIS2 was introduced to the Health Ministry, which was when an employee working at the Health Ministry in Nepal attended a conference/training organised by HISP India. The health information officer working at the ministry was also a self-learner, in addition to this, he got help from his colleagues to learn how it works. In order to teach others at different levels, they now arrange training sessions where users can learn how to create reports and enter data.

One of our interviewees, which is in-charge of the municipal health department, mentioned that she had got the training related to data entry in DHIS2 at the initial phase of her career in this position. Though after a while she had to take care of other responsibilities and in addition has been introduced to other HISs Logistics Management Information System (LMIS), Early Warning Alert and Response System (EWARS), Health Infrastructure Information system (HIIS) etc. Since she didn't frequently use the knowledge that she got during the training at the initial phase of her career related to data entry she forgot how to use the system. Further talking with other interviewees, we perceived that there was a separate budget that had been allocated by the municipality to train at least 2 personnel at each health centre on how to operate the system and learn data entry techniques. These training sessions were mainly set up for around 4 days for each cohort. For these interviewees training sessions were helpful, they meant that more and more sectors are gradually being digitised so learning these techniques would be beneficial as it will spare more of their time in their daily work. The lack of human resources that have technical experience or knowledge was a major issue that both interviewees mentioned.

Amongst the health assistant working in the health post, two of them are provided with 4 days of formal training. In the training, they learned several uses of DHIS2. She mentioned in detail the following:

“The training was really good. We were trained several times. I did bachelor in public health and I have a good knowledge about computers and worked as a trainer as well so it was kind of easy for me to catch. We were given 4 days of training. Those who have skill and knowledge can learn easily and quickly. But whatever we learned there, we couldn't properly utilize it. We are just using an entry system. We are not able to look after indicators, verification, and emerging datas we are just involved in the entry of data. So we are not able to use every function efficiently. I believe that it has not been used properly in any organisation like ours.”

~Health Assistant, Thankot -3 Health post

According to one of the interviewees, she felt that training sessions were not sufficient in the sense of time and the context. She wished that if the training were longer with rich context about the software itself, she could have been able to utilise the system to its fullest. Another senior health assistant from Maha Laxmi metropolitan city mentioned she had not been given training at all and learned the system through other colleagues.

“Formal training, four days. I felt the training programme was quite ineffective and the training was not completed. I felt I wanted more time to be trained about the software.”

~ Health Assistant at Tinthana Health post

“No training related to DHIS2 learned from the seniors or colleagues during work.”

~ Senior ANM , Mahalaxmi metropolitan city



Figure 5.1: Health assistants at Tinthana health post showing us paper-based information system

Another intriguing fact about Nepal that is contributing towards capacity building are, the students from Nepal who studies at University of Oslo and does their research around DHIS2. Fortunately, we had contact with one such student, who is a former master student at UIO and currently working as lecturer at Kathmandu University and has written his thesis on capacity strengthening in Nepal. He has also been actively involved in developing a master course combining public health and informatics in collaboration with professors at UIO. In the interview he also mentioned that several Nepali students in Norway especially from UIO are practically working on DHIS2 and writing their master's thesis with topics related to DHIS2, where they are learning about the system and contributing through their research works.

5.3 Resources and infrastructure

The resources and infrastructure are affected by several factors that can be economical, geographical, social, political, and environmental. Though Sri Lanka and Nepal fall under LMICs due to the difference in geography the availability of infrastructure are different. In Sri Lanka the employees working at the HIU which is also a national level are provided with all the necessary devices like laptops, mobile, and telephone services that are required for their daily routines. But they were also aware of the country's situation at the grass-root level and mentioned that lack of infrastructure, lack of staff, and poor IT literacy within the health sector are the biggest hindrance to effective implementation of HIS in the nation.

"Lack of infrastructure. lack of staff, poor IT literacy not features. But need more of this".
~ Senior registrar in Health informatics

Similarly, all the levels in Sri Lanka mentioned the poor internet facility is the main issue, even at the district and province level they still encounter such problems but for them it is more manageable. Luckily the district and province level doesn't create reports every day, so they aren't as much dependent on the system as the grassroots level is.

Regarding the infrastructure, the lack of internet connectivity in rural areas was a major problem. When the internet connectivity is lost, there is no possibility to enter data, to enter data into the system they have to wait until the connectivity is back. Another technical problem they often encountered was that they had to empty the cache every two hours so that the application could run better and more effectively.

"Do not have a problem with the system, but the main issue is internet connectivity. When the internet is off I have to take pics of the form, go back to the office and do data entry from where the internet is stable." Hardware problem, same user account on different devices, more than 5 login on same user not good. Only direct health can give access. Laptops are slow due to login and cache and overload.

~ Army officer at MOH Polonnaruwa

"The other thing is the cache memory every time one have to clear the cache and again so if you can handle it would work better."

~ Senior registrar in Health informatics

During our observation at the MoH areas we noticed that during the vaccination period, a lot of patients gathered at the MOH to get vaccinated. Since there was a specific time period for vaccination and the time period was quite short, it tended to be quite chaotic, but the health personnel working at the MoH tried to arrange it in queues as best as possible. We also observed and got to know that the army officers had to work in a very chaotic area, as their working station for data entry was normally in the MoH centre surrounded by locals who came for vaccinations where all wanted to get their job done hastily.



Figure 5.2: Local people getting vaccine and army officer entering data at MoH office, Hingurakgoda, date: 05.01.2022

At the Thinthan healthpost in Nepal we got to see how the manual jobs are done before entering data into the system. Normally before entering data into the system, health personnel will collect information by filling out this form (picture below), at the end of the month all forms will be gathered and information from the forms will be entered into the system by a health personnel that have knowledge in how to enter data into the system.



Figure 5.3: Heath post at Thinthana, Chandragiri 15

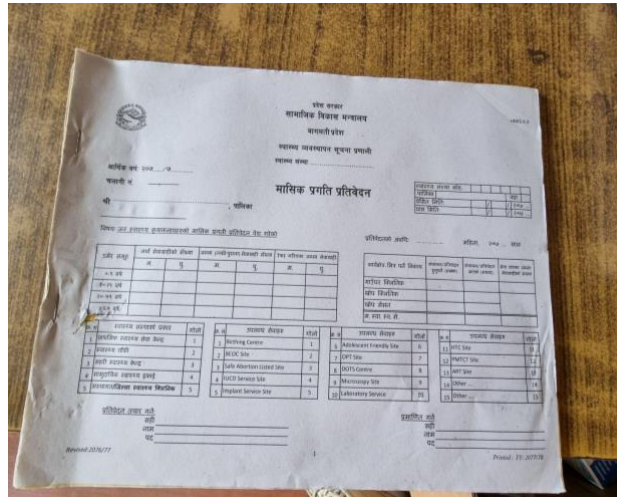


Figure 5.4: Illustrate the forms that are filled in manually by health personnel

In the municipal health office at MahaLaxmi municipality we could observe a health assistant working in an office filled with papers, files and boxes as well as working on a computer. This shows the dependency on paper-based systems even though they have introduced digital systems in the offices.



Figure 5.5: Pictures from Mahalaxmi municipality where health assistants are working on a desk filled with papers, files, and boxes in addition to a computer.

At one of the health posts, we observed that the interviewee was also comfortable using her own smartphone for reporting and data entry. She further demonstrated how the reporting and data entry worked on her phone. She mentioned that she preferred using her phone rather than computer for doing this, as it was easier to bring her phone. The same interviewee mentioned that she felt that the training that was given was not focused on all groups with different ages and knowledge as some participants in the training had difficulty using and understanding the system because they do not have sufficient technical knowledge. However, she agreed that with time and practise one can grasp the use of DHIS2.

The employees working at the Health Information Management department are provided with all the necessary facilities and equipment that are required for their daily work such as laptops, telephone, internet, computers, and printing machines. Similar to Sri Lanka, the officers in Nepal were aware of the geographical conditions and lack of fundamental infrastructure development which has led to deprived people in remote areas even the basic health facilities. Thus, they focus on the development of fundamental infrastructures like roads, electricity, and internet facilities to expand the health services and in addition to contribute to the growth of HIS in the country.

Other than that, load shedding which was a common issue in Nepal, there were no other issues related to the infrastructure they mentioned. When it comes to resources, lack of human resources working within an area of the municipality was a major problem, due to COVID-19 employees having more responsibilities leading to additional workload for each person.

"I'm moderately satisfied with the system. They should include more people in my age group to understand. And they should have less sections."

~ Regional epidemiologist, Anuradhapura

"Yes but the development officers enter data. And if some something accure like lack of development officers and high workload they have problems to enter data. If we have more People to enter data there are more comfortable for us. There are less People entering data. In tracker system i can enter individual data of person infected and which are this person is in. So its very easy to monitor."

~ Medical officer VP opd(Outpatient department) unit, Anuradhapura

"Lack of manpower who are good at using technology within health sector, one must focus on age group as well."

We observed that both the health posts we visited had electricity and internet connections, but they often face the problem of load shedding (power cut) which deprives them of using electronic devices and especially the internet. They also mentioned that those who got training also got provided with a laptop from the government of Nepal, which makes it easier for reporting. In one of the health posts, we saw the interviewee was also comfortable using her own smartphone for reporting. One of them also felt that the training was not focused on all the groups with different ages and knowledge as some participants in the training had difficulty using and understanding the system because they do not have sufficient technical knowledge. But both interviewees agree that with time and practise one can grasp the use of DHIS2.



Figure 5.6: health assistant using her mobile to enter the data

5.4 Feedback

We as researchers were interested to know about the use of feedback systems, communication channels and methods they use to communicate with each other and with the national and global level development teams. We discovered that most of the users in both study sites used direct calls and group chats in applications such as Facebook messenger and Viber, to complain about their problems, and share feedback and other important topics.

The registrars working at the HIU in Sri Lanka were responsible for handling hotlines and answering queries related to using HIS from the facility and province/district level users. If they

were unable to solve the issues or had any feedback related to the COVID tracker and covid immunisation tracker, they forwarded the queries or feedback to the development team which is HISP Sri Lanka. The senior registrar we interviewed mentioned that, at their office they have three hotlines, that are directed to queries related to the COVID-19 immunisation system, one of these three is directed to his personal phone so it happens that users call him directly. Other than this they also get informal feedback from users. Regarding the feedback, the senior registrar meant that it was: *“better to have an inbuilt feedback mechanism or at least to Google”* or *“better to use the inbuilt feedback mechanism”*.



Figure 5.7: Registrars working together at the health information unit.

The second picture shows a senior registrar attending a hotline call from a user

Medical officers at the VP OPD Unit communicate directly to the Family Health Bureau (FHB) when they encounter any issues, the expert there would advise on how to solve the problems. For efficient communication, they mainly used phones and sometimes e-mail, but there are no fixed channels they use to communicate. According to the medical officer, the phone is the quickest way to communicate. They are comfortable using phones as the other end is always welcoming and is willing to help with any problem they encounter. The RE mentioned the same, that he preferred using the phone to communicate as it is efficient. None of them wanted any other communication channels and were quite happy with how they communicated. The medical doctor at Jaffna Teaching Hospital also preferred using the phone, he directly called the HIU if he or any other employees at his facility encountered any issues.

Following the hierarchy of the organisational structure within the health sector at Sri Lanka, most of the important notices and information from the ministry level are made available via email or traditionally via post. On the contrary, when one has to communicate from facility level to higher level, they use mostly direct calls as they get a quick response which is also backed by the

personnel connection within the sector. Another important medium for communication is the use of the application “WhatsApp ” which allows people to call, and send messages, pictures, or videos within minimum cost or even no cost if there is the availability of wireless internet connections. In this application, they have made groups that involve personnel and experts from different levels and different departments within the health sector which allows them to share any experiences, problems, issues, or even solutions.

In the case of the army officers at the grassroots level regardless of any topic, they can communicate directly to MoH incharge since they are accessible at the vaccination centres or can also communicate to the responsible RE for that area. Further, if the issues persist locally, MoH incharge and RE will further report to the district or the national. Other than this, if army officers encounter any technical issues, they could communicate via direct calls to their senior officers or send messages in WhatsApp groups which include army officers who are trained and deployed for handling and entering data into the tracker system.

Users at the national level in Nepal communicate with other levels mostly by email, and if they need an emergent input or perspective on an issue, they will directly call to clear the problem. As other users also mentioned they felt like direct calls or email increased the effectiveness and response of feedback. The health information officer categorised the feedback or communication process as a bottom-up approach because the facility level communicates with the municipality and the municipality communicates with the province and province with the ministry. So each level will always communicate with a level that is above them. The health information officer further mentioned that they had close communication with HISP India on how to process issues they encounter.

Some of the response according to the interviewees upon the communication channels

“we communicate problems to the province, then they coordinate with the HIMS division family welfare division.”

~Incharge of the health department , Mahalaxmi Municipality

“We communicate our problems with direct communication with the department heads via telephone calls. Usually they have several responsibilities and are busy so they might not see the messages, direct call are more efficient, we have numbers of people working at departments.”

~ C ayeba adhikrit 6th, Chandragiri Municipality.

“collaborate with the municipality in monthly report meeting who will relay the problems to the direct focal person, and sometime a direct communication with direct focal person at CBS(CENTRAL BUREAU OF STATISTICS)”

~ Health assistance, Tinthana Healthpost

“For emergency purpose we call and solve the problem immediately.”

~ Public health Inspector, Thankot Healthpost

Similar to the district levels in Sri Lanka, municipality level users that we interviewed in Nepal mentioned that they would directly call the department heads if they encountered any issues via landline phones or even use mobile phone applications such as Viber. They further mentioned that these channels are in frequent use due to its quicker responses to issues and according to them it increased the effectiveness of entering data into the system if they cleared the problems through phone calls. They also have a Facebook group to communicate between the health centres within the municipality but for the formalities and proof, they have to send formal hard copies of the letter to all the health centres. Likewise, high levels send a formal letter to a lower level about any information or for conduction of programs. Reporting to a higher level or mayor of the municipality is done in several ways depending upon their convenience, it could be in person or during monthly meetings.

As a way to communicate, at least one representative from each health centre in a municipality gathers in a monthly meeting. In this meeting, they go through the monthly report and share every problem they have faced in the past month and plans for the future. In addition, when they are gathered together, they discuss DHIS2 and try to coordinate so that every organisation does everything similar. The grass-root level users also mostly prefer direct calls to get quicker response to the questions or issues they face, as it is more effective and efficient for them to make a direct call. The version of DHIS2 that is being used in Nepal has an internal communication channel, but unfortunately, that software is not being used yet.

Most of the time the grassroots level users communicate with higher level teams only when they face some problem with the system which is either related to server, functional or requirement problems. While the immediate management team of DHIS2 in both countries send notifications that pop up in the dashboard in case of any changes and even notify all the users via email. The feedback process either for negative or positive feedback in both countries are mainly informal which means that every form of communication was mainly through group chats and phone calls. This created a limitation on tracking the kind of feedback and response on the feedback, since

they were not documented in a proper manner. Thus, we asked them about the problems they face while using DHIS 2, which is discussed further.

5.5 Problem areas and feature that the DHIS2 is seen to be lacking

The participants mentioned several disadvantages with the current system menu, buttons and structures were just some of the issues that were mentioned.

The senior registrar from Sri Lanka mentioned the following:

“If we can customise the menu, for example, if you do not want to go to a particular menu, get a tracker capture and the name itself is not self-explanatory to most, rather than going for that menu if we could develop a menu dynamically like we can rate forms like menu structure like search button, register button, once we register we add the dose first vaccine dose like difficult words like event enrolment and tabular data entry, timeline data entry and those things are difficult so if we can omit them, only then we can show the end users the menu structure they need. It is a lengthy process and unnecessary details. you can have a menu customised so you can directly go for what you want”.

He further mentioned problems with the memory and analytics, as following:

*“the **Analytics**, I think that should be optimised analytics is difficult when they run for about 2 to 3 hours in midnight and that's one issue and the other thing is the **cache memory** every time one has to clear the cache and again so if you can handle and other certain things I can't understand for example when we go to edit, edit person then we however much we try to save it is not saving, then they have to change the district to another district then again to correct district, just then we can save, the same thing happened for the vaccination so we have to select another batch again go back to the correct batch then make complete so like that they are space for Improvements”.*

In general, there seems to be several problems even among the national users which are not frequent users of the system.

As a district/province level user mainly uses the system for reporting and coordination, so they are dependent upon data that are entered by grassroots levels. The RE in Polonnaruwa mentioned issues with entering vaccine doses correctly into the system, e.g., if a patient took 1st dose in a foreign country and took their 2nd dose in Sri Lanka it is not possible to enter the 2nd dose as the 2nd dose in the system it will be entered as the first dose. So, facing these issues with locating which dose of vaccine the patient took is difficult in this vaccine tracker. RE further mentions that the possibility of offline data entry as the cancer surveillance system will ease the work for those who enter data at grassroots level, he thinks it will contribute to data being more accurate.

Another problem mentioned by the interviewees is the lack of human resources. They delegated some development officers from each health department in the province and made them responsible to enter data and provide their help at COVID-19 vaccination centres, where the public health centres have a high workload, and it is problematic to enter data. All the interviewed participants conveyed that it would be more comfortable to work if they had more employees to enter data. According to them, interaction factors such as buttons, text size, and menu structure are not a great issue, but they face problems in connection to a lack of technical resources, lack of manpower, and infrastructure. RE mentioned that the situation they faced during the pandemic shows that they lack manpower within the health sector. Recruiting army officers to enter data was kind of the turning point for them, otherwise the workload for each employee at the facility level would have been immense.

Due to the lack of internet connectivity the army officers mentioned that they wish they had occasion to do offline data entry. They mentioned that they had to take pictures of the paper form so that they could enter the data into the system by looking at the pictures when the internet was restored. They also mentioned that they do data entry based on the voterID so if they have or are already registered with voterID it is easier to find the information about the person. VoterID is merely for people above 18, so when a person does not have a voterID data needs to be entered from the scratch meaning they have to enter gender, age, and address. Army officers mentioned that if there was a solution to this it would be much easier for them to enter data more efficiently and effectively. Another issue that was mentioned during our interviews was the stability of the system, since more than five people are using the same username the system becomes unstable. So, they wished that they had their own credentials to log in so that they don't face problems such as the system being unstable.

As for the health information officer the main issue is the lack of support and the need of upgrading the system. Due to problems with upgrading, they fall behind and face several technical issues and server downtime. According to both, it is not about features that are lacking but about the organisation and how they should solve the technical issues.

As for now they don't see any features that are lacking in the system, but the only problem they encounter lately is the lack of the opportunity to see the last remaining dose.

The interviewee mentioned that they have encountered server issues several times, which leads to delays in their daily routines. Another problem they have come across is with the logistics management in DHIS2. The example they provided was about immunisation, the health centre facilitates vaccination of DPT3, and TT every week. The vaccine has validity for 1 month and one pack has 10 vaccine doses, if 8 are used out of 10, the two remaining can be used for the next vaccine session. But Dhis2 lacks a section where we can add this remaining dose or transfer the remaining from the previous session. This shows a logistics error and incorrect report, as a report from DHIS2 shows 10 people have been vaccinated but in reality, it is only 8.

Due to load shedding they often experienced that they had to wait until the power came back to be able to enter the data. So as a solution for this they preferred the ability to do offline data entry, so even if the power goes, they are still able to finish their work. They mentioned that they only use DHIS2 for data entry, knowing the potentiality of other functionalities as well, the interviewee wishes to look after indicators, verification, and emerging data, to become more efficient. They also mentioned some functional errors as it is a lengthy process to complete a task. For example, every time they must enter 0 even when there are no patients suffering diseases like TB, HIV, and many more. The other problem is pressing the enter key will not allow them to move to another row or column, they must click the right side of the mouse, which is tenacious for one of the health assistants.

There were various thoughts on using the Nepali date syntax, when asking if they would be comfortable with using the Gregorian calendar one health assistant mentioned that since they had been using the Nepali calendar for so long it is the easiest way to continue to use it, but she wouldn't have any problem in using the Gregorian calendar. The other health assistant meant that DHIS2 should use Nepali date syntax as the software is being used in Nepal.

Both the incharge we talked with preferred the use of Nepali dates, since the Nepali calendar is used by all the government bodies, people are much familiar with Nepali dates. All the data entered, and every report are created with Nepali date, thus replacing it with others will not only take a longer time but it will be an issue when it comes to coordination with the daily program and monthly programs. For example, all the municipalities have to submit a monthly report which starts on the 1st of each month, according to the Nepali calendar, their new year is around the 14th of April which means the first day of the month in Bikram Sambat (BS) is equivalent to 14th or 15th day of the month Gregorian calendar it will create an imbalance as per one of the

interviewees. In addition, since they have been using the same calendar system for decades, they felt it would be easier and more comfortable for them to continue with the same system.

5.6 Maturity of system

We discussed earlier that political, economic, and geographical conditions restrict the HIS from being able to rapidly grow and provide quality and efficient health care.

Political commitment and support from the highest level of government is instrumental in driving the success of such initiatives. Sri Lanka's attempt in developing the COVID-19 tracker system was mainly an initiative taken by the HISP team which developed the tracker system, the informant mentioned the following:

“HISP Sri Lanka didn't charge the ministry of health for the project but created this project as a Corporate Social Responsibility (CSR), where the idea is that a company plays a positive role in the community and considers the environmental and social impact of a business decision”. ~ Registrar at HIU, Colombo

Nepal's process of transitioning to a federal system has contributed to lifting the health care services, though there are still ways to go to being able to provide health facilities to all citizens despite the geographical barriers. One of the informants during our data collection mentioned the following:

“The information system is not updated by the upper authorities like the center divisions, they think, it is an additional burden because there are no individuals who are specifically assigned to recording and reporting because they are also implementing services” ~ Informant group interview session, HVI, ADIS DHIS team

Geographically, even though we did not have the chance to visit remote areas that are difficult to reach, we understood that districts such as Mustang have both geographical and poverty-stricken living conditions. As mentioned earlier we had a conversation with an earlier master student, who conducted his research on Capacity building in case of DHIS2 in Nepal, we came to know that during his site visit in Mustang he faced both geographical and bad weather quality in Mustang which made it difficult to travel around the district to conduct the site visits he really wanted to. He further mentioned that: *“Health staff often do not retain for a longer period in those areas, because everyone wants to move to bigger cities such as Kathmandu”*. Another issue which was frequently mentioned by the users of the HIS was that the infrastructure was quite poor especially in the remote areas which were located in mountainous areas, so building a HIS which requires internet facilities can be difficult. In case of Sri Lanka mainly poor internet quality

were the main issues which caused issues and was a hindrance in being able to provide an operative HIS. The informant mentioned the following: *“And another thing is if HIS system is implemented in offline modus also so that people can enter data offline, because you know in some areas, we don't have much internet facilities so, if you can implement this in offline modus it would be great. We have such system called national cancer surveillance system”*.

There are several aspects which need improvements, and there are several facilities that could improve in form of quality. We argued earlier that LMICs mostly focus on delivering the public health services rather than incorporating digital HISs. In the case of Sri Lanka most known ailments at public facilities are free of charge for everyone. However, they still charge for specific treatments where there is a critical illness and condition, in addition to private hospitals you get charged but are given top quality treatment (Expat financial, 2022). From January 2008 there were provisioned free essential health care services to all citizens in Nepal. Under this system, decisions were made that emergency, inpatient, outpatient services and 40 essential drugs levied no charges, other services needed to be paid out of patients' pockets. However, based on a conversation with a former masters student at UIO and lecturer at Kathmandu University we came to know that the quality of services in the private healthcare system are higher than the public healthcare services (Sah K. M., et. al., 2020) and that more than half of the expenditure of Nepalis is still covered out of pocket (Kalaunee S. P., 2019). One informant which was a patient at public hospital told us the following:

“I mostly prefer public health services because it gives free and quality services which can be affordable by everyone, but the problem with public health services is the long waiting time and when it comes to service it takes a lot of time to get the help that we need. But I think public health services have become much better now than before. The thing is that it provides very limited services whereas in private health centers acute health services are provided with less waiting time even though it might cost a fortune.”

The registrar the HIU mentioned in Sri Lanka mentioned the following:

“All preventive services and most curative services are free in Sri Lanka, and we don't have private institutions for preventive services. There are of course some ques for surgeries and for some procedures that the patients need to undergo, but otherwise it is not much que for other services. Sometimes patients go to private institutions for their convenience if they want to get treatments through consultants only, but the public services are quite good in Sri Lanka.”

The capacity building in the country is also contributing to the level of maturity of the HIS. There is a difference in how the capacity is built in case of health in Sri Lanka and Nepal. One of the informants working at HIU mentioned the following:

“We are quite lucky we have a health informatics program where professionals can learn how to design, deliver, and evaluate mediate health informatics related projects. Not every low middle income country has the same opportunities, we are very privileged. If i didn't attend this program i would have had less knowledge of how to deliver a HIS that is ICT based, i learned the most from this course.” ~ Registrar HIU, Colombo

However, to be able to enter the BMI programme you have to fulfil the minimum requirements of:

1. A medical Degree registered with the Sri Lanka Medical Council (SMC) and
2. One year of internship recognized by the SMC and
3. One year of full-time post internship work experience in the health sector, recognized by the Postgraduate Institute of Medicine (PGM).

OR

1. Hold Dental Degree and registered with the SMC, to practise as a Dental Surgeon and
2. Completed at least 1 year in general dental practice in the government, university, armed forces, or private sector at the time of closure of applications for the selection examination (Postgraduate Institute of Medicine, 2022).

In Nepal the capacity hasn't been built as strong through knowledge-based courses as it has been in Sri Lanka. In case of Nepal the HIS was incorporated first and then they started training health personnel in it. But due to frequent rotations in positions, the personnel that get training have to take on other responsibilities which means other personnel need to get appointed to the positions that are left. This in addition means that the new appointed personnel need to get new training to be able to use the HIS. One of the informants from the health post in Nepal mentioned the following:

“The past months i have been doing other things and shifted my workplace, before i was the other healthpost now i'm working here.” ~ Heath assistant, healthpost Thankot, Kathmandu

5.7 Perception on DGPs

Since the term digital public goods is quite new, many were unfamiliar about the term, but well known about the concept and principles. According to the Senior Strategic Information Specialist working under the global fund in Kathmandu, DGPG has higher demands in public institutions, public services where the target audiences are general public, and can be applied in multiple disciplines as information and technology are key to all the sectors. They believe one can benefit from DHIS2 as it could help in policy making, procurement of different logistics, ease day-to-day operations in health centre level and site level. He further says that: *“Users can use it for policy planning, monitoring, and effectiveness of interventions. Planning, controlling, logistics. Management of medicines, test kits etc. They can see which areas are missing medicines, etc. Pass information to patients easily”*. However, he also mentioned the following:

“I agree 80% - 90% on the principle of DGPG considering its free open source software, but to run this effectively we need to invest in server and lots of hidden costs, to make it really fall under that dgpg, this requires to be more accessible to those we are living in remote areas, or with limited education, user friendly, It claims that it works offline but it's not that easy, and they also claim that it is easy to use but sometime my own colleague, subordinates has some problems.”

“Though it is free, it has several sister organisations, they charge a lot of money and they don't deliver all the activities, the system needs to be developed a lot and updated often to meet and fulfill the expectations of users.”

“One needs to consider the situations of all the lower and middle income countries, for the developed countries they are never going to use it, as they have capacity to build their own huge information system, create dashboards they want. But the users of DHIS are mostly in low and middle income countries.”

“Focus on users, users must feel this is my system”

The registrar working HIU was familiar with the term Digital public good, the registrars see the DGPs as potential remedy to the problems of digital exclusion, particularly for kids in emerging nations. They further mentioned the following:

“I see the DGPs as a system that can boost service capacity, decrease labour and inventory levels, improve cost control, and increase patient care and administration information speed and accuracy.”

“ However, experience suggests that most of these advantages will not materialise immediately after system adoption. The timeliness, accessibility, and accuracy of information may be compromised by operational issues; policies and procedures may not have been sufficiently adapted to match the reality and intentions of the systems, and tasks assigned to employees may not have adequately been reorganised. Healthcare organisations must make plans and implement tactics to leverage these advantages if they fully utilise the potential of information systems. The opinions and requirements of users who will be the primary beneficiaries of any DGPGs should be considered; this is essential for a successful DGPG project. In addition, the opinions and demands of users in underdeveloped nations must be considered. The context for attaining the Sustainable Development Goals is shifting due to the quick changes in digital technologies. For millions of people, these technologies have, in the best scenarios, greatly improved access to public services and economic prospects. A growing movement highlights the necessity of digital public goods such as DHIS2 against this background”.

~ Registrar at HIU, Sri Lanka

Further, when it comes to DHIS2 as an DPG the registrar sees it as:

“Like other global goods, DHIS 2 is Open source, scalable, well documented, interoperable through open standards, and flexible enough to be tailored to the demands of particular nations and projects. DHIS 2, used in many other countries, has been used in Sri Lanka for a while now”.

But he also suggests focusing on the users’ demands and their opinions.

“The opinions and requirements of users who will be the primary beneficiaries of any GPG should be considered; this is essential for a successful DGPG project. In addition, the opinions and demands of users in underdeveloped nations must be considered”.

Chapter 6 Analysis and Discussion

This chapter provides an analysis and discussion of the challenges and problems users face, and the discussion on approaches that are required to overcome these challenges within HIS in both countries. Based on our findings, we have pointed out and categorised the important issues which can contribute to providing a better system for the users.

6.1 Challenge in promoting user participation through feedback

The implementation of DHIS2 nationwide has created a pool of users of DHIS2 in both nations at all levels in the health system. The users at the different levels are more specifically health personnel at the different departments under the health ministry, developers, and support teams, who are also the frequent users of DHIS2. In the case of Sri Lanka midwives at each MoH are responsible for entering data, whereas in Nepal at least two health personnel at the facility level at each health post in a ward are trained for using DHIS2. Providing basic health facilities to the general public is a major struggle in most developing countries, so it is more important to prioritise the circumstances and situations than the users in any development process. Their prime concerns are mostly on providing clinical services, and general clinical services in all the communities. Unfortunately, due to several reasons such as financial, political, geographical, future plans, strategies, and adequate health services seem to be lacking in LMICs.

As we discussed earlier, health resources are important in the process of digitising the health sector in LMICs. However, it also requires that the health personnel have the knowledge, digital and technical understanding to be able to be involved in the design process of HISs. User participation has several benefits, as it encourages mutual learning where users must have an understanding of the technical possibilities in order to become able to envision new solutions and new practices that can be brought to the system in use (Joshi & Bratteteig, 2016).

In our case study, the lack of required human resources has resulted in work overload, lack of training, good techniques, and management for existing health personnel. In addition, since most of the manpower had a background in the medical and clinical domain, they needed capacity building in the technical domain. This induces the ability to incorporate user participation in the design process in both of the study sites.

6.1.1 Challenges to users' participation

Although we have previously mentioned some of the significance of User participation, there are several challenges when it comes to the application of this concept. As user participation is most commonly practised in western countries and associated with certain contextual assumptions and beliefs, which is emphasised through socio-political targets such as workplace democracy and local empowerment often backed by technical capabilities, users' motivation, availability of resources and long-term support mechanisms, which sometimes may be challenging in case of LMICs (Kimaro et. al., 2008), which does apply in the context of Nepal and Sri Lanka. Our study has identified some factors that deter user participation, which can be classified into technical and organisational. In this section we will discuss factors that constrains the user participation practices in Nepal and Sri Lanka.

1. Technical factors

Operational System: As discussed in Chapter 1 that DHIS2 platform is an operating system which was implemented in the year 2011 and in the year 2016 in Sri Lanka and Nepal respectively. According to the findings, the majority of the users mentioned that they were not involved during the initial implementation, most of them joined when the system was implemented. Furthermore, customisation is done according to situational needs, for example if there is a disease outbreak, they customise DHIS2 for monitoring the particular disease outbreak. In Sri Lanka, this is done by the local HISP Sri Lanka developers, whereas in Nepal, the country reaches out to HISP in India. This indicates that the user is not taken into consideration in an operating system.

Shortage of skilled human resources: Given that most staff in the health system was hired much before digitisation, there is a short fall in capacities to work on computerised devices, software, and different digital tools. User participation requires to go beyond participation of skilled users in design, and also incorporate training and learning (Bødker et al., 1987, Tollmer, 2001) to empower intended users with lack of skills to contribute to the design in the long run (Walsham, 2002). Moreover, training of intended users prior to their participation creates a democratic and empowered environment (Byrne and Sahay, 2003). Here in case the users of DHIS2 are not given regular training, in the quickly developing and high-level technological progression the users cannot be

expected to keep updated more often. Thus, this has created hesitation in implementors as users might not provide appropriate initiatives for the system development.

2. Organisational factors

Organisational practice and culture: The national health information system is implemented in a top-down approach by the ministry of Health. As mentioned earlier such large implementations with lack of adequate capacity does end up in sub-optimum implementations. The system of top-down approach creates a barrier between those in the top level and those working in the lower level. The flexibility of expressing lower-level staff gets suppressed, such practice regularly becomes a habit. Similarly, the global organisations, donors and policy makers held communication with those at top level only, this creates a huge gap between the need of lower-level users and the implementers at the top level. This culture of top-down approach institutionalised the problem of centralising power and authority among the top level, where those at bottom level are not able to participate in decision making or express and communicate their needs freely. Another practice of job rotation and transfer is absolutely typical in government bodies, which is the reason it is rare to find someone working within the same domain for a longer period. In such practices it is obvious that we can get several numbers of users but on the other hand provides less timeframe for users to understand the system as well as their needs. Even if health personnel get the required training they get transferred to other places and positions which means they do not get enough chances to practise what they have learned during their training sessions for the betterment of the system.

Priority on basic needs: LMICs mostly struggle with being able to provide basic health facilities such as the supply of medicine, quality medical services, and clinical services to the general public. Hence, the priority lies in being able to provide basic needs rather than digitising the health system. While LMICs provide their first concern towards fundamental health facilities and making efforts on maintaining a better HIS at the same time, they prioritise the regular operation of the system giving less attention to the users of the system.

Time and financial resources: For the users to be able to contribute to the design process they must have capacity (Grønbaek et al., 1993), however, to cultivate such

capacities and to motivate health personnel and relevant personnel for participation requires a significant number of financial resources and must be invested a good amount of time by both the implementers and users. According to the information gathered, the users of DHIS2 are already facing a burden of work overload, as they are not only responsible for the functionality associated with DHIS2, but instead it has become their additional responsibility besides their regular jobs. On the other hand, most health centres exercise paper-based recording systems as well as a digital system, so the employees must do the same job twice, which is causing duplication of work.

6.1.2 Feedback for promotion of user participation

Despite the challenges of user participation, the positive impact of user feedback for system development has been proven through several studies. Throughout our data collection process, some of the interviewees at the top level in both countries expressed that they motivate and encourage all the staff to provide feedback. They also realise user participation can lead to quality design, and feedback could be a new approach to promote participatory approaches, in order to improve quality of public service provision and help in delivery of good governance. Implementing feedback within an operational system has two-way benefit, it helps user feel empowered as they get chance to voice their concern, complains, suggestions and positive reflection, on the other side government, implementers, developers of the system get opportunity to utilise such feedback to expand and improve quality of the system.

Motivating user participation

Even though most literature promote user participation in developmental phase or initial phase of system implementation, technologies are evolving rapidly, and system implementers have to adapt accordingly. However, it is not just about the technologies that are evolving, it also depends on the situation and demands of the users which requires a quick response for the development or update of the system.

Even though the system is operational, user participation must be encouraged as users are the source of knowledge and also the source of creativity (Følstad, A. 2017). Implementation of feedback systems could be a sustainable solution, involving users and encouraging user participation helps to promote capacity building. Users are more likely to provide detailed and structured feedback when they get the intrinsic motivation to contribute to producing and maintaining high-quality software (Johanssen, 2019 pp 160). Motivation can also be provided by

offering better incentives, which could be *financial* and *non-financial*. *Financial incentives* could include raise in salary, if a user provided feedback on a regular basis they will be rewarded, and *non-financial* incentive could be promotion, introduction of a new position in the organisation, rewarding quarterly or yearly based on their performance, assurance of a better system and convincing that their involvement and provided feedback will in return help to make their job easier.

Implementing feedback system: Improving and updating the feedback system

Our research also identified that the feedback is not practised systematically in both countries. The only kind of feedback we could identify is at the time of system troubleshooting or a health crisis. The COVID tracker system in Sri Lanka included a hotline calling system, where users can call if they encounter any problem in the system. Whereas in Nepal there is no such not dedicated feedback system in case of DHIS2 aggregate system. However, the common thing we noticed about both countries is that the users prefer to call directly to a person they are in contact with, who is currently working with a particular HIS and the person in contact will further convey the message to the dedicated team to solve the problem. This practice clearly points out that the feedback they receive from the users are not properly documented and both countries do not have a dedicated feedback system.

DHIS 2 has an integrated message and feedback feature, but this feature is used very rarely in both of the study sites. As mentioned earlier, health personnel in both countries preferred to call the person in their contact to clarify, rather than using the digital toolkit to report their problem or concerns. None of the participants interviewed used this feature and some of them were not even aware of this feature. They generally prefer direct calls when providing feedback, which is a deeply ingrained culture of the organisation and has been a common behaviour. For an organisation to succeed, such culture needs to be replaced with a feedback friendly culture. Such cultures emphasise the importance of feedback in the organisation while providing support for using feedback and taking a stand on the quality of feedback (Baker,2013). Thus, it is recommended either to introduce a new feedback system for all the HISs in use or encourage users to use the existing DHIS2 message and feedback feature continuously.

Actively making use of feedback system might generate following benefits:

1. Help in measuring and tracking user experience, which could contribute to recognising where the HIS stands out and where it falls short.

2. Monitoring raised feedback and issues
3. All the generated feedback and responses can be documented,
 - a. There is no doubt that LMICs implement several projects with the help of funding from international and global organisations. With an appropriate feedback system, it is possible to create appropriate and adequate documents where the problem areas, as well as the specific needs, causes, and requirements, can be visualised to the funding organisations in a more effective way. Thus ultimately, by doing so the chances of getting financial aid from international and global organisations are subsequently increased as the funding organisations will be more inclined to support a well-documented project.
 - b. Documentation also helps for future reference as this will act as a guideline, solving the similar problems and follow the potential procedures and discard the irrelevant ones.

Feedback Process

For a feedback system to be successful only gathering the feedback is not enough, a set of steps must be followed. Feedback is a never-ending process. The figure below is a suggestion for the feedback framework including important steps required in a feedback system.

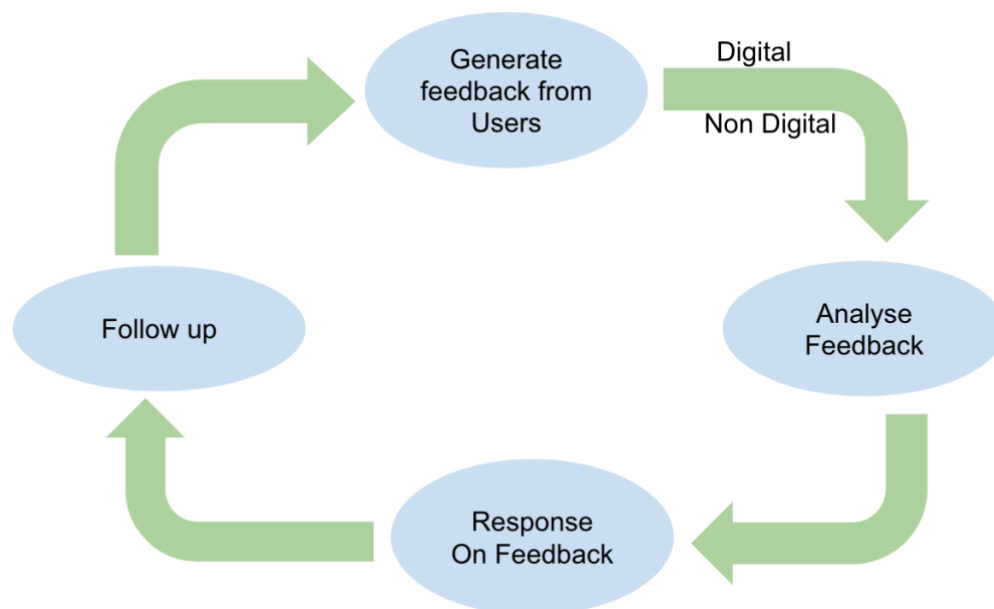


Figure 6.1: Feedback process

1. Feedback Generation:

Different methods are suggested for collection of feedback such as; online report forms, online discussion forums, and diary as methods to gather users' self-reports of problems or incidents, interviews and questionnaires as means of gathering details on usability problems as part of usability testing debriefs, online discussion forum and focus groups for purposes of stand-alone usability evaluations (Følstad, A. 2017).

There are several ways to generate feedback, it could be digital such as an interrogated system, a system to collect feedback, or non-digital such as direct feedback to the implementers or developer via telephone calls, messages, email, posts or surveys after each meeting or training session with a list of questions. Among these several available methods, the most effective and efficient in the sense of practice and economical value would be to use a digital feedback system. Economically, a digital feedback system requires an initial investment for the installation, and later it can be managed at a low cost. Practically, generating feedback creates enormous numbers of feedback, which require ample storage, deep analysis, proper categorisation, and appropriate response. A digital feedback system is able to support all these post functions and requirements with limited human involvement in addition to saving time and other resources.

2. Feedback evaluation:

The next important step after generating feedback is to evaluate the feedback. Since there are different types of feedback, which can be negative feedback or positive feedback. Negative feedback are mostly complaints, suggestions or gaps users are experiencing and positive feedback are such feedback where users mention positive effects and admire the system. The negative feedback can be used for further developing, changing, or updating of a system whereas positive feedback provides positive motivation to the implementer. Thus, the evaluators must be clear about which issues they need to prioritise and provide responses accordingly.

3. Response to Feedback:

The other step in the feedback process is giving appropriate responses to the feedback. If the users get a quick and immediate response to their feedback, they might be more motivated to provide accurate feedback more constantly. Regardless of what platform that is being used to provide the feedback, it is important to give a quick response back to the feedback initiator.

4. Follow-up:

Follow-up with users is an important step in the feedback process. After the response is provided on the feedback, the receivers should check up with the feedback sender, this will contribute to informing the users that the feedback receivers are in his or her best interest. Additionally active follow up will contribute to building trust in the system and the processes around and contribute towards sustainability of the system.

The above-mentioned steps are very essential for a feedback system. Feedback is not only the complaints and suggestions, but it is the voice of those genuine users who want the change in the system as well as appreciate the worth of the system in their day-to-day life. Feedback on the other hand is one of the methods for user participation, in which users are primarily responsible for pointing out potential problems and solutions that the developers have not been able to identify (Grønbaek, 1993). User participation also increases user satisfaction, democratic practice and helps in generating quality feedback.

6.2 Discussion on DHIS2 as DGPGs

During this research we have seen DHIS2 in the light of a digital global public goods in two countries, where the software platform has promoted innovation. DGPG are digital technologies designed to have all the essence of being re-programmable, modularized, and re-combinable, which are non-rivalrous and non-excludable (Sæbo, *et.al.*, 2021). In case of DGPGs in LMICs, it has definitely contributed to the process of digital initiatives. However, the availability of technical expertise has been a major challenge for implementing DGPGs, as these efforts need to be reinforced with a stronger focus on country-level capacity and user journey (Pande & Massally, 2022). The strength of DGPGs is that it can enable deep involvement of local expertise in country-specific implementation and can be deployed together with dedicated efforts to build long-term local capacity to maintain and iterate these implementations for future needs. It can also be adapted to fit local needs which can help build long-term ownership and agency for implementing countries. We will look at the factors which enact and rescind DHIS2 being a DGPG.

First, DHIS2 is available as a FOSS where it enables LMICs to manage their information and advance their knowledge rapidly. DHIS2 being a FOSS indicates that anyone can download the software, modify the codebase, and redistribute the software as they want, without affecting any

other users of the system (Utvik, 2022). In context of this research, we have looked at Sri Lanka and Nepal as examples, where predominantly both countries have utilised the potential of DHIS2 to modify the codebase to fit their needs.

HISP Sri Lanka showed an admirable example of how DHIS2 could be modified in the form of innovating the covid-tracker during the pandemic. However, this has only been achievable because of the strong local capacity and resources that have been built. Based on the knowledge of members in the HISP Sri Lanka team, they were able to freely modify the system and redistribute it without financial support from other organisations. Additionally, the open-source codebase has made it easy for the local team to address issues without any dependencies on the global team or other organisations.

Comparing the level of the independence throughout the innovation process between Sri Lanka and Nepal, we divulge that Nepal is highly dependent upon HISP organisations located in other countries (such as HISP India), global teams, and organisations for being able to update and develop DHIS2 within the country. The site visit in Nepal evinced that DHIS2 is not as flourished as it could have, a main reason for this may be the high dependence upon others and less investment and promotion towards building capacities within the country. As we discussed earlier, a major difference between both case sites is the capacity-building model used in both countries. Sri Lanka has built the capacity to develop and implement the system within the country prior to implementing the system itself. This has made Sri Lanka able to update and customise DHIS2 within the country without depending upon other organisations. However, this is a drawback in the case of Nepal as they did not build their capacity prior to implementing the system.

Second, in addition to being non-rivalrous and non-excludable DGPGs should also be available across the globe at the same time locally relevant (Kaul et. al., 1999). The case study shows that the software is available and that it can be operated as a national HIS in countries providing services to all without excluding individuals or groups, and that the system can be utilised without affecting others' consumptions. However, in case of LMICs there is tension between scaling and striving to be relevant globally and locally, while still being able to serve a diverse base of users. Most LMICs suffer from being able to provide good infrastructure to be able to deliver a better HIS that is used nationally. In case of both Sri Lanka and Nepal, lack of infrastructure such as

good internet connectivity, stable servers and electricity is a major drawback in being able to provide a stable system.

Although DHIS2 offers a wide range of functionalities and is being used nationally in both Sri Lanka and Nepal, full potential of DHIS2 has not been realised due to the shortage of skilled manpower in both the nations.

HMIS, in most of the LMICs are either suggested by global organisations like WHO, UN and funded by global donors, NGO and INGO, which mainly focus on the global issues rather than local needs. But on the contrary, many LMICs struggle even with the fundamental needs, for example: better health services, availability of medicines to all and building of hospitals and health centres and many more.

Keeping the system operational 24 hours a day is difficult due to the poor infrastructure and unstable system. Further, the system becomes underexplored and underused because of insufficient skilled manpower, while due to the involvement of overly powerful global organisations and global donors, countries keep their basic requirements out of focus, thus it will be difficult for DHIS2 to stay relevant locally.

Thirdly, to claim DGPG, the goods are expected to be available free of cost, DHIS2 can be downloaded, reconfigured, and re-programmed by anyone and for anything free of cost.

However, DHIS2 is not static and continuously keeps evolving with the development of technology as well as ever-changing user needs. DHIS2 digital innovation platform fulfils many of the characteristics of a DGPG but the total cost of ownership is not zero and comes with several hidden costs for implementation and operation (Sæbø et.al., 2019). Development, customisation, and maintenance requires a sum to be paid to the core team, developers and implementers (Sæbø et.al., 2019). For instance, if health ministry's face some problems and request the global team for the change, the core team in Oslo gets a request. For a request to be prioritised, the core team follows a special system, to identify requests and add them to their roadmap. There are several criteria for a request to become a ticket and show up in the core team's roadmap since they get several requests daily from users, groups and health ministries for changes and new functionality (Nicholsen, et.al., 2022).

For the development of HMIS most of the projects in LMICs are directly funded by donors, NGOs and INGOs paying for particular functionality to be implemented, but other actors such as ministries of health or their representatives do not have the same financial “muscle” to influence the system in use (Sæbø et.al., 2019). Unfortunately, the ministries of health of low- and middle-income countries are typically not directly paying for the follow-through on their requests, as these are met through a complex mechanism of pooled funds from donors to the core team in Oslo. Consequently, their voices tend to be heard less than those directly paying for their requests (Nicholsen, et.al., 2022).

It is not a fact that DGPGs will only contribute to easing technological development, DGPG infrastructures in India have not solved the problems of undemocratic and opaque governance processes, nor prevented the oppression and exploitation of marginalised groups by the elite. In India it has added new layers of technological complexity that the public has to navigate, without necessarily having made it easier for public demands to be met. This inevitably leads to an increase in inequality when the gains and losses from new technology infrastructures are not equitably distributed among the members of the public (Seth, 2022).

From the overall evaluation of the findings, we have understood that the DGPG which is supposed to be a public product has missed the main focus: the global users, similarly DHIS2 which claims to be DGPG is implemented by a top-down approach, has raised the question of who is the public in the public goods, are they concerned and involved during the development and implementation? A top-down agenda of the state to formulate technologies for social control and to prevent misuse of public funds, but neither were the assumptions adequately tested nor were other goals debated in a democratic manner for which altogether different technology infrastructures may have been required.

Many DGPGs imposed by the state in a top-down manner, or private platforms such as for social media and the gig economy, are in contrast built specifically to disallow any local management and which further weakens community institutions. Who should identify such values, and how, to guide the design and management of technologies? The answer clearly lies in leveraging the structures of bottom-up democracy, rather than a small group of elite technologists or the state imposing their worldview in a top-down manner (Seth, 2022).

It is a mistaken belief that technology imposed top-down can solve corrupt or exploitative practices on the ground. Such practices can only be solved bottom-up by strengthening community institutions and providing them with the necessary tools that are designed with their participation and managed by them. DGPGs built with such a vision as technologies for communities are likely to be more relevant and lead to more equitable empowerment in communities (Seth, 2022).

Based on findings and our analysis we suggest several turning points that could contribute towards improving the DGPG that is provided. In addition, scaling up the focus and upgrading the factors that are listed below will result in DHIS2 being a full-fledged DGPG.

- ❖ Challenges regarding internet connectivity and infrastructure was a major issue in both countries as it was very time-consuming to conduct data entry for example as the connectivity was very unstable which led to longer waiting time, to be able to connect again to enter the data.
- ❖ The users faced frequent server issues, the main reason for frequent server issues is, as stated above frequent power cuts and poor internet connectivity that leads to buffering, and obstruction in accessing required files. Similarly, a huge number of users and large data overloads the server. For a developing country, building a server provides a huge financial burden and must be dependent upon server capacity from others. This issue affects the sustainability of the use of DHIS2 since a system that is slow and lagging, in the long run will not be effective to be used as a national system.
- ❖ Without proper user participation and user feedback it is difficult to understand what users actually feel about the system. Several of the users mentioned that the layout of the form could improve with only features that are needed for individual users.
- ❖ According to what we have seen in the system during our site visits and what the users have told us we understood that there might be some features that are global and are integrated for everyone. We think that features and functions that are not relevant for users should be removed and that there should be limited functions for users according to what kind of user type you are.

Public goods seek to coordinate collective action on behalf of the public (Ostrom and Ostrom, 1977). When it comes to DHIS2 platform, UIO as the global team has taken the responsibility with partners, donors and ministries to coordinate the action. We cannot sweep under the rug the

immense success and improvement DHIS2 has provided, but the challenges we highlighted above might hinder the fact of being non-rivalry and non-excludable. Surmounting these challenges DHIS2 has definitely a potential to become a full-fledged DPGG (Nielsen, et.al, 2022). DHIS2 is recognised as an open-source platform which is free for everyone to install and use, though we can fully understand that managing a HIS requires more than just installing it and using it. A platform such as DHIS2 which has the potential to be used as a national HIS, requires the system to have powerful infrastructure and be reliable, trustworthy, and scalable. Human resources become essential in this process, as there needs to be local capacity in countries that have the skill and knowledge to discover and solve issues that are related to the HIS.

6.3 Context and maturity of the system

We argue that there are contextual conditions that are a bottleneck in being able to provide quality and efficient healthcare. The conditions seem to be quite the same in both countries, however based on the data collection we came to know that in Sri Lanka there is a close collaboration between the health ministry and other organisations in the country. In addition, the government is the main funder of health services in the country and the public health services are provided free of charge at the point of delivery. Even though there has been some political instability in the country due to the civil war, it seems like the government and political leaders have prioritised the need for good health services in the country. Sri Lanka's publicly financed, administered, and delivered state-centric healthcare system has made critically important contributions to the country's access to achievements (Kumar, 2019). In Nepal, most of the crucial decisions related to nationwide implementation of health information systems are made by the central government, thus if the central government does not determine to upscale the persistent IS the situation of such systems remain unchanged, even though other levels and organisations demand the upgrade. Thus, only the central government plays a vital role in promotion of HIS within a nation. Based on the findings, the governments of both countries focus on improving the quality of services of public healthcare systems for the betterment of the overall health status of people of the country with better satisfaction.

Geographically the substantial problem in both countries is not being able to provide infrastructure which is stable enough. Internet and server issues were problems which were frequently mentioned by informants in both Sri Lanka and Nepal. To be able to provide a quality and efficient healthcare system, there needs to be investment in enhanced infrastructure. Many

informants requested offline data entry into the system, this is definitely something that should be provided as this is more related to features that the informants wish they had in the system and a feature that is essential in case of remote areas in LMICs.

In the case of the economic condition, we understand that people prefer public health services in Nepal as it is free, but the problem was that there was a limited number of services that was provided through the public sector, so people mostly had to visit private health services. When they had to use private health care services, they had to pay a fortune through their own pockets. Time consumption in public health care services was a fact, they had to wait for a longer period of time to get the help they needed. However, in private health services it was handled more quickly. In Sri Lanka all preventive health services were free of charge and most curative services were also provided free of charge, this might be one of the reasons the health care services in Sri Lanka have achieved remarkable success. Therefore, most of the patients utilise public health care services as they provide quality health service to the patients. During our field visit we observed that at MoH areas, for example in Hingurakgoda, there were often a very long queue especially during the covid period, as people wanted to get vaccinated. Since the vaccination process was only set for a specific period of the day, many people visited at the same time. This created a chaotic period in the MoH as the centre did not have a specific management system for handling patients. We could observe that the army officers entered data into DHIS2 tracker, over patients that were vaccinated. The army officers who were entering data were working in an unpleasant environment as they were surrounded by noise and crowds of people.

The condition of capacity models is one of the things that most diverge from each other. The capacity model in Sri Lanka seems to have contributed to a larger positive change and have contributed to increasing the level of maturity of HIS. Building capacity through their master's program in bioinformatics has contributed to growth of the HIS and better techniques and procedures for handling HIS. Sri Lanka has a more mature system since the DGPG DHIS2 and the process of building health informatics capacity started in 2009 (Amarakoon et.al., 2021). Whereas, in Nepal there is a quite new system, they started implementation and integration process of DHIS2 not later than 2014. Prior to implementing DHIS2 they did not build the capacity which could handle the HIS, as a consequence they are not able to upscale the system to the fullest till the date.

Since the maturity of a system is affected by several influencing factors, where some are uncontrollable factors like geographical, political, and economical conditions it is difficult to make a quick change. The process of making changes in these factors needs to be done over time. However, there are many other small steps that could be taken to help in overcoming the uncontrollable factors. Economically the government and political leaders need to invest in better infrastructure and management systems so that the health sector could persevere. Geographically there could be provided better infrastructure in rural areas so that they have the same opportunities as other more developed cities. Additionally, the human resources need to be built stronger in rural and geographically difficult located areas so that the rural areas have access to the same health services as other bigger cities.

6.4 Capacity Building

As we stated in earlier chapters, the importance of ICT has contributed to an immense change in every sector. Since ICT has become a significant part of our life it requires the necessity to strengthen digital skills to narrow the global digital divide. Digital skills are the key to digital transformation and a significant enabler of each country's digitisation. Instilling the necessary skills has become a key part of national digital transformation strategies (The international Telecommunication Union, 2021). Developing countries are especially the ones that are affected by this development as the access to technology is less obtainable, so the ability to learn and develop their knowledge and skills are challenging.

In the two case sites, we have been investigating in this research building capacities of human resources has been a challenging aspect. In the context of Sri Lanka and Nepal, lack of health resources, job transfer, education, knowledge, and skills are major barrier in being able to develop capacity. Moreover, lack of education, knowledge and skills influence the ability to involve users in the development, customisation, and implementation process. Specifically, health personnel tend to have less knowledge around the system, therefore they will be ineffective in participation and will have less influence in the design process. As users it will be hard to provide feedback on something they have inadequate knowledge about. We argued that all the concepts that are relevant for this research are in some way interconnected with each other. Capacity building is interconnected with user participation as the capacity of individuals shapes their ability to participate. Integrating user participation in the design process of a system, enhances and strengthens the capacity.

6.4.1 Challenges of Capacity Strengthening in Sri Lanka

Sri Lanka is lately known for their strong public health system, however there are several challenges that limit them from being able to strengthen their capacity in a progressive manner. Sri Lanka's implementation of the BMI program at the university has helped them build their capacity strongly where they have provided education in health combined with informatics which has made it easy for employees to understand the concept of digital health easily. With this education, students could easily enter the public health facilities as employees with good knowledge within IT and health. However, this kind of education requires fulfilling several conditions to be able to get admission, one of them being a medical or dental doctor. This means that other health personnel such as nurses and midwives don't get the same opportunity to acquire the knowledge and skills. During the implementation process of covid tracker module, there have been well-organised formal and informal training for health personnel. In addition, there have been provided user manuals in form of one-page guideline which explains how to do data entry into the covid tracker system. However, even though all these training and support is provided, the knowledge level in IT is lacking. The RE at Polonnaruwa MOH mentioned that he didn't get knowledge in ISs before implementing electronic reproductive health management information systems (eRHMS). Predominantly lack of basic computing skills and knowledge on how to use digital technologies was according to RE the major issue among health personnel in Sri Lanka. When it comes to the training that is provided, several of the informants mentioned that the training covers the essential parts of the system or more basic functions of the system but learning more advanced functionalities requires more and continuous training and learning. Continuous training will improve their knowledge of HISs and what strategic values it provides to the national health system that is provided.

The lack of health workforce is a major bottleneck in being able to provide health services. Several of the informants mentioned that due to the pandemic they suddenly got several responsibilities to take care of this resulted in work overload. We earlier discussed that there is not enough training for the personnel, but when there is limited workforce there is also not time for the already existing personnel to be able to participate in the training and learning sessions as their workload takes up most of their time. Staff are needed for data collection, reporting and analysis if the few personnel that are available are supposed to do this, in addition to offering primary care to patients it suddenly becomes an overload of work for them.

6.4.2 Challenges of Capacity Strengthening in Nepal

Nepal faces different challenges when it comes to strengthening their capacity in the health domain. As they are in quite an early stage in the enforcement of HIS, it is difficult to introduce concepts such as feedback systems, user participation and involvement to improve the overall implementation of HISs for an effective, futuristic, and sustainable system. The number of health workforce in different districts is factors that are relevant for why there are challenges. Districts with higher populations such as Kathmandu district, have more health staff employed at health facility centres. Thus, in mountainous districts such as Mustang and Gorkha have less health staff as the geographical location makes it difficult to live in such areas which again contribute to less access to health facilities and less health workers available. The number of health staff plays a significant role in the health system, because availability of more skilled human resources nationally leads to development of HIS and helps functioning in a positive manner (Dahal, 2019).

The number of health staff that are trained in every health facility varies from one health facility to other, but on average there are around 1-3 health staff that are trained in using HISs at health facilities in Bagmati province. Using HISs requires a dynamic knowledge of health-related education, skills and knowledge, to understand the importance of HIS. Since only 1-3 health personnel on average were trained to use the systems at the lower level, thus the amount of work for those 1-3 health personnel will be overloaded as they have to do their daily routines and in addition work with creating appropriate reports, statistics, enter data and in general use the HIS. The amount of workforce that have this dynamic knowledge seems to be lacking, as there are only a few of the health personnel at each facility who know how to use the HISs.

Another important thing worth mentioning is that even if they have the available means of ICTs to enter data, create reports and statistics, they are still fully dependent on using pen and papers. The employees enter the data into the system after collecting data from several patients. This process can be done for example at the end of a week or a month. A reason for this is the lack of infrastructure, capacity and proper learning and education. To be able to enter data at the point of data reception, the infrastructure such as internet stability, electricity and data availability need to be stable, which is troublesome in mountainous and arduous stationed facilities in Nepal. Additionally, there needs to be available capacity which could enter the data.

Job transfer of health personnel stationed at health facilities in Nepal was a major issue as they often got transferred to other sections or facilities. Due to this it was difficult to enter data at the

point of reception as the people with knowledge often got transferred, whereas the existing personnel or new employees are not provided with proper education or learning. Providing technical support, adequate resources and education becomes important in this case to continue the functioning of the HISs. Due to the lack of health workforce, the personnel that have training in using HIS need to take on several responsibilities which result in work overload. To be able to strengthen the capacity within the health domain, the infrastructure needs to be strengthened. This is because if the health personnel are equipped with infrastructure that is optimal, they will be able to utilise the HIS even more. Based on our observation the HIS is just an asset which is used in addition to the traditional way of collecting data through pen and paper. Since it might just be an additional job to the daily routine of collecting data, entering data into the digital system, might be seen as work that overburden their responsibilities.

Capacity models in both study sites

While comparing the two models of capacity strengthening in Sri Lanka and Nepal the way of building the capacity within health have been approached differently. Sri Lanka strengthened their capacity through the BMI program where several medical doctors graduated with education in public health combined with informatics. However, Nepal is in the process of strengthening their capacity through a master's program at the University of Kathmandu years after implementing the HISs. The capacity is being built with the help of the students from UIO who did their research around DHIS2. There is actively being developed a masters course combining public health and informatics which can contribute to strengthen the capacity in Nepal. Looking at the fact that Sri Lanka has made a huge progress by implementing the capacity in the forehand of implementing the system, it comes off as this kind of approach has made a larger success. The fact that Nepal had less capacity which had knowledge and skills while implementing the system might be a reason for why the system is not as flourished as it could have been.

6.4.3 Action and approaches for building capacity

Earlier in this chapter we discussed the challenges of capacity building in both countries. In this subchapter we propose action and approach which can support the process of building a stronger capacity in the country to be able to provide a stronger HIS. Braa & Sahay (2012) argues that a key strategy to build capacity is through collaborative networks (Braa & Sahay, 2012). Although both countries are in different phases of developing capacity this strategy can still be relevant for both as some of the issues are common.

Sri Lanka has made pioneering efforts in capacity strengthening and innovation in the field of Health Information System. Through the BMI program and training that has been provided they have laid a foundation for creating capacity for implementation of eHealth in Sri Lanka, additionally they have made a foundation for a sustainable development without external experts (Dissanayaka, 2018). The critical mass has been reached by multidimensional scenarios comprising graduate, resource persons, functional HIS and researchers in health informatics (Siribaddana et.al, 2019). Actions taken in Sri Lanka provide key insights on how to implement similar programs in other LMICs. On the other hand, there are also weaknesses which limit them from being able to further develop in a progressive manner.

The BMI program is an excellent effort into building knowledge and skills, however it needs to be flexible and adaptable for everyone. In other words, it needs to cater to a broader spectrum of people where the program allows not only doctors but also other health personnel such as midwives, nurses, and other students. Capacity development in LMICs should not only target medical doctors but all kinds of health personnel which can contribute to strengthening the HIS. Additionally, in case of LMICs IT courses should be provided from the primary school so that the competence and knowledge will be developed from a young age.

In Sri Lanka there was already a statistic of shortage in the health workforce, and due to the pandemic situation, the shortage became an even larger fact as already existing personnel had to take on several responsibilities than before. To manage the problem policies and action are needed so that the workforce can be strengthened and performance of existing HIS could be better (Shrikant et. al, 2010). The following actions are suggested as an approach to managing the problem of shortage in the health workforce:

1. Increasing the training capacities
2. Improving the overall working conditions
3. Giving better incentives to retain staff
4. A balanced distribution of the health workforce, as most personnel prefer working in urban areas with better facilities

In case of Nepal, there needs to be a stronger network with partners and other relevant organisations. The issue regarding the calendar system has been a major bottleneck in being able to think sustainable and futuristic when it comes to DHIS2, because it hinders the ability to update the system to the newest version. This might also be one of the reasons why the system stagnates

and is not able to mature in a progressive manner. However, a close collaboration with the global team and other HISP organisations could help in being able to build the capacity so that the issues that are being encountered could be solved in country. To increase the capacity in the country there is the need to provide courses and knowledge on HIS, where students through courses will be educated on different kinds of HISs and their importance. The newest update on the capacity part on Nepal's side is that 4th of November 2022 Kathmandu University is set to launch a new master's degree program in Health Informatics from the next academic session. The course will be a multidisciplinary approach to Health Science and Information and Communication Technologies. This kind of approach is a first of its kind in Nepal, where the significance of HISs is recognised. This program is aimed to play a key role in enhancing HIS users' abilities to use various HISs, carry out HIS development tasks, engage in health research and innovation, and finally make HISs long-term sustainable (Edusanjal, 2022). This contribution will make a basis for continued DHIS2 development in the country.

HISP India has been a regional hub for Nepal where health personnel in Nepal have been able to get training and technical support, however getting help from other organisations causes them to overly depend on other organisations rather than having their own dedicated resources. Consequently, the implementation of the new master's program will contribute in developing dedicated resources that could help in resolving HIS related issues in Nepal.

It will be beneficial for Nepal if it could establish a HISP organisation like HISP Sri Lanka or HISP India, this will contribute to enhancing DHIS2 development in country and help in managing all the HIS within the health institutions. HISP Sri Lanka's effort in supporting the government in maturing the system has been an exceptional example on how a non-governmental organisation could provide their support. HISP Nepal should be a primary resource which provides the government of Nepal support in maturing the HIS. In addition, the initial tasks of HISP Nepal could be to be an initiator for establishing strategies for building capacity in country.

The strategies for building capacity should as mentioned in chapter two include:

1. Establishing formal education in Public Health Informatics
2. Short-term specialised courses for In-service
3. In-house Training
4. Support through global, regional, and national networks
5. Hand holding and support - learning by doing in context over time

6. Supporting capacity development through toolkits
7. Remote training

6.5 Concluding remarks on the contextual conditions

Considering all issues discussed over HISP organisations in both countries should primarily focus on providing support to the government so that the system can mature in a progressive manner. With the potential to become full-fledged DGPG, the maturity of the system needs to develop by strengthening the capacity, the form of knowledge building and reinforcement of the workforce in areas with lack of human resources. The outcome of improving the DGPG, maturity of system and capacity building will impact the feedback process. The feedback process will again contribute to expanding and improving the quality of the system. Additionally, incorporating a feedback process will contribute to user satisfaction as quality feedback will contribute to system improvement. We summarise the problem areas and strategies we propose in the table below.

Concepts	Problems	Strategies	Outcome
User Participation	Less to no involvement of users in the development, customization, or implementation process.	Mutual learning Surveys	User satisfaction System improvements
DGPG	Limited knowledge around DGPG and its benefits	Strategies for capacity strengthening	Better knowledge around the systems that are being used
Maturity	Political, economical and geographical aspects restricting from being able to develop.	Better political support to which will provide economical support and maybe build more health facilities in the rural areas.	Universal access to health.
Capacity Building	Lack of health resource	Formal education In-house training Zoom-based training	Minimises knowledge gap Increase workforce in health domain

Table 6.1: Summary of problem areas, strategies, and outcomes of implementing the strategies

Contemplating the analytical framework we proposed earlier, we state capacity building, maturity of system and digital public goods are contextual conditions which are overlapping and

are interlinked with each other. Capacity building helps strengthen the knowledge and skills in the country which contribute to evolving the maturity of the system in a positive manner. Additionally, it is important to make users aware of DGPG and the concept of FOSS, this will contribute to skill development which ultimately affects the capacity building as users could also contribute to developing the system with the background knowledge of DGPGs. Incorporating feedback processes in LMICs is not prioritised, the reason is that delivering quality health services is much more prioritised. For a sustainable system the feedback from end-users should be prioritised and taken into account.

Chapter 7 Conclusion

This chapter provides a conclusion of the thesis ‘**Mapping feedback loops: Role of ICTs in making invisible voices visible** - A case study from Sri Lanka and Nepal’, it also addresses the research questions posed in this thesis.

7.1 Overview

Based on the empirical research, this thesis has discussed several factors surrounding the HIS in Sri Lanka and Nepal in the case of DHIS2 with a greater emphasis on its users. Also, it contributes towards the expansion and advancement of HIS in these countries and other LMICs. This study has analysed user participation in an operational health information system, understanding their perception of DGPG, process and efforts made on capacity building, and level of maturity of HIS in both countries, using qualitative methods such as interviews, observation, and field visits. This thesis began by defining a gap in the literature, where we desired to fill the gap of demand-side conditions, representing the actual use of the DGPGs.

Through the study site in districts of Sri Lanka and Nepal, we have got an insight into the perspective of user participation and how important user feedback is to understand the possible changes that are needed in the system. The answers from the participants in the interviews have provided valuable feedback which can contribute to the development of the HIS. The HIS that we have investigated is an operational system and the focus of our study highlights user participation in an operational system, which is different from other existing literature which has a dominant focus on user participation during the early design and development process of a system. Initially, we claimed that involving users during the operation of the system after the implementation of a system via feedback could strengthen the users' motivation and satisfaction to make better use of the system, such as the functionalities of dashboards and data analytics.

We have visited two districts in Sri Lanka and two municipalities in Kathmandu District in Nepal as a study site in this research. In all these study sites, the level of participation of the users during the implementation and even while the system's operations are quite negligible. Besides, the approaches of capacity building within DHIS2 in both countries are contrasting to some extent, Sri Lanka has adopted an educational system by providing masters course in BMI combining medical and IT prior to the implementation of DHIS2 and is able to develop and customise

DHIS2 model with the capacity available in the country with minimum help from foreign organisations and global teams. On the other hand, Nepal has chosen the method where employees and health care personnel are being trained on daily use of HIS, which has contributed to the smooth flow of data entering, but the software is not being explored optimally. Since the DHIS2 platform is well known as a DGPG, this study also points out the perceptions of the users on DGPG and their expectations from a DGPG. Undoubtedly, both countries are gaining a lot from the use of DHIS2, but due to the circumstances such as unavailability of proper infrastructure (internet, server), shortage of skilled human resources, hidden costs, and less focus towards global users, has shrunk the belief that the DHIS2 can be claimed as DGPG.

The maturity of the system that deals with the political, economical, and geography of a field site plays an important role in the present condition of DHIS2. Both countries with different levels of maturity have made a remarkable effort to implement DHIS2 countrywide, but due to some common issues like political instability, remote areas with power cuts, unstable internet, and server problems have been obstacles to achieving effective utilisation of HIS. The major problem that is discovered in this research is the lack of user involvement while users must be prioritised throughout the life cycle of a system, while in this case, DHIS2 is an operational system in both countries where there is rare evidence of user participation. Thus, this study suggests encouraging user participation through feedback implementation throughout the operation of the system, to gain an understanding of user's perception of the system in use and bring their voices that have been invisible till now, to make an effective change in the system.

7.2 Research question

The research has posed the following research question in this thesis: *What are the available means for users to provide feedback while working with an operational open-source-based HIS, and how effective is this feedback addressed by the developers and implementers?*

In the process of exploring, it has required to do analysis of the following:

1. Processes of feedback cycles include collecting and responding to user feedback
2. Promoting user participation through means of effective feedback systems
3. Understanding the gaps inherent between the production and use of DGPGs

The thesis provides insights into three main contextual conditions which extend our knowledge of the importance of user participation and user feedback to be able to provide a better HIS. In the process of exploring these three contextual conditions, we are also able to answer the research question.

First, this thesis showed the importance of user participation in an operational system by explaining that user participation can contribute to user satisfaction, motivation, and improvement of the system. This will promote a better sense of system ownership as we see their problems and suggestions will be heard and addressed. It will also encourage them to provide more feedback rapidly so that implementers could understand all the problem areas of the system that are in use. The end users are always the most important as they are the ones that are going to use the system; therefore, user participation becomes an important concept to be able to provide a system that is for the users and by the users. In the case of Sri Lanka and Nepal, feedback is mainly provided through direct calls, emails, and group chats on applications such as WhatsApp and Viber. The effectiveness of the response to the feedback generated from the above-mentioned methods is not well documented, thus even though the participants stated that they get prompt responses, it is hard to know what kind of feedback they have provided and how was the quality of response they received.

Secondly, we argued that conditions that influence user participation and quality feedback are capacity building, maturity of the system and DGPG. These conditions influence in the form of: getting quality feedback requires the users to be knowledgeable so that they are able to provide feedback which could be valuable for system implementers and developers. The maturity of the system is influenced by factors such as political economical and geographical conditions, to overcome those issues governments and political leaders in those respective countries need to support the process of building the health care system in the country. They need to support building infrastructure, providing aid or other supporting initiatives. At the present, available manpower is not capable of using all features to the full extent, this requires more training, knowledge, and skill building. Strengthening capacity contributes to system maturity, whereas with stronger capacity the system can grow continuously, as having proper techniques, procedures and human resources helps in developing the system. Building capacity will also contribute to exploring ways to reach the goal of being a full-fledged DGPG. The concept of DGPG needs to be reinforced so that the health personnel are aware of the full potential of DGPG. Even though DHIS2 supports innovation and enacts the traits of being a global public good by

fulfilling the combination of factors of being non-excludable, non-rivalrous, and locally relevant, there are still aspects such as unforeseen expenses, under consideration of global users especially in remote areas, insufficient skilled manpower, it restricts from being a full-fledged DGPG.

7.3 Conceptual and practical contributions

The findings in this study have been limited to one platform within two countries, which requires validation by other platforms, networks, and more countries to falsify, extend or confirm similar phenomena. Additionally, we both are not experts in DHIS2, do not have any medical background and since this is our first research this has been our limitations throughout the study. Beside these limitations, in this sub section we present our conceptual and practical contributions we have dragged from the analysis.

Examining all the aspects around capacity building, maturity of the system, and DGPG, all these conditions together have influenced the feedback process, which is also promoted by user participation and incorporating feedback into the development process will contribute to quality feedback that will further contribute to better system development.

The study has explored the organisational and technical factors that are challenging for involving users in the design and development phase of the system. The culture for implementing a system that is supposed to have many users is decided by the top-down approach in most LMICs. Similarly, due to the economic conditions of LMICs and limited resources, their main prioritisation is concerned with fulfilling basic clinical needs all over the country, rather than understanding the real pain points of the users. Thus, the focal point must be shifted toward users by involving the users. Collection of feedback as a major mechanism of user participation helps to understand users' needs and problems better, which will in return help to increase the feeling of ownership over the system and satisfaction among the users. As a result, satisfied users are further motivated and can bring out the best in them and further development of the system.

Looking from a demand-side perspective, we identify the following consequences of having a poor feedback system:

1. Users do not feel empowered as they do not have the chance to voice their concerns, complaints, suggestions, and positive reflections.

2. Governments, implementers, and developers do not have the opportunity to utilise feedback from users to expand and improve the quality of the system.

Moreover, the suppliers of DGPGs should therefore acknowledge these concerns from the actual users and reconsider the requirements and struggles of the users globally. Similarly, the role of context in shaping the maturity of the system, capacity and DGPG is crucial to be able to enhance the feedback process.

Practical Contribution

As we have mentioned in chapter 1, this study after a deep analysis, suggests a list of practical changes that each country could imply for the advancement and expansion of HIS. As the major issue in both study sites is minimal user participation in system development, the implementers of the system can design and implement the feedback system regularly to empower the users. It would be remarkable if the countries could conduct periodic surveys on users' problems and their needs. Furthermore, the lack of skilled manpower is also another non-discardable problem, thus we notice the urgency of building capacity through training, workshops, and educational programs. In case of Nepal, due to the calendar issues the system has struggled to upgrade DHIS2 to new versions, if Nepal could collaborate with global organisations, other relevant teams and invest in building their own capacity, they would be able to modify the system themselves within the country, such that the system can be explored to its fullest.

Additionally, we believe that conducting research in LMICs or any field sites should not be done just for research purposes only, the aim should also be to repay the respective countries so that the research could be valuable for them as well. This will contribute to more innovation, and development of those that do not have the same opportunities as other western countries.

7.4 Further research

The concluding remarks on this thesis should be considered as a spark to conduct more research in LMICs based on DGPG and its users, and user participation in an operational system and feedback processes in a HIS. Due to political, economical, and geographical conditions LMICs are struggling to enhance HIS in a progressive manner, this is the case of both Sri Lanka and Nepal. However, other studies and evaluation of the existing system should be investigated so that it could be developed a wider theoretical framework and conceptual apparatus to understand the impact of capacity building, maturity of the system, and DGPG on feedback processes. This

research has only focused on the platform DHIS2 and the two LMICs Sri Lanka and Nepal, more research is needed in other LMICs too to be able to validate the phenomena discussed in our research.

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Appendix-1: Request for access to conduct fieldwork

UiO : University of Oslo
Department of Informatics

Date: January 10, 2022

Dr. Dipendra Raman Singh
Director General Health Services
Ministry of Health and Population
Kathmandu, Nepal

Subject: Requesting access for two researchers from University of Oslo, Norway

Dear Sir,

I write this letter to request access for the following Informatics Masters students/researchers from the Department of Informatics, University of Oslo, Norway, for whom I am the primary supervisor – Pilasilda Antony George and Rajani Shrestha.

This research study is being carried out to understand the user feedback, in relation to Nepalese calendar in DHIS2.

To conduct the fieldwork on this project, the students will spend two-weeks in Nepal and will seek to meet with team in the facilities, district and the Ministry using DHIS2 for reporting and data collection. Given the Covid19 situation, it will be helpful if the district fieldwork is completed in district Kathmandu. All data collected will comply with ethical guidelines, particularly related to anonymity and informed consent, stipulated by the University of Oslo. The students will also provide a summary of their findings to your unit to improve relevance of their research.

If there are any further clarifications you may need, I will be happy to provide

Vennlig hilsen




Arunima Sehgal Mukherjee
Post-Doctoral Research Fellow



Postal address: P.O.Box 1080 Blindern, N – 0316 Oslo, Norway
E-mail: arunimam@ifi.uio.no
<https://www.mn.uio.no/ifi/english/people/aca/arunimam/>

Appendix-2: Approval letter for fieldwork in Nepal



नेपाल सरकार
स्वास्थ्य तथा जनसंख्या मन्त्रालय
स्वास्थ्य सेवा विभाग
व्यवस्थापन महाशाखा

फोन नं : ५३६१७६८

पत्र संख्या:- ०७८/७९
चलानी नम्बर:- १३१५

पचली, टेकु
काठमाडौं, नेपाल

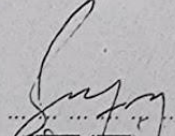
मिति: २०७८/१०/१०

विषय: DHIS2 सम्बन्धमा आवश्यक सहयोग गरी दिनु हुन ।

श्री प्रमुखज्यू
स्वास्थ्य शाखा
चन्द्रागिरी नगरपालिका, काठमाण्डौ ।
महालक्ष्मी नगरपालिका, ललितपुर ।

उपरोक्त विषयमा Oslo University, Norway बाट DHIS2 सम्बन्धी Masters students तहाँ नगरपालिकामा भिजिटमा आउनु हुनेछ । उहाँहरूको आवश्यकता अनुसार स्वास्थ्य तथा जनसंख्या मन्त्रालय, स्वास्थ्य सेवा विभाग अन्तर्गत संचालित DHIS2 मा रेकर्डिंग तथा रिपोर्टिंग सम्बन्धी जिग्यासाहरु सहित छलफलमा आउनु हुने हुँदा उहाँहरूलाई तहाँ स्वास्थ्य शाखाबाट यस सम्बन्धमा आवश्यक सहयोग तथा कोअर्डिनेशन गरी दिनु हुन अनुरोध छ ।

सहभागि विचार्यीहरु :
श्री रजनी श्रेष्ठ
श्री पिनासिन्डा एन्थोनी जोर्जे


अनिल थापा
निर्देशक (तथ्यांक)

Appendix-3: Detailed plan for stay in Sri Lanka

Hi Piasida/Rajani,

Wish you a happy new year! We hope that you have safely arrived in Sri Lanka. Kindly let us know where you are staying and local numbers to contact you if you have already obtained them.

We have prepared a tentative agenda for your visits after contacting relevant departments in the Ministry. In addition to Roshan, team members from our team Priyanga, Ruvinda and Wedika will assist you with your field work (copied here). Please contact Wedika (+94717421421) on Whatsapp for any assistance. The tentative agenda we have prepared is below. Let us know if you have any concerns about it.

31 December (Fri) - Arrival at SL

01 January (Sat) - Free day

02 January (Sun) - Free day

03 January (Mon) - Morning (10-12) - Introduction by Dr Roshan (venue: we will update)
Evening (2-4) - Briefing by Dr Priyanga (venue: WHO SL)

04 January (Tue)

05 January (Wed) - Exposure visit North Western Province (Dr. Wedika)

06 January (Thu) - Exposure visit North Western Province (Dr. Wedika)

07 January (Fri) - Exposure visit North Western Province (Dr. Wedika)

08 January (Sat) - Free day

09 January (Sun) - Free day

10 January (Mon) - 9-12 - Exposure Visit to HIU (Dr Ruvinda)

11 January (Tue)

12 January (Wed)

13 January (Thu) - Briefing/Discussion with Dr Roshan

14 January (Fri) - Briefing/Discussion with Dr Priyanga - 10-12 WHO Sri Lanka

15 January (Sat) - Free day

16 January (Sun) - Departure from SL

Appendix-4: Semi-structured interview guide

Introduction and roles

- Your title and Brief on roles at responsibility
- How is your everyday routine?

ABOUT HIS

- Has HIS influenced/ changed, enhanced or burdened your work practices? and how?
- How much has this changed your daily work?

About DHIS

- How often are you using DHIS2 for your daily work?
- How was the concept of DHIS2 introduced?*
- How was the implementation process?
- Have you been given any training or guidelines on how to use DHIS2 efficiently?
- How was the system before DHIS2 was implemented? Books? Journals? notes ? other systems?
- What kind of problems do you face during usage of the system?
- How do you report/communicate the problems? And who do you communicate the problems to?
- Do you have any feedback systems or how do you communicate with other levels?
- What kind of feedback/changes do you get? And how are they processed?

General

- Have stakeholders been engaged in the design and implementation processes?
- What is the process of training/capacity building?
- How many people were trained initially in HMIS and how many of you are working currently?
- What kinds of training were given that are related to HMIS og DHIS?
- How did you train/ build the capacity of your country on this system?
- How do you receive feedback from districts and other users?
- What are the different channels to receive user feedback?
 - Do you have a separate system?
- How do you communicate feedback with the global dhis2 team?
- What are the common issues encountered in the system? How do you tackle them?
- What are the future plans for DHIS2? Adding new features? Capacity building?

COVID TRACKER

- How has covid impacted on your daily basis?
- What is the overall situation of covid in the country regarding vaccination, covid-cases, certificates etc.?
- How do you use the tracker system ?
- How did you decide about using dhis2 for covid19 monitoring / surveillance?
- What was the process you followed in customising dhis2 for covid19 monitoring?
- How did you plan implementation of this system?
- Who managed the technical roll-out.?

- How did you train/ build the capacity of your country on this system?
- How was the training given and how long was the training?
- Is the current training enough to fully use the system at the local levels?
- How do you use the data that is being entered?

Problem

- How easy was it to start working on covid surveillance system?
- What kinds of problems do you face during planning and controlling processes?
- Was there anything you could not fix locally, and had to ask the global team for fixing?
Can you please give examples?
- Under the implementation process did you need any help from the core team in Oslo regarding implementation?

Feedback

- What kind of feedback did you receive from the users?
- How did you address this feedback?
- Do you have any feedback systems or how do you solve them? On spot? or takes time?
- How do you generate feedback? In general like surveys, monthly, weekly quarterly, yearly meetings?

Changes and communication

- What kind of changes do you want to make in the system?What is lacking in the feedback systems?
- What has been the communication process with the district and implementation team regarding the system use?
- How do you think you can increase the effectiveness of feedback systems?
- Are there any features you wish you had?
- From 1-10 how satisfied are you with the system?

Appendix-5: Semi-structured interview, DGPG

Digital global public goods related questions:

1. Are you familiar with the term digital global public goods(DGPG), if yes, can you explain briefly and give an example of a DGPG?
2. Do you use any DGPG, how do you use it?
3. What kind of benefits do you get from using the HIS?
4. What is your perspective on DHIS2 as a dgpg?
5. As dhis2 claims to be a dgpg, has DHIS2 met your understanding of DGPG?
6. What do you think about your involvement or involvement of the users, while developing a gdpg.
7. Do you think that using digital public goods such as DHIS2 in the health sector helps in speeding up the efforts to achieve the sustainable development goal by WHO?
8. Do you think that DHIS2 is contributing to strengthening the health information capacity for the national, district and facility level?

Other questions:

1. What are the main responsibilities for the Regional epidemiologist?
 - What are his/her working areas? One MoH? Or several MoH? District level or Moh level?
2. People we interviewed at the provincial health training center - north-central province in Anuradhapura, are they mainly district/province level users?
3. Is there a Biomedical informatics(BMI) programme for people working within the ministry? Or can anyone else enter the programme
MD PROGRAMME OF HI
4. Medical officers working at HIU, what are their responsibilities? Are they involved in the implementation process?
5. Who are the main developers of DHIS2 covid tracker system?
6. As we understand you know most of the issues related to DHIS2 such as menu structuring, customizing, offline data entry etc. so what are the barriers in implementing those?

Appendix-6: Consent forms

Consent form

Informed Consent Form for District (Public) Health Officers/Municipality Chairperson/ Health Co-ordinators

Name of Principal Investigator 1 : Pilasilda Anton-Geroge

Name of Principal Investigator 2 : Rajani Shrestha

Name of Organization: University of Oslo

Status: Master Students

Email: pilasila@uio.no rajanis@uio.no

Phone no. : 0047 91912371; 0047 91525359

We are doing a comparative study for the research on “HMIS Implementation in Nepal and Sri Lanka: Understanding The Process of User Participation In HIS Design: Case of using DHIS2 Dashboard in Nepal”. With this form we want to inform what this research is about and what we will use the data from this study for.

We want to interview you about the use of DHIS2 as well as observe the use of the system in practice. The purpose is to understand more about how the system works in a natural context and we will therefore use the data we get from the interviews and observations in our thesis. You do not have to decide today whether or not you will participate in the research. Before you decide, you can talk to anyone you feel comfortable with about the research.

This consent form may contain words that you do not understand. Please ask me to stop as we go through the information and I will take time to explain. If you have questions later, you can ask them of me or of another researcher.

Purpose of the Research

The purpose of this study is to understand how the actual users are operating and interacting with DHIS2, since the users from Nepal and Sri Lanka were not involved during the development process. As DHIS2 is in used in both the countries within the Health information system, we will focus on how the users perceive the system, and look at the changes after DHIS2 has been implemented. Explore the problems and come up with the possible solutions. The main concepts of the research will therefore be to study users' feedback and perception towards the system. Here with users of DHIS2, we aim to observe if the users are efficient in using the overall system.

However, even though both countries started the digitisation process around the same time, they seem to have taken different trajectories on implementation, capacity building,

user acceptance, building linkages with DHIS2 communities and in-country technical capacities. Even though there are many similarities, at the same time the two countries have had different processes. Hence, we find it very intriguing to understand the user acceptance, participation and usability processes in the two countries, through comparative case studies.

Data collection

We will take audio recordings of the interview as well as take notes during the interview. In addition we will be taking pictures, but we will only ask you for permission when it becomes relevant. Data collection will be used to carry out an analysis of the context, and will be presented in our thesis.

Type of Research Intervention

This research will involve your participation in a interview/discussion that will take about one hour.

Participant Selection

You are being invited to take part in this research because we feel that your experience as district officer/health coordinator/local leader can contribute much to our understanding and knowledge of DHIS2 implementation in the district.

Voluntary Participation

Your participation in this research is entirely voluntary. It is your choice whether to participate or not.

If you do not wish to answer any of the questions during the interview, you may say so and the interviewer will move on to the next question. No one else but the interviewer will be present unless you would like someone else to be there. The information recorded is confidential, and no one else except the principal researcher will access to the information documented during your interview.

You do not have to answer any question or take part in the discussion/interview/survey if you feel the question(s) are too personal or if talking about them makes you uncomfortable.

Benefits

There will be no direct benefit to you, but your participation is likely to help us find out more about how to strengthen capacity level and information use with DHIS2 system.

Reimbursements

You will not be provided any incentive to take part in the research

Confidentiality

We will not be sharing information about you to anyone outside of the research team. The information that we collect from this research project will be kept private.

Right to Refuse or Withdraw

You do not have to take part in this research if you do not wish to do so and choosing to participate will not affect your job or job-related evaluations in any way. You may stop participating in the discussion/interview at any time that you wish without your job being affected. I will give you an opportunity at the end of the interview/discussion to review your remarks, and you can ask to modify or remove portions of those, if you do not agree with my notes or if I did not understand you correctly.

Contact Information

If you have any questions, you can ask the principal investigator now or later. If you wish to ask questions later, you may contact the investigator again.

This proposal has been reviewed and approved by NHRC which has an ethical committee whose task it is to make sure that research participants are protected from harm. If you wish to find about more about the NHRC, contact information can be received from nhrc.gov.np

Statement by the Respondent

I have read the foregoing information, or it has been read to me. I have had the opportunity to ask questions about it and any questions I have been asked have been answered to my satisfaction. I consent voluntarily to be a participant in this study.

Print Name of Participant _____

Signature of Participant _____

Date _____

Day/month/year

I have accurately read out the information sheet to the potential participant, and to the best of my ability made sure that the participant understands the purpose and conditions of the research.

I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

A copy of this ICF has been provided to the participant.

Print Name of Researcher _____

Signature of Researcher _____

Date _____

Day/month/year