Information use and data quality assurance practices in Rwanda

An interpretive case study

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Acronyms

ANC   Antenatal Care

BCG   Bacille Calmette Guerin

CSPro Census and Survey Processing System

DE   Design Ethnography

DHIS2 District Health Management Information System 2

DQR   Data Quality Review

GESIS Gestion du Systeme d'Information Sanitaire

HIS   Health Information System

HISP   Health Information Systems Programme

HMIS   Health Management Information System

ICT   Information and Communication Technologies

IS   Information System

LMICs Low- and Middle-Income Countries

M&E   Monitor and Evaluation

MoH   Ministry of Health

NGO   Non-Governmental Organization

OPD   Outpatient Department

PRISM Performance of Routine Information System Management

R-HAP Rwanda Health Analysis Platform

RBC   Rwanda Biomedical Center

RHIS   Routine Health Information System

SCIS   Système communautaire d'information sanitaire

SOPs   Standard Operational Procedures

UiO   University of Oslo

WHO   World Health Organization

WHO DQ WHO Data Quality

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Abstract

The Health Management Information System (HMIS) in Rwanda is in a continuous process of strengthening information use and data quality practices for data-informed decision-making. Earlier studies have identified limited evidence of information use in the decision-making process in several developing countries that use District Health Management Information System 2 (DHIS2). This thesis is an interpretive case study on Rwanda's information use and data quality practices, and how they impact the decision-making process at the national level. It sought to identify how DHIS2 supports information use within the facility level, as well as if other tools were preferable, or used in addition to DHIS2. The purpose of each tool that supports information use and data quality is described with respect to the context of use. The study has involved users from all levels of the Rwanda HMIS to get a grasp of the socio-technical aspects of the health system. This was done through a one month field trip in Rwanda, which involved attending meetings at the national level, participating in data quality workshops, and conducting interviews and observations at health facilities. A key contribution of this study was to explore the relationship between information use and data quality, which mainly argues the view of information use and data quality as interrelated concepts.

1 | Introduction

Sound data that is timely and accurate is critical for making public health decisions (AbouZahr & Boerma, 2005). A Health Information System (HIS) is responsible for generating, analyzing, and disseminating this data (Adu-Gyamfi et al., 2019; Lippeveld, 2001). However, the HIS are often not supporting these activities adequately. Due to historical, social, and economic factors, HISs have become intricate, disjointed, and unresponsive to the demands of the population (AbouZahr & Boerma, 2005). In the case of many developing countries, international donors contribute to this issue, having prioritized short-term needs for data over long-term country capacity building. This problem affects the use of information and data quality, which has limited the actions of evidence-informed practices regarding health service planning and delivery (Byrne & Sæbø, 2022).

This thesis is written in collaboration with Health Information Systems Programme (HISP) University of Oslo (UiO), which is a research initiative that is enabling and supporting the implementation of sustainable and scalable health information systems in over 100 developing countries [1]. HISP UiO also coordinates the development of DHIS2 software, an open-source system with data warehousing features and customizable modules for integrated health data operations. More about HISP and DHIS2 is covered in Chapter 2. This thesis explores the information use and data quality practices in Rwanda based on an interpretive case study. A one-month field trip to Rwanda was conducted in conjunction with the data collection process. Prior to this research, we know that there is a considerable amount of literature regarding health systems, data collection, and ways to improve data quality (Wickremasinghe et al., 2016). However, there is less documentation on how the information is used.

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[1] https://dhis2.org/

1.1 Research Question

The objective of this thesis was to look at the ways in which managers and decision makers use information and identify common information use and data quality practices within the district and national level of the Rwanda HMIS. The thesis also focuses on describing the advantages and shortcomings of functionalities of the tools that are being used to support data collection, data visualization, data analysis, and decision-making. Hence, this thesis will try to answer the following research question:

> *What information use and data quality practices enables informed decisions within the healthcare sector in Rwanda?*

1.2 Motivation

The field of HIS is rapidly evolving. Advances in information technology, along with the development of new concepts and methods, are allowing for more effective use of existing data in managing health services and resources (Lippeveld et al., 2000). As healthcare costs continue to rise, there is a growing need for efficient information management to control expenses and optimize staff time. In order to reduce data handling and improve accuracy in data, the use of information needs to be documented more adequately and consistently (Wickremasinghe et al., 2016). As the DHIS2 software platform and its implementations mature, new research topics are emerging (Adu-Gyamfi et al., 2019). Key research themes related to this include ensuring high-quality data collection and gaining a better understanding of how to improve and strengthen information use for better decision-making for each specific context.

1.3 Organization of the thesis

Chapter 2 - Research Context

This chapter presents the contextual background of the study, which contains general information about HISP, DHIS2, and Rwanda.

Chapter 3 - Related Literature

This chapter presents the literature on HIS, information use, and data quality within the context of Low- and Middle-Income Countries (LMICs). Additionally, it includes literature specifically on the data quality status in Rwanda.

Chapter 4 - Research Approach

This chapter introduces the methodology and methods used for this study.

Chapter 5 - Findings

This chapter presents the findings from preliminary- and field work.

Chapter 6 - Discussion

This chapter discusses the research question based on the Findings- and Related Literature chapter.

2 | Research Context

This chapter outlines background information on HISP and DHIS2, and provides general information about Rwanda, as well as the health system architecture and health challenges of the country.

2.1 HISP

HISP was established as a joint project that brought together the University of Cape Town, the University of Western Cape, and a Norwegian Ph.D. candidate from the UiO (Adu-Gyamfi et al., 2019). The primary objective was to help solve the information management issues facing the South African health system, which was highly centralized and severely fragmented at the time. Today, HISP is an international action research project that is considered to be UiO's greatest success. As a part of this project, they have developed the DHIS2 software, a digital platform for collecting, validating, analyzing, and displaying data for health information management tasks[1]. HISP UiO mainly coordinates the development and implementation of DHIS2 (Roland et al., 2017).

HISP UiO works in partnership with a global network of HISP groups and regional partners to provide DHIS2 implementation support, local customization and configuration, and capacity building through the DHIS2 Academy program (Adu-Gyamfi et al., 2019). Additionally, they promote DHIS2 as a global public good. HISP groups are also involved in the DHIS2 software development process, such as requirements gathering, providing feedback from the field, and development of web and mobile applications, and local configurations that can be integrated into the core platform[2].

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[1]https://www.mn.uio.no/hisp/english/index.html
[2]https://dhis2.org/hisp-network/

2.2 DHIS2

DHIS2 is a global digital public good supporting health information management around the world. Public goods are considered nonrivalrous, meaning that the consumption of the good by one individual does not diminish the availability of the good for others (Nicholson et al., 2022). DHIS2 is a web-based, open source platform that is widely used as an HMIS[3]. It is currently the world's largest HMIS platform used in over 76 LMICs. DHIS2 is used in more than 100 countries if we include the Non-Governmental Organization (NGO)-based programs as well[3].

The DHIS2 platform offers data warehousing, various data visualization features (see Figure 2.1), and the possibility for data users and decision makers to generate analysis from live data in real-time[3]. DHIS2 is released as free and open software under the BSD 3-clause license, meaning that the application can be used free of charge. Anyone can access the source code and may even modify and redistribute the software[3]. DHIS2 is currently developed and maintained by a team of global developers based at the UiO, and multiple local teams across countries such as Vietnam, India, Tajikistan, Nigeria, Kenya and Ghana to mention a few (Gizaw et al., 2017). The system is compatible with Windows, Linux and Mac operating system, and it works both offline and online through local installation and cloud deployment. DHIS2 is a robust solution that is designed to work in resource constrained settings[3]. Where internet coverage is not reliable, DHIS2's android app allows for mobile data capture in offline mode. The core web platform also facilitates for aggregate data reporting at any level of an organizational system[3].

2.3 Rwanda

This section presents general information about Rwanda while also providing historical and current challenges of the healthcare system in Rwanda.

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[3]https://dhis2.org/about/

Figure 2.1: DHIS2 data visualization tool. Screenshot from dhis2.org

2.3.1 General Information

Rwanda is a small country in East Africa (see Figure 2.2), bordered by Uganda to the north, Tanzania to the east, Burundi to the south, and the Democratic Republic of the Congo to the west [4]. Its capital city is Kigali. The country has a population of around 13,4 million people, with four official languages: Kinyarwanda, French, Swahili, and English.

Rwanda is known for its landscape of rolling hills, green valleys, and numerous lakes, as well as its wildlife, including the famous mountain gorillas[4]. The country is also known for its tragic history, including the 1994 genocide in which an estimated 800,000 people were killed in just 100 days[4]. Despite its troubled past, Rwanda has made significant progress in recent years, with strong economic growth and improvements in areas such as health, education, and infrastructure. The government has implemented a number of ambitious development programs aimed at promoting economic growth and reducing poverty, and the country is often held up as an example of successful development in Africa[4].

2.3.2 Health system architecture

Within the domains of computing, software engineering, and information systems, the term "architecture" is used to describe a number of

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[4]https://en.wikipedia.org/wiki/Rwanda

Figure 2.2: Map of Rwanda. Sourced from Encyclopedia Britannica

concepts (Jolliffe et al., 2015). The architecture of the Routine Health Information System (RHIS) in Rwanda is an ongoing endeavor that is historically situated at a moving intersection of concerns in global health discourse, global capitalism, the global HISP project, and most importantly, within Rwanda's historical path of social, political, and economic growth, particularly in its healthcare and Information and Communication Technologies (ICT) sector. Within the information systems discipline, architecture resonates with a perspective that sees information systems mainly as socio-technical, simultaneously creating technical artifacts and configurations in tandem with social practice. As an example from the Information System (IS) literature, Braa & Sahay (2012) notes that the term "architecture" is variously used to depict socio-technical procedures and systems, as well as technical design and software system architecture. This understanding of architecture is fundamental for the Rwanda Ministry of Health to address a central concern, which is to figure out how to appropriately direct and sustain the national HIS architecture (Jolliffe et al., 2015).

2.3.3 Health challenges in Rwanda

Similar to many other countries. Rwanda has encountered significant challenges regarding access to accurate health information, such as clinic attendance rates and statistics on provided treatments (Jolliffe et al., 2015). Where such information was available, it was typically not easily shared with other relevant stakeholders in the healthcare sector. A national HMIS should collect a broad range of health service indicators that assist stakeholders at all levels of the healthcare system in developing appropriate plans and programmes (World Health Organization, 2022). Information needs to undergo the processes of processing, transformation, communication, and use to help determine resource allocations, policies, staffing, service delivery, cost-recovery, supportive supervision, and other components that contribute to better health results.

Before 2005, efforts to digitize the HMIS primarily concentrated on the national level, leaving health facilities and districts to rely on paper forms and reports (Jolliffe et al., 2015). Despite receiving external funding since 1977, the Gestion du Systeme d'Information Sanitaire (GESIS) software, an electronic HMIS, was deemed to have several limitations [5]. One of its main drawbacks was its ownership by external agencies, which meant that even minor modifications to the data collection tools required their intervention. At that time, the technology used for GESIS was already outdated and it did not allow for any network usage. The data collected from paper-based registers underwent several manual aggregation steps before being entered into the software at the national level. Hence, the system faced significant challenges in terms of data sharing and quality, which resulted in limited usage of the data.

The Ministry of Health (MoH) modified the data collection forms and database in 2008 and expanded the electronic system to the health facility level equipped with computers (Jolliffe et al., 2015). However, the new GESIS still had several similarities with the earlier design, as changes to the forms still required interventions of a programmer. Despite the ongoing issues with the new system, in 2009 the MoH

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[5] United States Agency for International Development, Rwanda HMIS Assessment Report, p23-26

launched a program with a greater impact on data quality than the software change. A group of new data managers were hired and provided with specialized training in areas such as data entry, data checking, data analysis, and data quality assessment. At the district level, supervisors and M&E (Monitoring and Evaluation) specialists have been recruited with explicit job descriptions. The MoH's HMIS unit improved its capacity by providing training on various aspects of data management. Each district hospital and health center in Rwanda now employs a dedicated data manager who is responsible for tasks related to data management.

The MoH was introduced to the DHIS2 software in 2010 through its contacts with the World Health Organization (WHO) (Jolliffe et al., 2015). Replacing GESIS with DHIS2 had several attractions for Rwanda. Hence, in February 2012, the Rwanda MoH collaborated with the WHO and the UiO to launch the Rwanda Health Management Information System project, which was supposed to replace GESIS with DHIS2. The new system was designed to reflect the latest global standards.

3 | Related Literature

This chapter presents the knowledge and understanding around information use and data quality practices in LMICs. The first section starts by explaining information use in the HMIS context, followed by an explanation of what data quality is in the context of HMIS, as well as the efforts done to assure good data quality in Rwanda. A section summary is included for both information use- and data quality sections of this chapter.

3.1 Information use in HMIS

Information use in the context of HMIS refers to the process of utilizing the data collected by the system to generate useful information for decision-making and healthcare management (Byrne & Sæbø, 2022). However, it is evident that utilizing data extends beyond completing data reporting forms at the various levels of the HMIS and the passive distribution of reports and information products. Information use in HMIS involves converting raw data into meaningful information that can be used to identify health trends, monitor disease outbreaks, evaluate the effectiveness of interventions, and guide resource allocation (Kumar et al., 2018; Shamba et al., 2021). This information is typically presented in the form of reports, dashboards, and other data visualization methods that enable users to quickly and easily understand the data and make informed decisions (Chrysantina & Sæbø, 2019).

3.1.1 Health information systems

Effective utilization of information is essential for all management levels of health services, ranging from peripheral to central (Lippeveld et al., 2000). It plays a critical role in managing patients/clients, health unit operations, and health system planning and management. This indicates that not only policymakers and managers, but also healthcare providers such as doctors, health technicians, and community health workers who need to incorporate information in their decision-making

processes. Unless this occurs, the large opportunity costs involved in establishing and sustaining health information systems can be difficult to justify. Lippeveld et al. (2000) notes that the primary role of an IS is to "provide data that can be used to assist decision-making in the political as well as the management realms, where decision-making is defined as the capacity to formulate alternatives, estimate effects, and make choices" (p. 128). Unfortunately, information systems are often perceived as overwhelmingly complicated. However, if the system is design appropriately, it should facilitate decision-making.

Defining health information system

Lippeveld et al. (2000) defines information as "a meaningful collection of fact or data" (p. 2), and a system as "any collection of components that work together to achieve a common objective" (p. 2). However, defining the term "information system" is less obvious, and there is a lack of an agreed-upon definition of IS in the academic information systems discipline (Alter, 2008). Alter (2008) has listed over 15 alternative definitions of IS. Some of them are from (Davis, 2000; Lyytinen & Newman, 2008; Pawlak, 2002).

Davis (2000) provides a simple definition of an information system, stating that "an information system is a system in the organization that delivers information and communication services needed by the organization" (p. 67). Additionally, an expanded definition from his simple definition states that "the information system or management information system of an organization consists of the information technology infrastructure, application systems, and personnel that employ information technology to deliver information and communication services for transaction processing/operations and administration/management of an organization. The system utilizes computer and communications hardware and software, manual procedures, and internal and external repositories of data. The systems apply a combination of automation coming human actions and user machine interaction" (Davis, 2000, p. 67).

In this thesis I understand health information systems as an act of improving actions by using information rather than just acquiring information. When applied in the health sector, health information systems

can be defined as a collection of components and procedures that are structured to produce information that facilitates decision-making related to healthcare management at all levels of the health system Lippeveld et al. (2000).

Current challenges with health information systems

Health information systems generates data on health service provision and the health status of the population (Wickremasinghe et al., 2016). This data are aimed at supporting decision-making and planning across all levels of the health system, with a particular focus on the local level where they are collected. Yet in practice, HMIS data are not being adequately utilized at the community and district level. Harrison & Nutley (2010) and Qazi & Ali (2011) argue that the reason to this might come from the lack of a standardized process for their usage. The lack of integration of existing information systems in the overall healthcare system and structural weaknesses are the main causes of inefficiency in information systems in developing countries (Lippeveld et al., 2000). Like in many LMICs, information systems were not deliberately planned to offer management support to health services in an integrated manner. This was due to the fact that foreign aid towards the health sector primarily focused on programs instead of the entire health system.

Lippeveld et al. (2000) summarizes the challenges with current health information systems in five points: (1) Irrelevance of the information gathered, (2) Poor quality of data, (3) Duplication and waste among parallel health information systems, (4) Lack of timely reporting and feedback, and (5) Poor use of information. Shamba et al. (2021) identified both barriers and enablers to routine data collection for newborns and mothers. Initially, the significance of register design was acknowledged, but it was perceived as complicated, and the necessary data elements were not always standardized. Secondly, the register was completed by nurses who were overburdened, had varying degrees of training, inadequate supervision, and faced challenges related to the availability of logistical resources. Byrne & Sæbø (2022) studied the use of DHIS2 by conducting a scoping review and revealed the need to document information use in more detail, design systems based on work practices, and in tandem develop and promote forums where

conversations around information can take place.

In the context of HMIS, Wickremasinghe et al. (2016) identified broader impediments to using data reasonably for decision-making. This comes from the users' perceptions that data are irrelevant or inadequate because data collectors and users are two separate groups. While numerous studies have focused on improving health systems, data collection, and data quality, there is limited documentation on the actual use of the data. Hence, this thesis focuses on challenges around information use and data quality, and on identifying the optimal information use and quality practices that enables informed decisions in a low- and middle-income setting.

3.1.2 Using information to make decisions

Information in itself is not a final end, but rather a tool to facilitate informed decisions in policy design, health planning, management, monitoring, and evaluation of programs and services, including patient care (Lippeveld et al., 2000). This, in turn, improves the overall performance and outcome of health services. Unfortunately, having access to high-quality information does not ensure that it will be appropriately used in the decision-making process. The HIS literature is replete with anecdotal evidence of data being underutilized. The current scenario with informed decision-making is that much of the information remains unprocessed (Chambers, 2014), and even if the information is processed, it often remains unanalyzed. If it is analyzed, it may not be read, and if the information is read, it may not be acted upon or used. Only a negligible proportion of the findings have an impact on health service policy.

Information use definitions

In the context of HMIS, information use refers to the processes of analyzing, synthesizing, interpreting, and reviewing data for data-informed decision-making process, despite the source of data (Nutley, 2012). Analyzing health data involves identifying patterns, trends, and relationships that can inform decision-making. Synthesizing health data refers to the process of using a theoretical framework to make formal sense of the data. For example, Nutley (2012) uses the Performance of
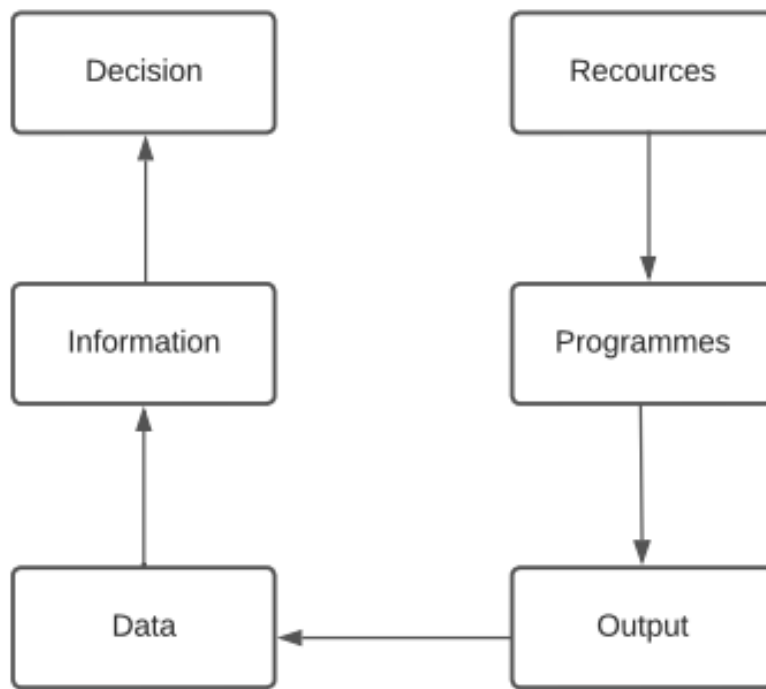
Figure 3.1: Transforming data into decisions

Routine Information System Management (PRISM) framework to identify three interrelated components that are needed to improve routine information systems and the use of the data that it collects. Interpretation of data involves categorizing the analyzed data to provide a real-world context (Andersson et al., 2003). Reviewing the data refers to identifying questions on whether the data is actually being for action and decision-making (Byrne & Sæbø, 2022).

Lippeveld et al. (2000) explains information use by illustrating how data is transformed into decisions (See Figure 3.1). It is an model of an idealized relationship between data, decisions, resources, and programmes which is showing that the process of selection and reduction is used to transform data into information. This general perspective on the connection between information and decision-making can be applied to patient care, health unit, and system levels.

Wali Van Lohuizen (1986) proposed a knowledge-driven model for the decision-making process shown in Figure 3.2. The interpretation of this knowledge is determined by subjective assessment, rather than

objective and scientific rigor. This model serves the purpose of defining discrete stages that can be influenced independently (Lippeveld et al., 2000). However, it does not reflect the complete reality since it does not adequately shed light on the political and social dimensions of decision-making.

How decisions are made

Little is known about the processes that generate decisions within the different levels of the health system (Lippeveld et al., 2000). The majority of our knowledge on decision-making comes from the analysis of the policy-making process, with the analysis primarily originating from sectors other than health. At all levels of management, decision-making is a fundamental task and the most central process within organizations (Li, 2009). Cole (2003) argue that decision-making is the act of recognizing an issue, considering multiple options, and then ultimately deciding on a single solution. This statement suits the rational model for the decision-making process, such as the model proposed by Schoenfeld (2011) (see Figure 3.3). According to Lunenburg (2010), "Administrative decision-making is assumed to be rational when school administrators make decisions under certainty: They know their alternatives: they know their outcomes: they know their decision criteria, and they have the ability to make the optimum choice and then to implement it" (p. 2).

Schoenfeld's linear decision-making model has been criticized by those who argue that real world decision-making are not likely to be made in such a neat and logical way (Lippeveld et al., 2000). Reasonably, phases overlap, and options are hardly compared methodologically. It is important to acknowledge the conflicting interests and inputs from sociopolitical "pressure groups" and players, such as governments, political parties, the media, and donors in the decision-making process and that decisions are more likely to be made in an iterative way rather than linear. These various influences on the decision-making process is shown in Figure 3.4. Hence, Lippeveld et al. (2000) concludes that "the decision-making process is 'messier' than the linear model suggests." (p. 36).
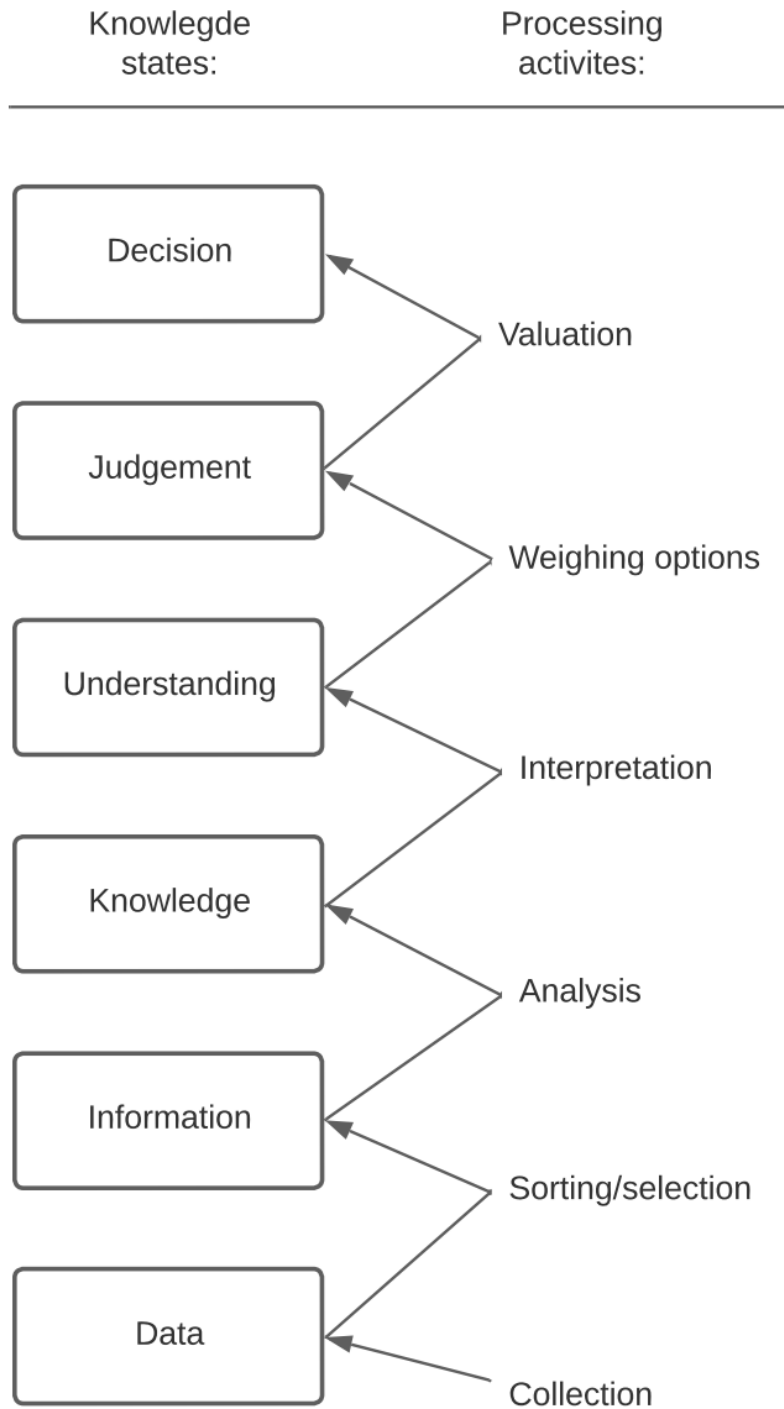
Figure 3.2: The Knowledge driven model of decision-making

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┌─────────────────────────────┐
│   Identifying the problem   │◄──────────────────┐
└─────────────────────────────┘                   │
              │                                    │
              ▼                                    │
┌─────────────────────────────┐                   │
│   Generating alternatives   │                   │
└─────────────────────────────┘      Recycle      │
              │                       process      │
              ▼                         as         │
┌─────────────────────────────┐      necessary     │
│   Evaluating alternatives   │                   │
└─────────────────────────────┘                   │
              │                                    │
              ▼                                    │
┌─────────────────────────────┐                   │
│   Choosing an alternative   │                   │
└─────────────────────────────┘                   │
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┌─────────────────────────────┐                   │
│  Implementing the decision  │                   │
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┌─────────────────────────────┐                   │
│ Evaluating decision effectiveness │──────────────┘
└─────────────────────────────┘
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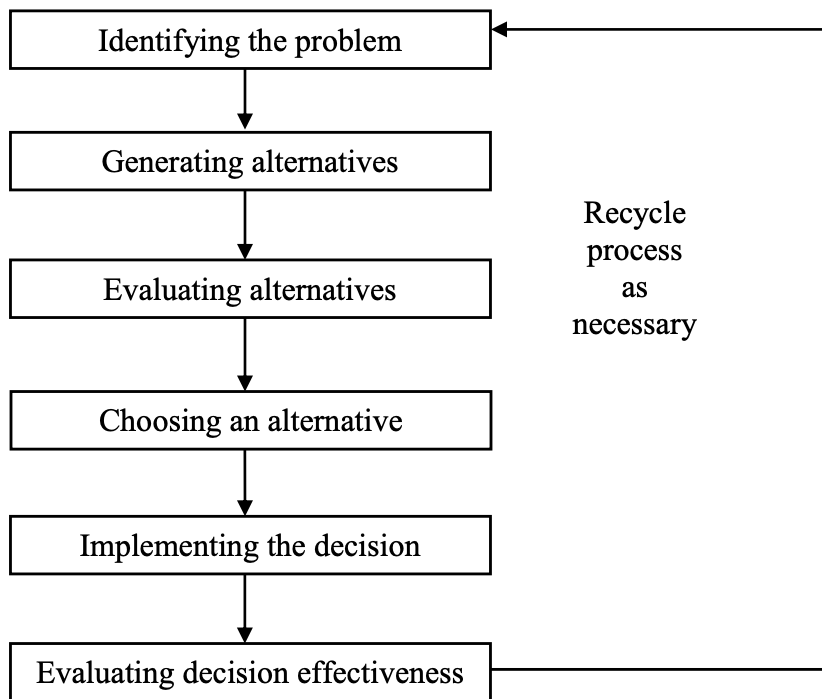
Figure 3.3: Model of rational decision-making process
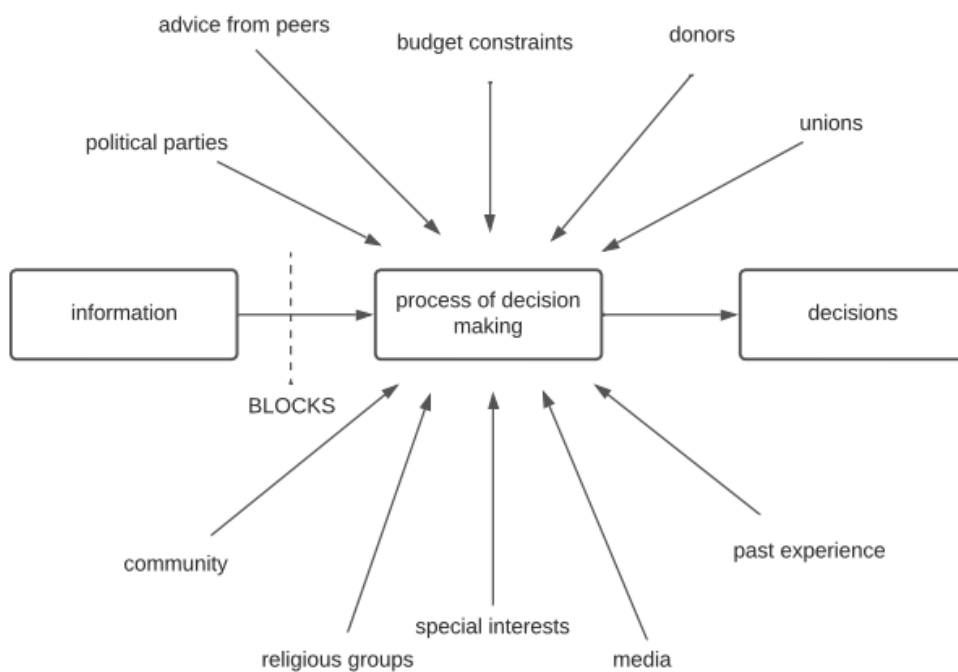
Figure 3.4: Various factors influencing decision makers

3.1.3 Section summary

Defining the concept "health information system" is complicated due to the many definitions of "information system" that are available in the IS literature. Despite the lack of an agreed definition of information systems in the academic discipline, experts acknowledge that the primary objective of health information systems is not just to acquire information, but rather to facilitate action. From here, we start looking at information use. Information use refers to the processes of analyzing health data, trends, and relationships that can inform decision-making. IS researchers have illustrated models of information use that drives decision-making. However, these models are borrowed from the policy-making literature since little is known about the process that generates decisions within the HIS. The models are still highly relevant for the HIS literature and can be used as an inspiration for developing information use models that are tailored to the HIS literature.

3.2 Data quality in HMIS

Data quality refers to the overall accuracy, completeness, and consistency of data. It is the measure of how well data meets the requirements of its intended use[1]. In many LMICs, national HMIS have been set up to routinely collect and manage data on health care services (Nshimyiryo et al., 2020). When the data is of good quality, it can be utilized with minimal expenditure to pinpoint areas that require improvement, to assess different health interventions, to provide evidence-based policies, and to create programs and distribute resources at all levels of the health system.

3.2.1 Data quality definitions

In public health, data quality has different definitions from different perspectives (Chen et al., 2014). Data quality also has various definitions depending on the field, period, and researchers and experts understanding of data quality (Sidi et al., 2012). The Canadian Institute for Health Information (2017) refers to data quality to the quality of the underlying data that is collected and used to produce outputs from statis-

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[1]https://www.gartner.com/reviews/market/data-quality-solutions

tics, indicators, analytical reports, electronic reporting tools, and other information products. According to Chen et al. (2014), the concept of data quality is recognized to have multiple dimensions in public health and other sectors. Different dimensions of data quality have been defined by researchers, each providing a distinct view on quality (Sidi et al., 2012). The dimensions are shown in Table 3.1.

DQ dimension	Definition
Accuracy	"The extent which data is correct, reliable and certified" (Sidi et al., 2012, p. 302).
Completeness	"Percentage of the real world information entered in the source and/or the data warehouse" (Sidi et al., 2012, p. 302).
Consistency	"The extent to which data is presented in the same format and compatible with previous data" (Sidi et al., 2012, p. 302).
Timeliness	"Timeliness refers only to the delay between a change of a real world state and the resulting modification of the information system state" (Sidi et al., 2012, p. 302).
Availability	"Extent to which information is physically accessible" (Sidi et al., 2012, p. 303).
Reliability	"Extent to which information is correct and reliable" (Sidi et al., 2012, p. 303).
Value added	"To extent to which information is beneficial, provides advantages from its use" (Sidi et al., 2012, p. 303).

Table 3.1: Data quality dimensions

3.2.2 Challenges with data quality in LMICs

Health systems in developing countries are still suffering from insufficient quality and inadequate use of data collected by their routine

information systems (Lemma et al., 2020; Braa et al., 2012). Lemma et al. (2020) conducted a scoping review, targeting studies from Sub-Saharan Africa on interventions that focused on data quality and data use. Incomplete registers, inconsistent registers and reports, and low data accuracy levels are commonly cited as the issues affecting the quality of data. Furthermore, population-based surveys often show discrepancies in results when compared to data generated by the routine health information system. Some studies that dealt with the use of data have identified both barriers and favorable factors. These can be summarized broadly into issues related to data quality, users, and resources. Poor data quality and limited data availability have been found to hinder the implementation of data use interventions. Limited user acceptance of the interventions and a lack of value or trust in the quality of data among users have been identified as barriers.

Although we acknowledge poor data quality from the health systems (Braa et al., 2012), it has proved difficult to develop strong health information systems for several reasons, mainly due to "fragmentation and lack of coordination of health programmes and insistence by international agencies on maintaining their own vertical systems; unrealistic ambitions; lack of shared data standards; unrealistic ambitions; inability of system developers to handle complex organizational, social and cultural issues; and problems of sustainability." (Braa et al., 2012, p. 397).

Lippeveld et al. (2000) notes that there is a trade-off between producing the data of high quality and the expenses associated with collecting it. As the required quality increases, so does the cost of producing the data. Therefore, it is important to consider what level of quality is needed in order to avoid unnecessary workload to the data collection and analysis process. Not all management decisions requires a high level of precision. Hence, methods of data collection should be weighted against other methods.

3.2.3 Improving data quality in Rwanda

Performing regular assessments of data quality is a method that can be used to enhance the quality of HMIS data in LMICs (Nshimyiryo et al., 2020). The WHO issues guidelines for Data Quality Review (DQR)

that involves a desk review of data that has already been reported to the HMIS and the verification of HMIS data quality through facility survey (World Health Organization, 2017). A desk review is a process of examining and analyzing documents and data that are already available or have been previously submitted, such as data submitted to a health information system, without physically visiting the source of data[3]. HMIS data quality are assessed in four dimensions: 1) completeness and timeliness, 2) internal consistency of reported data, 3) external consistency; and 4) external comparisons of population data (Nshimyiryo et al., 2020).

A case study by Nshimyiryo et al. (2020) revealed that the data quality assessments yielded high quality of Rwanda HMIS data regarding completeness and internal consistency of reported data. Good quality HMIS data improves the process of identifying areas that need improvement, monitoring, and evaluation interventions. Over the past twenty years, Rwanda has made significant strides in decreasing the mortality rate among children under the age of five. This result is showing that high quality HMIS data on maternal and newborn healthcare are essential for identifying gaps in current facility-based care, developing suitable interventions, and monitoring advancements.

An intervention worth mentioning is the "All babies count (ABC)". Since 2013, the ABC intervention is centered around improving the quality and accessibility of antenatal, maternity, and postnatal care services. However, the assessment of the effectiveness of these initiatives has been expensive, as it requires collecting data on program indicators via HMIS and reviewing facility source documents due to concerns about poor quality of HMIS data (Nshimyiryo et al., 2020). However, Karengera et al. (2016) studied the quality and use of routine healthcare data in selected districts of the eastern province of Rwanda, where they conclude that levels of data accuracy, completeness, and timeliness did not match the rhetoric that data quality in health systems in developing countries is poor.

3.2.4 Data verification in Rwanda

WHO has official guidelines on DQR and system assessment to calculate verification factors (VFs) (Nshimyiryo et al., 2020). A verification

is calculated by the ratio of recounted number of events from facility source documents to the reported number of events from the HMIS, where a VF of 1.00 indicates a perfect match between recounted data and HMIS data. According to the WHO, the acceptable margin of error for the mismatch between HMIS data reports and recounted data in facility registers is (0.90 <= VF <= 1.10).

Nshimyiryo et al. (2020) concluded that a high proportion of health facilities achieved acceptable VFs for these data elements: new antenatal care registrants, the number of deliveries, live births, and newborns who received postnatal care within 24 hours, while the proportion of health facilities with acceptable VFs was lower for the number of women who received iron/folic acid, and the number of women who were tested for syphilis on new antenatal care registrants.

The result of the study indicates that the quality of HMIS data differs according to the specific data element (Nshimyiryo et al., 2020), but there were similar patterns of reporting accuracy, regardless of the geographic location of the healthcare facility. Notably, some data elements particularly those requiring more complex generating processes, were less accurately reported to the HMIS.

3.2.5 Section summary

High-quality data can be used to identify areas that need improvement, evaluate various health interventions, develop evidence-based policies, design programs, and allocate resources at all levels of the healthcare system with minimal cost. Researchers have defined various dimensions of data quality, with each offering a unique perspective on the notion of quality. Common challenges with data quality in developing countries are found in incomplete registers, inconsistent registers and reports, and low data accuracy levels. The fragmentation and absence of coordination among health programs, combined with international agencies' insistence on preserving their own vertical systems, are the primary reasons for this. However, Rwanda has achieved remarkable progress in reducing the mortality rate among children under the age of five. This indicates that high-quality HMIS data related to maternal and newborn healthcare are crucial for identifying gaps in current facility-based care, devising appropriate interventions, and

monitoring progress.

4 | Research Approach

This chapter introduces the methodology and methods used for this study. The chapter starts of by presenting the researchers' philosophical understanding, followed by a detailed explanation of the research approach. Additionally, the chapter provides details on how data analysis was conducted.

4.1 Philosophical understanding

This research has been conducted with the interpretivist lens. In IS research, interpretivism presupposes that our knowledge of reality is gained only through social constructs such as language, consciousness, shared meanings, documents, tools, and other artifacts (Klein & Myers, 1999). Interpretive research aims to capture the subjective understandings of social and organizational phenomena (Klein & Myers, 1999). The empirical grounding of this thesis stems from the collaboration with the research initiative, HISP UiO and HISP Rwanda. Data was gathered from informants associated with HISP Rwanda, Rwanda Biomedical Center (RBC), MoH, and hospital facilities. To gain an understanding of the HIS in Rwanda, we applied Klein & Myers' explanation on the nature of interpretive research, stating that our focus should be on the complexity of human sense in making as the situation emerges. In other words, it is necessary to immerse ourselves into the culture to better understand the IS context.

The focus on the intersubjective human understanding and the interpretation of the studied context has been done from the philosophical perspective of hermeneutics (Klein & Myers, 1999). According to Myers (2004), hermeneutics can be defined as "the theory or philosophy of the interpretation of meaning" (p. 103). It is concerned with the meaning of text or text-analogue. Myers (2004) describes text-analogue as "anything that can be treated as a text, such as any human artifact, action, organization or culture" (p. 103). The primary objective of hermeneutics is human understanding (Myers, 2004), i.e. the

understanding of what people say and do, and why (Braa et al., 2004). This thesis supports the interpretive paradigm as it borrows inspiration from the hermeneutic way of sense-making and understanding.

4.1.1 Case study

An interpretive case study is the methodological framework that is used in this research. The case study approach is typically seen in social and life sciences (Heale & Twycross, 2018), but it is also frequently being used by IS researchers (Walsham, 1995) to conduct systematic data collection and analysis through an interpretive lens. A case study can in simple terms be described as "an intensive study about a person, a group of people or a unit, which is aimed to generalize over several units" (Heale & Twycross, 2018, p. 7). However, a case study can be done with a positivist or interpretive stance, or a combination of both stances (Klein & Myers, 1999). One way to further explore the distinctions between interpretive and positivist approaches is to examine their respective epistemological and ontological stances (Walsham, 1995).

4.2 Data collection

Preliminary work was conducted to learn about the environment of the research phenomena. The primary data collection took place in October 2022, which entailed a one-month field trip to Rwanda together with a group of researchers from HISP UiO (Figure 4.1 shows a timeline of the activities conducted during fieldwork). Prior to the field trip, approval of the research was applied to the Norwegian Centre for Research Data. A copy of the approval can be found in Appendix A. The purpose of the field trip was to gain an understanding of the Rwandan healthcare infrastructure and how the stakeholders interact with the HMIS tools and software on a daily basis. A secondary goal was to identify any difficulties, complications, or confusion around the relationship between information systems and healthcare. A range of qualitative methods has been used, and this section will account for these methods and why they are used in this case study.
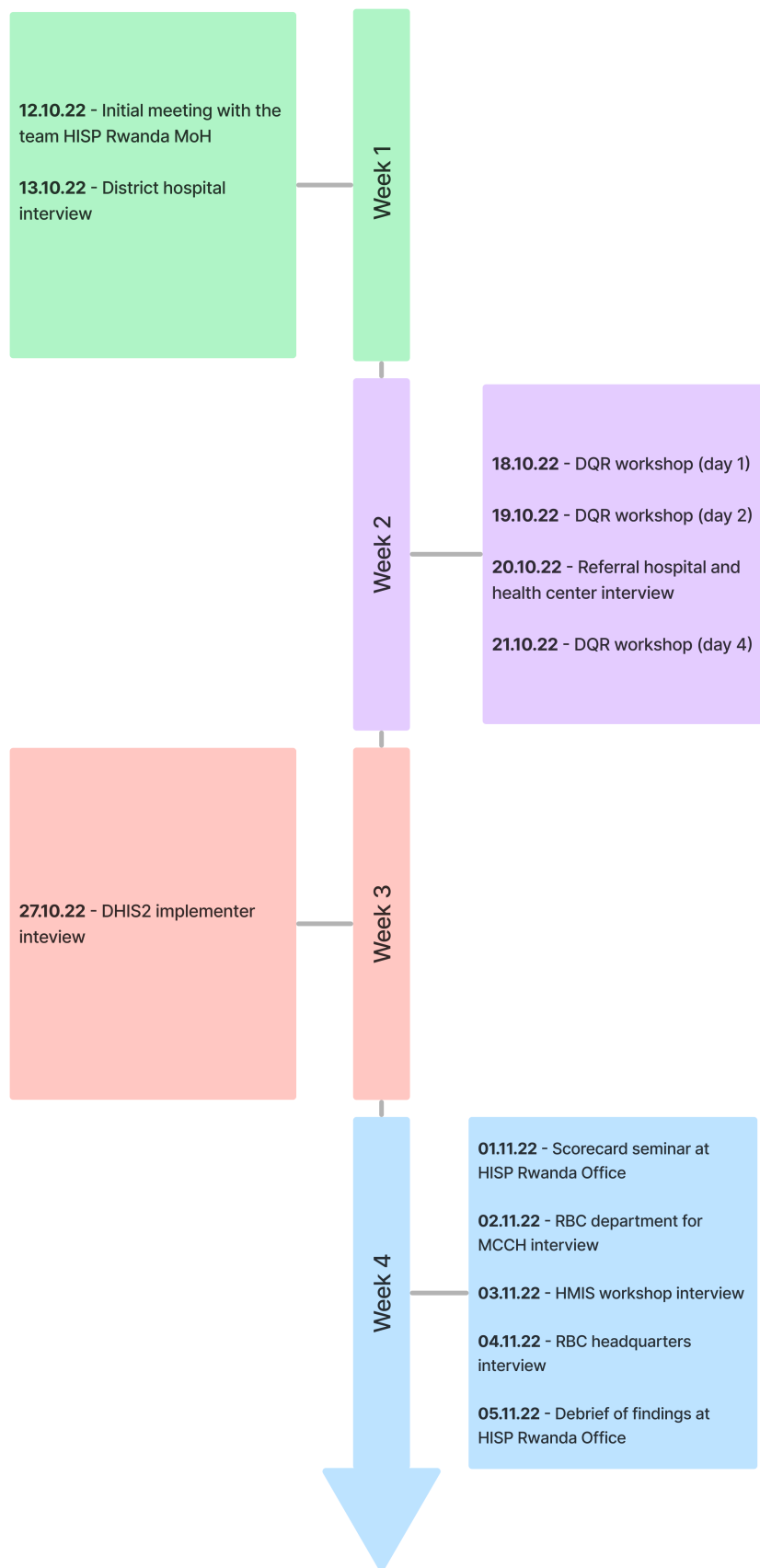
Figure 4.1: Time of the activities conducted during fieldwork

4.2.1 Interviews

The primary data collection resource for interpretive case studies is interviews (Walsham, 1995). According to Crang & Cook (2007), interviewing is a primary means through which ethnographic researchers have made an effort to learn and grasp the context and contents of different people's everyday, economic, political, cultural, and social lives (Crang & Cook, 2007). Walsham (2006) states that interviews are a part of most interpretive studies as a key way of accessing the interpretations of informants in the field. Interviews can range from highly structured (where the researcher is asking predetermined questions in a specific order), semi-structured (where the researcher and participant(s) set some broad parameters to a discussion), to the unstructured (where the researcher and participant(s) set the tone for a friendly conversation with no predetermined focus) (Crang & Cook, 2007).

All interviews were conducted during field work in Rwanda. These interviews were unstructured and semi-structured. The majority of the interviews were documented through pen and paper while a few where audio recorded and transcribed. The topics of these interviews ranged from general information use at all levels of the Rwandan healthcare system, to more detailed descriptions about challenges with data representation and data quality assurance.

To gain an understanding of the levels of access and use of health data, participants within different levels of health facilities were included in this research. Planning of field visits was mostly out of the researchers control. It was mostly the people from HISP Rwanda who help the the researchers arrange interviews with informants from different levels of health facility levels. It was usually meetings between the researchers and one or two informants from the health facility or other facilities tied to the Rwandan healthcare sector. Notes and audio recordings were shared and discussed among the researchers, which was useful in leading us closer to the right informants. The choices of destinations for field visits were depended on practical concerns such as time, availability and transport. The facilities were usually close to the researchers location of stay, which were urban areas.

During visits of health facilities, the interview subject would sometimes give a tour of the facility, which led to meeting other people who were interested in taking part of the research. Unstructured interviews and semi-structured were used depending on the situation. See Table 4.1 for a list of facilities that were visited. Only the first interview at a district hospital were completely unstructured since the researchers had little to no prior experience with interviewing in this field. The rest of the interviews were semi-structured. The researchers chose to stick with semi-structured interviews for the following interviews as the wish was to combine both features from structured and unstructured interviews. This gave the interviewer an opportunity to be more present during the interviews, which allowed the conversation to flow more naturally (Adeoye-Olatunde & Olenik, 2021).

Facility name	Facility type	Interview subject
Kibagabaga District Hospital	Public hospital	Data manager
Muzanse Referall Hospital	Public hospital	Data manager
Muzanse Health Center	Public health center	Head of health center
HISP Rwanda	HMIS Office	DHIS2 implementer
RBC MCCH	MCCH Division office	MCCH representative
RBC	RBC HQ	Data analyst
La palisse hotel Nyamata (HMIS Workshop)	Hotel	Data manager, data analyst

Table 4.1: Facilities visited and interviews conducted during field trip

4.2.2 Observations

Observation is a way of gathering qualitative data about people by observing and interacting with them in their "natural" setting (Baskerville & Myers, 2015). The idea of doing this kind of research comes from Design Ethnography (DE). DE involves active engagement of the researcher (Baskerville & Myers, 2015). Crang & Cook (2007) describes the basic form of participant observation as a three-stage process in

which the researcher first, gains access to a particular community. Second, lives and/or works among the people under study to grasp their world views and ways of life. Lastly, travel back to the research institution to make sense of this by writing up a report of that community's culture.

Being a part of a "culture" requires the researcher to become deeply involved in the daily rhythms and routines of the community, build relationships with people who can explain what is happening, and experience a variety of relationships and emotions that come with the process (Crang & Cook, 2007). Participant observation should not be treated as separate "subjective" and "objective" components. It should be used as a means to develop intersubjective understanding between the researcher and the researched (Crang & Cook, 2007). Intersubjective understanding is a concept that refers to the shared understanding between two or more people. It is based on the idea that two or more people can come to a mutual understanding of a phenomenon without relying on a single point of view.

Observations that took place during fieldwork were not necessarily observations in the strictest sense. Some observations were more related to demonstrations during interviews. For example, a data manager demonstrates how he is creating dashboards and visualizing data using DHIS2. Other observations were conducted more passively. For example, the researchers were invited to participate in a four-day data quality workshop conducted by several workers from MoH and RBC. During lunchtime, the researchers had the opportunity to sit with the workers and ask questions regarding the workshop. See Table 4.2 for a list of observations. Apart from conducting interviews and workshop participation, the researchers usually sat at the HISP Rwanda office during work hours and were free to roam around the office, ask questions, observe, and participate in work meetings. By doing this, the researchers were able to get a sense of how everyday life was at the HISP Rwanda office.

Facility name	Observations
HISP Rwanda	Scorecards seminar
MoH Rwanda	Executive meeting
Hotel Muhabura	DQ workshop

Table 4.2: Observations conducted in Rwanda

4.3 Data analysis

This section will outline the approaches used to analyze the qualitative data for this case study, which is in the form of thematic analysis. The data gathered from fieldwork, the motivation phase, and the continuous evaluations underwent thematic analysis. According to Crang & Cook (2007), data collection and analysis should be ongoing throughout the research process. Following this approach, I have continuously engaged in activities to better understand the data and utilize it in the creation of a naturalistic generalization of the data as a whole.

4.3.1 Thematic Analysis

According to Boyatzis (1998), thematic analysis act as a translator between the languages of qualitative and quantitative analysis, enabling communication between researchers who use different research methods. Thematic analysis is a method for identifying, analyzing, organizing, describing, and reporting themes found within a set of qualitative data (Nowell et al., 2017). A systematic thematic analysis can generate trustworthy and insightful findings. However, there is a lack of agreement on how researchers can apply the method. This case study has borrowed inspiration from a step-by-step approach towards conducting thematic analysis suggested by Nowell et al. (2017).

Familiarizing with the data

The data mainly comes in the form of recorded observations, text, and documents. Textual data includes field notes from observations and narrative stories (Crabtree & Miller, 1992). Thoughts, interpretations, and questions were documented during data collection, which Tuckett (2005) marks as the beginning of data analysis. Following Braun & Clarke (2006) recommendation, the entire data set was read through at

least once before beginning coding. A few ideas were shaped from this action, which was useful in systematizing the data collection process.

Coding

Coding in qualitative research is a reflective process that involves interacting with and analyzing data. It helps the researchers to narrow down and focus on specific characteristics of the data (Nowell et al., 2017). As researchers progress from raw and unstructured data to more structured and refined concepts, they develop an understanding of the underlying themes and patterns. The coding process began once field notes and audio recordings from interviews and observations were transcribed. This was done manually. A coding framework was developed through an iterative process of re-reading the data, identifying initial codes, and grouping them into broader categories. This helped to indicate the key themes and patterns from the data. An example of coding a summary document can be seen in Figure 4.2.

Finding and reviewing themes

According to DeSantis & Ugarriza (2000), a theme is: "an abstract entity that brings meaning identity to a recurrent experience and its variant manifestations. As such, a theme captures and unifies the nature or basis of the experience into a meaningful whole" (p. 362). Themes are recognized by combining individual components or pieces of ideas or experiences that may not have a meaning on their own (Aronson, 1995). The importance of a theme in relation to the research question is not necessarily dependent of quantifiable measures, but rather on whether it effectively captures something meaningful (Braun & Clarke, 2006). Themes may be derived from the raw data set using an inductive approach or from existing theories and prior research using a deductive approach (Boyatzis, 1998). This case study has taken an inductive analysis approach towards generating themes. Inductive analysis involves coding the data without trying to fit it into a pre-existing coding framework (Braun & Clarke, 2006). This type of thematic analysis is driven by the data itself. The themes were also reviewed to verify whether they truly represent the meanings of the data set as whole.

Codes:

Information use
Data Quality
Improvement
Frustration
Alternative use

On data use

The data manager prepares coordination meeting presentations with key indicators with data from DHIS2. Some data managers prefer to extract the data sets from DHIS2 into Excel, RHAP or Power BI to create data visualizations. One of the key indicators which was presented in one of the coordination meetings at Kibagabaga was ANC 4th standard visit coverage (based on CBR) in Gasabo District.

The data managers demonstrated how they made their presentations. Once they are done creating the data visualization from their collected data sets in DHIS2 or with their preferred data visualizer tool. Then they take a screenshot of the representation and paste it into their presentation. Excel is also used to prepare for coordination meetings, and the reason given is that sometimes the total of data elements with disaggregation do not show up in the DHIS2 data visualizer tool. We believe that cases where Excel is needed is related to how metadata is defined for certain data elements. Maybe the data sets do not align or make sense with the disaggregation options provided in DHIS2.

When it comes to data representation, a data analyst from RBC expressed some limitations with DHIS2. The data analyst was not satisfied with the options that the DHIS2 data visualizer tool provided for him. It lacked flexibility in graph manipulation, choice of color options, and user friendliness. Due to the limitations with the data visualizer in DHIS2, the data analyst finds it easier to import the metadata from DHIS2 into Power BI or Excel, and work on data representation from there. A key advantage of Power BI and Excel is that it functions properly offline.

Figure 4.2: Example of coding of the transcribed summary document

5 | Findings

The purpose of this chapter is to present the findings from the case study described in Chapter 4.

5.1 Information use practices

This section covers all findings related to information use in the Rwandan healthcare sector which adds to the knowledge of work practices around data collection and data visualization. We mainly follow the routines and practices of data managers working at the facility level and data analyst working at the national level.

5.1.1 Data entry in DHIS2

At the beginning of every month, the data managers at the district health facility level in Rwanda sends forms to the various department, which health workers have to fill out the forms and send back to the data manager. The data manager then spends two days entering the data into DHIS2. Following the Standard Operational Procedures (SOPs), the data manager has to verify the data by comparing the data which has been entered to the forms that he has received. They have until the 15th of the month to make corrections in DHIS2 before the data locks.

Every health facility that we visited had at least one person designated as a Data Manager. This person possessed a high level of expertise in DHIS2 and was accountable for all DHIS2 related tasks at their assigned facility. Data entry was based on paper forms collected and completed by other healthcare staff. This was demonstrated to us during an interview with a data manager at a Referral Hospital (See Figure 5.1). Register for hospitalization is shown in Figure 5.2. It is the data manager's responsibility to ensure that the clinical staff at the health facility are using the data collection forms and tools that are up-to-date.

Figure 5.1: Interview with a data manager at a Referral Hospital

5.1.2 Preparation for coordination meetings

All districts in Rwanda conduct monthly meetings where district managers and data managers from different health facilities gathers at the districts level to perform what they call a 'coordination meeting', where they assess last month's data, look at patterns and discuss necessary actions. Before the meeting takes place, the data manager prepares a presentation with key indicators for the various departments to help coordinate resources and discuss actions regarding health programs.

A data manager working at a district hospital demonstrated very good experience with the DHIS2 visualizer app, easily making charts with data he wanted to display, and putting together a presentation with key indicators using a snippet tool and PowerPoint. The data manager also used other tools for the presentation. He demonstrated the use of a national health analysis tool called Rwanda Health Analysis Platform (R-HAP), a platform developed by Zenysis. It was mentioned by one of the data managers that using R-HAP to display maps felt more convenient than displaying maps with the DHIS2 visualizer. The platform's functionality and design looked very similar to DHIS2. R-HAP fetches data from the three instances: The HMIS instance, which is the

Hospitalization register

N° de serie mensuelle *Monthly serial number*

N° Dossier du malade *Patient file number*

Nom et Prénom Name in Full
En haut: Nom / *Upper space Surname*
En bas: Prénom/ *Lower space given name*

Chef de Famille (Nom et prénom) *Family head (full names)*

Addresse *Address*
En haut: District *upper row: District*
En bas: Secteur *lower row: Sector*
En haut: Cellule *upper row: Cell*
En bas: Umudugudu *lower row: village*

Provenance (Z, HZ,HD)

Nouveaux Cas (NC) / Ancien Cas (AC)

Statut d'enregistrement
1. Référé(e)
2. Patient habituel
3. Contre référé

AGE
- 0-11 mois
- 1-4 ans
- 5-14 ans
- 15-19 ans
- 20-34 ans
- 35-49 ans
- 50+ ans

Sexe *Sex* (M/F)

Polds *Weight*

Symptomes et signes cliniques *Clinical signs and symptoms*

Figure 5.2: Hospitalization register

main DHIS2 instance; The HIV instance, which is owned by RBC; and Système communautaire d'information sanitaire (SCIS), which holds data for community health services.

Coordination meetings takes place at both district and national level. At the district level, the meeting focuses on discussion around what the key indicators are showing based of the data that is collected within the certain period of time, if the indicators reflects reality, and the need to adjust formula of the indicator. In HMIS, an indicator is a core element of data analysis, it is a calculated formula based on a combination of data elements, category option, and a factor [1]. For example, the indicator "Bacille Calmette Guerin (BCG) coverage < 1 year" is defined by a formula with a factor 100 (to obtain a percentage), a numerator "BCG doses given to children under 1 year", and a denominator "Target population under 1 year" [1].

The data manager facilitated at a district hospital showed us one of his PowerPoint presentations that were used in a coordination meeting that took place in August 2022. Unfortunately, we did not get the opportunity to take part in a coordination meeting during our field trip. However, we did manage to get a grasp of what a typical coordination meeting at the district would look like. This was done by looking through the PowerPoint presentation that he sent us, as well as listening to his explanation of the key indicators which was discussed during that coordination meeting. One of the focus areas from that coordination meeting was the "Gasabo District Antenatal Care (ANC) 4th visit" indicator, where the target is set to higher 51% coverage of the ANC 1st visit in Gasabo District. Slides from the presentation are shown in Figure 5.3 and 5.4.

At the national level, coordination meetings take place at RBC twice a year, where they bring in directors from national and district hospitals. At this level it is normal to have a data analyst from RBC to generate a presentation using Power BI and data from multiple instances to create a broad picture of the current national healthcare situation for the purpose of helping the directors facilitate reasonable decision-making.

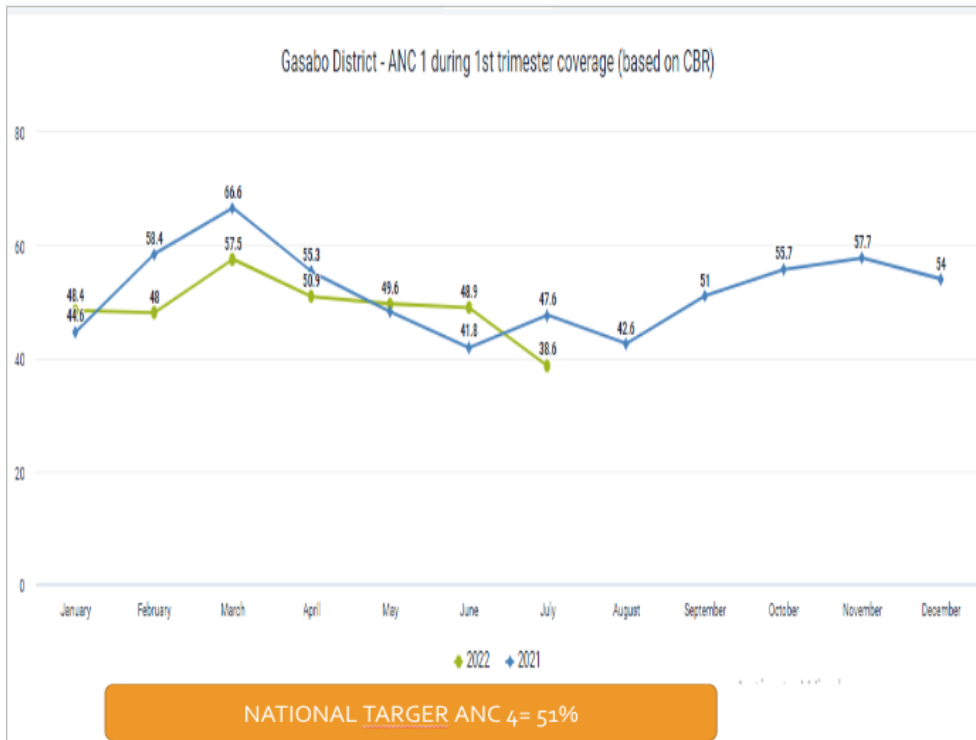[1]https://docs.dhis2.org/en/implement/database-design/aggregate-system-design/indicators.html

Figure 5.3: Line chart showing ANC 1st visits in Gasabo District

Figure 5.4: Line chart showing ANC 4th visits in Gasabo District

5.1.3 The use of DHIS2 dashboards

Studies have indicated limited use of DHIS2 dashboards since other tools such as Excel were preferred for data analysis and use (Russ-patrick et al., 2021). However, the findings from this study have shown adequate use of DHIS2 dashboards for overall monitoring of relevant health programs and presentations related to monthly coordination meetings. A data manager from a district hospital had 6 different dashboards which he made himself. WHO dashboards were not in use (Poppe et al., 2021). One of his dashboards indicated new cases from the Outpatient Department (OPD) for the health facilities they supervise, which was a simple table showing how many patients that have been treated each month. Another data manager working at a Referral Hospital used several dashboards, both for monitoring health programs and for coordination meeting presentations. He also made the dashboards himself. From what we were able to capture, his dashboards consisted of charts and pivot tables indicating ANC visits, confirmed malaria cases, and immunization coverage.

DHIS2 dashboards is mainly targeted for users working at the facility level. The people who have access to DHIS2 dashboards and who are using it on a daily basis are data managers and Monitor and Evaluation (M&E) officers. Data managers finds DHIS2 dashboards useful in aspects of conducting monthly data analysis for key indicators and assuring high quality data by focusing on the accuracy, completeness, integrity, precision, and timeliness of the reports that they generate and submit to the national level.

At the national level, analysis of DHIS2 dashboards and coordination meetings presentations are used to plan field visits and health program guidance for health care providers at the health facilities. This intervention is necessary for program managers to gather qualitative data from the field and then use that data to compare it with the data submitted to the national level. From there, they plan new interventions to meet gaps in the current health programs.

5.1.4 The use of Excel and Power BI

All data managers included in this study demonstrated good use of pivot tables, charts, maps, and dashboard in DHIS2, but the data managers also expressed limitations with DHIS2. Not being able to manipulates charts and tables, and add text and colors are some of the few. Although is it possible to do so in DHIS2, the process of doing it is not as straightforward as it is in Excel. Due to these limitations in DHIS2, data is collected as a means to export data to Excel. A data analyst from RBC expressed similar limitations with DHIS2 and preferred to work in Power BI, using the data he had exported from DHIS2, as Power BI offers more functionality and flexibility related to data manipulation.

Power BI is typically used by data analysts and program managers at the national level. They find it useful when there is necessary to combine data from multiple instances. Since HMIS data is stored in three different instances in Rwanda, Power BI allows them to pull data from all three instances together, and from there, conduct analysis using methods such as triangulation, put together presentations for coordination meetings, make reports or form relevant indicators on health programs based on their analysis. In Figure 5.5, a data analyst working at the national level demonstrated the use of Power BI. The data analyst have to update and make visualizations for the weekly bulletin on relevant health indicators, which was for this case, the distribution of deaths by age group and gender.

5.2 Data quality practices

Based on the interviews and observations conducted during fieldwork (See Table 4.1 and Table 4.2 in Chapter 4 for the facilitates and locations we conducted our interviews and observations), our findings aims towards understanding data quality practices which relates to the information use practices of data managers and stakeholders from all level of health facilities.
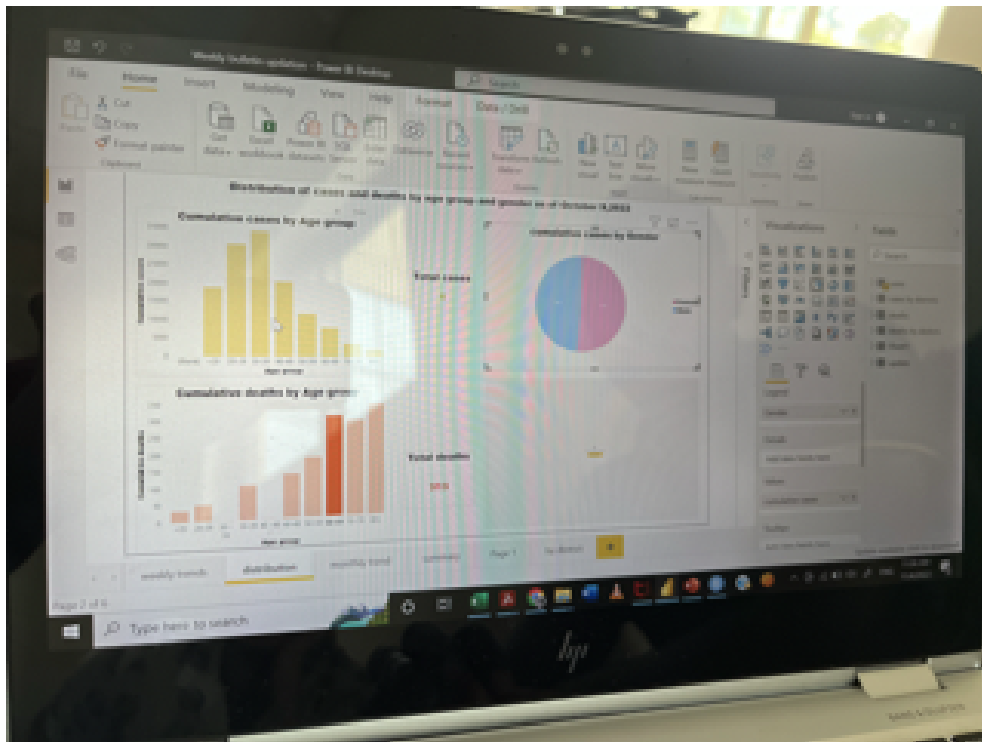
Figure 5.5: A Data Analyst demonstrating the use of Power BI

5.2.1 Standard operating procedures for data quality assurance

To ensure the quality of data, hospitals are obligated to evaluate the record keeping and data management practices of their service units, departments, and supported health centers. This evaluation is carried out on a monthly and quarterly basis in hospitals and health centers. At the facility level, data managers must ensure that internal data errors or omissions are corrected before the 15th of each month, which involves checking data inconsistencies by looking at the timeliness, accuracy and completeness of the data collected at the health facility.

5.2.2 Findings from data quality workshop

DQR meeting is conducted twice a year, where the MoH invites data managers and M&E officers from district hospitals, supervisors from RBC, and DHIS2 implementers from HISP Rwanda to collaborate in a workshop that is designed to assess the quality of data generated by the national HMIS. The workshop is based on a toolkit developed by

WHO departments and external partners [2]. It includes several modules on approaches to assess data quality at the facility level based on practices and lessons learned from all around the world.

Observations from a DQR meeting in Rwanda indicated adequate use of the WHO toolkit. A site assessment (data cleaning) and a discrete desk review are the two separate processes that the DQR methodology comprises of. Conducting a site assessment involves evaluating the quality of data by visiting health facilities and district offices[2]. The assessment entails verifying source data and evaluating the system's ability to produce reliable data[2]. It can either be a part of the routine data quality assurance cycle that involves supervision or it can be conducted as a discrete or cross-sectional assessment. Conducting a discrete desk review involves evaluating the quality of aggregated reported data using standardized data-quality metrics[2]. It can as well be performed either as a part of regular data quality checks or as a discrete or cross-sectional assessment[2].

Following the DQR methodology, the participants of the DQR meeting were split into two teams. The first team was responsible for the process of data cleaning. The other team was tasked to review the aggregated reported data using the WHO data quality tool. Data cleaning is the process of fixing incorrect, incomplete, duplicate, or otherwise error nous data in a data set (World Health Organization, 2017). The MoH has collected data sets from around 145 health facilities. All facilities have been visited by supervisors from RBC before the meeting. All health facilities use Android tablets for data entry and the data is stored in the Census and Survey Processing System (CSPro) database. CSPro is a software that lets you create, modify and run data entry from a single, integrated development environment[3]. In order to access the data from CSPro, the team used a tool within the CSPro software to concatenate all the data files from the Android tablets and covert the file to a CSPro database file. Once the files were concatenated, the team had to check the key fields in the data file for errors using the cleaning batch tool within the CSPro software. The cleaning batch tool automatically identifies missing values in the data

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[2]https://dhis2.org/who-dq/

[3]https://www2.census.gov/software/cspro/documentation/cspro75.pdf

file. At last, the team exported the data files into Excel, where they further checked for any duplicate facility codes. Duplicate and empty cases were then deleted by the team.

The team who worked on the discrete desk review (See figure 5.6) examined the quality of the data sets collected across four dimensions: completeness, timeliness, internal consistency, and external comparison with other data sources (validity). A discrete desk review of the data sets detects errors in aggregation and reporting (World Health Organization, 2023). The tools that they used to conduct the discrete desk review were the WHO Data Quality (WHO DQ) App and Microsoft Excel. The WHO DQ App is a part of the DHIS2 software, which has incorporated the DQR metrics (dimensions). The findings from the discrete desk review indicated high scores of completeness in facility reporting across the different health facilities (The use of WHO DQ App is shown in Figure 5.7). Facilities must meet the 90% overall score threshold for the reporting to be valid. However, some facilities displayed abnormal completeness levels when the selected data element was used in more than one data set. Another problem occurred when there was only possible to disaggregation by levels, as they also wished to disaggregate between public and private health facilities.

5.2.3   WHO Data Quality App

The WHO DQ App(Also called the WHO DQ Tool) is an application that enables users to quickly assess the completeness and consistency of HMIS data. The WHO DQ Tool can significantly aid data managers in charge of ensuring the accuracy of the data reported by health facilities. This includes staff at the district or facility level who have online access to the DHIS2, as well as personnel at higher levels of the health system. At the national and regional levels, this may encompass staff who work for specific health programs and those who have cross-cutting responsibilities for data management, such as the HMIS unit or M&E staff.

5.2.4   Data quality dimensions

The most relevant data quality dimensions that we came across during the data quality workshop was completeness and consistency. The

Figure 5.6: The team who worked on the discrete desk review
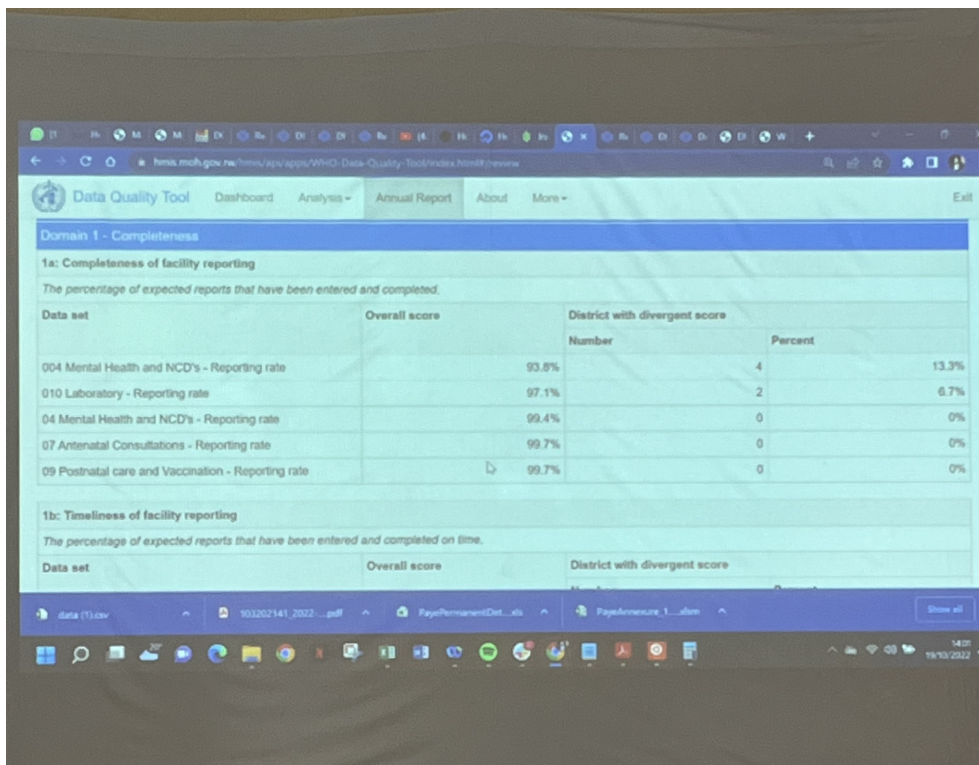
Figure 5.7: The use of WHO Data Quality App

measurement of completeness was determined as a percentage of reports that did not have missing data (Nisingizwe et al., 2014). Consistency was determined by evaluating the lack of extreme outliers, internal consistency between interrelated indicators, and the consistency of indicators over time. The reports were generated using the "Annual Report" function in the WHO DQ app. With this, they managed to generate a nationwide completeness report for all data sets that were collected before the data quality workshop.

5.2.5   The use of DHIS2 scorecard app

The DHIS2 scorecard app is mainly used at the national level (by organizations such as RBC and MoH) for advanced data quality analysis. We took part in a DHIS2 scorecard seminar at the HISP Rwanda office (See Figure 5.8). We learned that the DHIS2 scorecard app is designed to provide a standardized approach to monitoring and evaluating progress toward achieving specific goals and objectives. Furthermore, The app allows users to track key performance indicators through the use of traffic light color codes and a consolidated table format, providing an easy-to-understand visual representation of data [4]. The app is optimized for advanced scorecard analysis, and it provides users with advanced control and power to create and analyze multiple elements and dimensions of the data. Additionally, the scorecard app can be used offline, making it an accessible and versatile tool for monitoring and evaluating performance in a variety of settings.

5.3   Summary of findings

This section summarizes the tools and applications that supports information use and data quality assessments. Table 5.1 focuses on the tools intended use for a HMIS specific context and how the tool are being used during our observations in that context.

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[4]https://docs.dhis2.org/en/full/use/optional-apps/interactive-scorecard-ap-manual.html
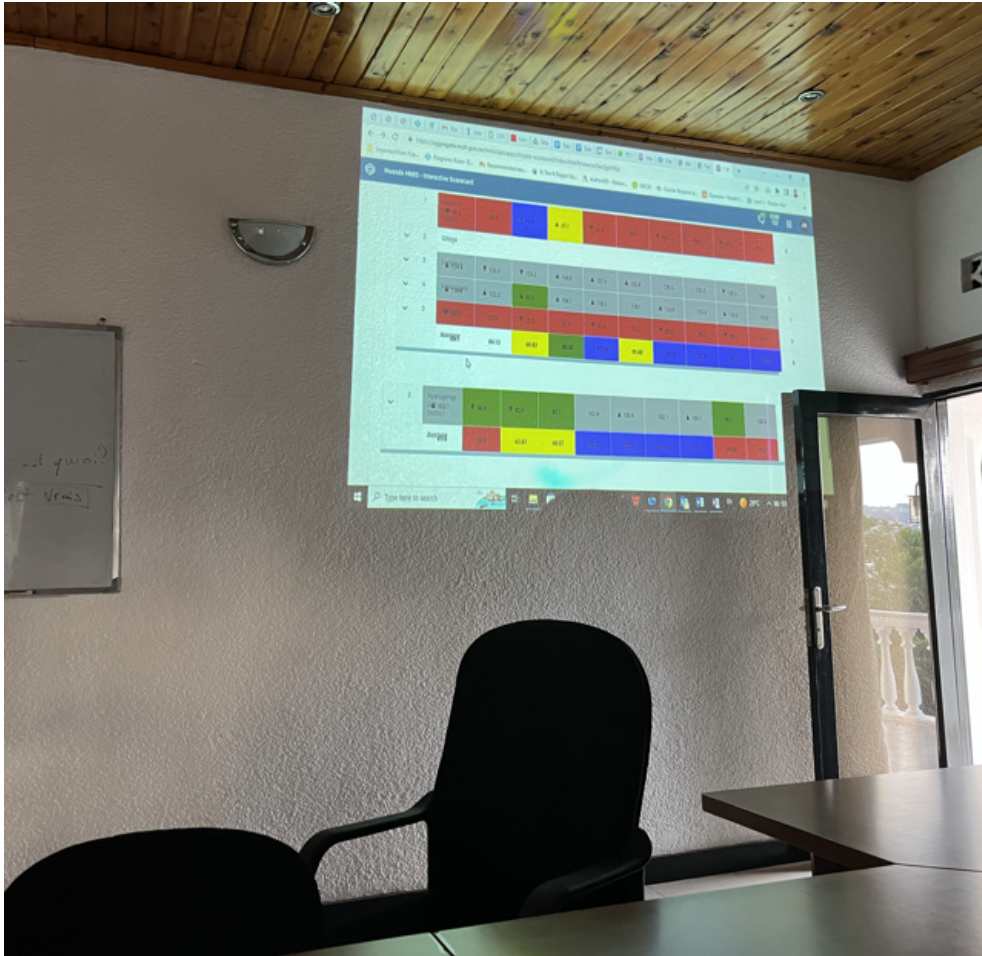
Figure 5.8: Scorecard seminar at the HISP Rwanda office

Tool/App	Intended use	Observations
DHIS2 Data Entry app	The Data Entry app is where you manually enter aggregated data in DHIS2. You register data for an organization unit, a period, and a set of data elements (data set) at a time [5]. A data set often corresponds to a paper-based data collection tool.	Data managers possesses a high level of expertise in DHIS2 and is therefore accountable for all DHIS2 related task at their assigned facility. Data entry was based on paper forms collected and completed by other healthcare staff.
DHIS2 Dashboards app	The Dashboards app makes it possible to present a high level overview of your data, including displaying analytical objects such as maps, charts, reports and tables, as well as displaying text-based information, resource links, and app widgets [6].	The Dashboard app is mainly targeted for users working a the facility level. It is useful in aspects of conducting monthly data analysis for key indicators and assuring high quality data by focusing on the accuracy, completeness, integrity, precision, and timeliness of the reports that they generate.

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[5]https://docs.dhis2.org/en/use/user-guides/dhis-core-version-239/collecting-data/data-entry.html

[6]https://docs.dhis2.org/en/use/user-guides/dhis-core-version-master/analysing-data/dashboards.html

Microsoft Excel	Spreadsheets are very useful tools in public health because they are widely available, and can be used for collecting data, statistical analysis, constructing graphs and tables which can be exported into other applications or converted into image files (Boston University, n.d.).	Data is collected as a means to export data to Excel. The process of manipulating charts and tables, and adding text and colors is perceived to be more straightforward in Excel than it is in DHIS2.
Microsoft Power BI	The built-in data visualization and report creation capabilities of Power BI are robust, making it a useful tool for healthcare sector entities to take advantage of (ImensoSoftware, 2022).	Power BI is typically used by data analysts and program managers at the national level. They find it useful when there is a need to combine data from multiple instances. Data is stored in the HMIS, HIV, and SCIS instances, and Power BI allows analysts to pull data from all three instances, making it possible to conduct triangulation to increase the validity of data.

| WHO DQ app | The WHO DQ App can be a valuable tool for personnel tasked with ensuring the accuracy of data reported by healthcare facilities. This includes both district and facility-level staff with online access to DHIS2, as well as higher-level staff at the national and regional levels. These staff members may work for specific health programs or have cross-cutting responsibilities for data management, such as HMIS unit staff or monitoring and evaluation personnel (World Health Organization, 2022). | The WHO DQ App supports the conduct of discrete desk reviews, where the purpose is to generate an overview of the quality of the data across different programme areas in the routine health information system. However, the desk review team were met with issues when using the WHO DQ App to generate completeness and timeliness reports. Some data sets from the facilities displayed abnormal completeness levels and the issue were not resolved during the data quality workshop. |

DHIS2 Score-card App	The scorecard app is a performance monitoring tool that allows users to track the comparative performance of indicators over time and against different organization units and/or levels. With easy to use color coded outputs, the scorecard is meant to allow users to make data-driven decisions using the performance outlined via the scorecard app's outputs [7].	The Scorecard App is mainly used at the national level for advanced data quality analysis. It is typically used by data analysts from RBC or decision makers from MoH. DHIS2 experts from the HISP Rwanda office are the ones who offer training on Scorecard App

Table 5.1: Summary of findings

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[7]https://apps.dhis2.org/app/6e3af2e6-6dac-49b8-baa1-40019a684252

6 | Discussion

This chapter bridges my findings together with the related literature through a discussion that aims to answer the research question presented at the beginning of this thesis. As pointed out earlier, the main challenge of information use is to identify what information use practices that actually drives informed decisions. This case study extends the literature on the interrelation between information use and data quality in the context of HMIS in developing countries. The first section discusses how appropriate information use and data quality practices influence the relationship between data, decisions, resources, and programmes. This section is followed by a discussion of the tools that are mentioned in Chapter 5 and how those tools contribute to the overall quality of health data. The last section covers the limitations of this case study.

6.1 How information use and data quality practices influence decisions

6.1.1 Information use

Prior research on information use in LMICs stresses that information should serve as a means to facilitate informed decision-making in areas such as healthcare planning, management and evaluation of programs, and services (Lippeveld et al., 2000). However, the ownership or access to good quality data does not guarantee the actual use of these data (Byrne & Sæbø, 2022). Studies conducted on information use at health facility and district level in Rwanda indicated that, although data was regularly used during monthly coordination meetings, the DHIS2 dashboards and other analytical tools were not frequently used because users were more comfortable with using Microsoft Excel for data analysis and use (Russpatrick et al., 2021).

This case study has been concerned with addressing the information use and data quality assurance practices, and their influence

on decision-making within the healthcare sector in a low and middle-income setting. Our findings clarify some understanding around how DHIS2 software platform and other analytical tools are actually utilized. Additionally, it has discovered some shortcomings of the tools that need more attention. Due to the rapid and extensive scaling of DHIS2 (Byrne & Sæbø, 2022), this case study largely focuses on the parallel increase in the scaling of information use. However, our approach does not report on the technical aspects of system implementation. It is rather concerned with the socio-technical aspects of the whole HIS in itself, i.e. the understanding of how technologies shapes and are shaped by people, organizations, and society. An example of this is how the DHIS2 data entry tool is shaping the trust and value of information use within the facility level. Each role within a health facility needs to be included in the growing information culture in order to sustain the rapid scaling of digitization.

6.1.2 Data quality

The quality of data is critical for managers and operating processes to identify related health programme issues (Sidi et al., 2012). Prior research on data quality and use of routine health information system data in low and middle income countries stresses on the inadequate use of information for decision-making despite the increasing availability of health information (Lippeveld et al., 2000). Despite the wide range of techniques for accessing and improving data quality (Sidi et al., 2012), this case study identifies some of the more relevant data quality dimensions that fits the Rwanda HMIS context, which is mainly the completeness and accuracy dimensions. However, many of the completeness and accuracy definitions in the data quality literature does not fit the data quality assurance practices within the Rwanda HMIS context. Therefore, it is important to be aware of the context in which the definition applies to. For example, the DHIS2 documentation provides definitions of completeness and consistency which fits the overall HMIS context. Overall, our observations of data quality practices showed high use of information through rigorous quality checks of the HMIS data by supervisors from RBC and MoH, and DHIS2 experts.
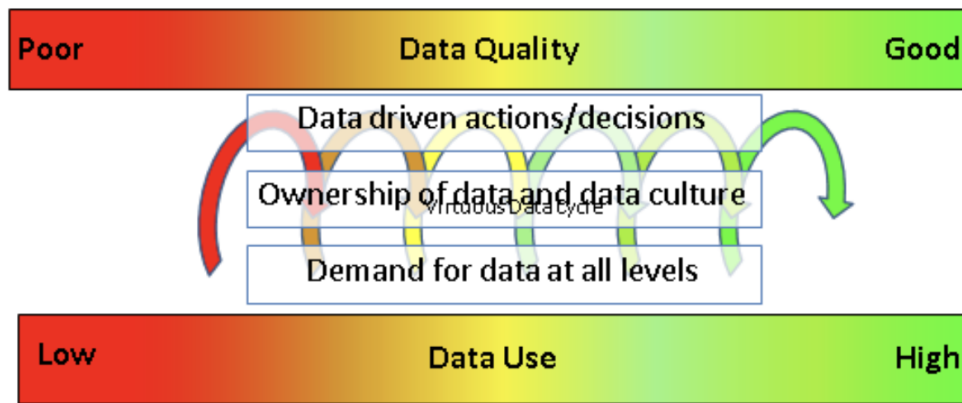
Figure 6.1: Virtuous data cycle from the DHIS2 documentation

6.1.3 Information use and data quality interventions in Rwanda

The interrelation between data quality and information use can be seen as a vicious and virtuous data cycle [1]. In the context of HMIS, the vicious data cycle describes a scenario where healthcare workers and other stakeholders provide poor quality data, which leads to less trust and use of the data. The virtuous data cycle describes a scenario were trust in the data facilitates more use of the data, which then further improves the quality of the data. The DHIS2 documentation illustrates the virtuous data cycle as shown in Figure 6.1. This is a continuous and gradual process that requires time and should be driven by an increase in demand for data, local ownership of data, and clear connections between data and decision-making. The outcome of the virtuous cycle is a thriving culture of information use.

Lemma et al. (2020) reported improvements in data quality after implementing a modified "Plan, Do, Study, Act" (PDSA) framework in Rwanda. The framework consisted of several steps such as the identification of data quality problems, implementation of facility based data quality assessment, training on data review, feedback on performance, and follow-up for action. In this case, it is the implementation of the PDSA framework that drives the virtuous data cycle. The modified PDSA framework that was used to inform the development and implementation of data driven quality improvement in Rwanda (Wagenaar et al., 2017) is shown in Figure 6.2.

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[1]https://docs.dhis2.org/en/implement/chis-implementation/data-quality-and-use.html
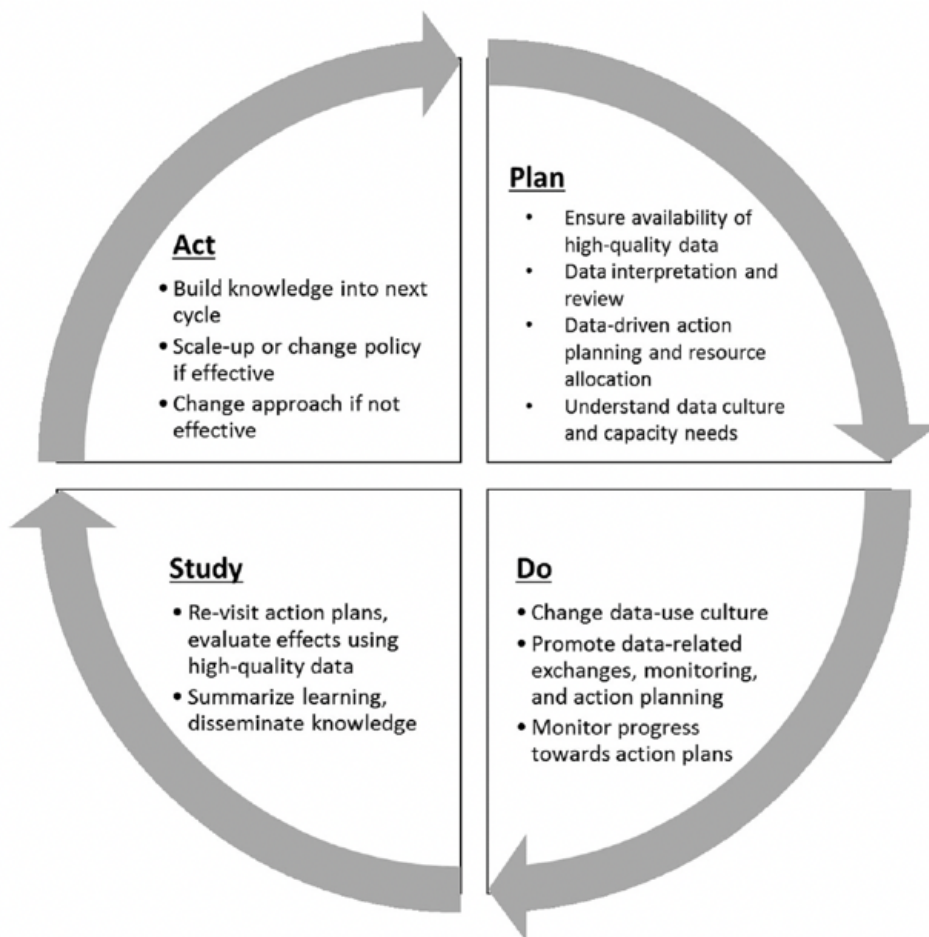
Figure 6.2: Screenshot of the modified PDSA framework from Wage-
naar et al. (2017)

The "Do" step in Rwanda focused on implementing data-focused meetings, monitoring activities, and implementing feedback loops and other intervention activities (Wagenaar et al., 2017). The aim was to enhance the utilization and value of reliable high-quality data to identify and address issues related to management and system performance. This corresponds significantly with the findings from the field trip, as the interviews were heavily focused around coordination meetings and the use of tools to support monitoring activities and data analysis in order to meet the goals of the "Do" step. Wagenaar et al. (2017) notes that these activities improved the data quality in a number of key area, as well as the health workers' value and ownership of existing and future data.

6.1.4 How it influences decision-making

In reality, particular day to day decisions are seldom consciously made and frequently rely on subjective feelings and past experience (Lippeveld et al., 2000). However, it is the reliability and validity of information that convinces decision makers to deliberately incorporate information to ensure that informed decisions are made. For this reason, the quality of the data is a crucial factor to consider throughout the operation of the system by routinely verifying its validity and reliability, not just the outset of a HIS during the design phase. The success around building a strong information culture in all levels within the health system is to ensure that the national level strongly advocate a sense of ownership to be fostered among all potential users of information (Shamba et al., 2021). The strong emphasis in using and updating the national standard operating procedure is an example of how the Rwanda MoH have built its strong information culture.

6.2 Use of data collection, analysis, and quality tools

Informants from Rwanda highlighted the wide acceptance of DHIS2 at the national level (Belizán et al., 2023). Electronic data collection has become the norm at almost all health facilities in Rwanda due to the initiative of the MoH that encourages all stakeholders to sup-

port the HMIS system, which is the DHIS2 platform. To maintain the strength of the HIS, it is necessary to regularly conduct coordination meetings at district and national level to make sense of the data that is being collected. Large volumes of data elements are being captured (Shamba et al., 2021), hence it is important to evaluate the need and relevance of each data element to avoid unnecessary complexity that comes from the register design. Monthly coordination meetings at the district level and bi-annual coordination meetings at the national level have encouraged both data managers and data analysts to use advanced analysis tools to make data visualization aimed at a broader audience, and identify discrepancies and outliers within the data itself. It is the activities around coordination meetings which has strengthen the quality of the data within the national HMIS. Data quality initiatives from WHO, such as the WHO DQ toolkit, has a significant impact on the data quality practices in Rwanda, given the high use, knowledge and adaption of data quality instruments for DQR.

6.3 Information use and data quality as interrelated concepts

The purpose of gathering qualitative data around information use and data quality from Rwanda is to gain a clear picture of why information use and data quality within the HMIS context should be seen as interrelated concepts. The quality of the data collected and entered into a system determines the usefulness of information and the reliability of decisions. If the data entered into an HMIS is of poor quality, the information generated by the HIS may be inaccurate or incomplete (Karengera et al., 2016). This can lead to incorrect decisions being made by healthcare providers, policymakers, and managers, which can ultimately have negative impacts on the quality of healthcare services (Byrne & Sæbø, 2022).

To learn about how data managers at the district level and data analysts at the national level uses information to support their tasks is key for us to understand if the tools that are in use actually fits the socio-technical context. Through interviews and informal conversations with data managers and DHIS2 implementers, we can assure that the uti-

lization of digital tools within the public health sector at all levels are high, and that there are far less variations in the tools being used. This has become possible due to the implementation efforts of the DHIS2 system nationwide since 2012, which enabled a standardized and efficient way of collecting health data.

6.4 Limitations

The strength of this is study is the four week fieldwork in Rwanda and as we managed to collect valuable data for this case study, we noticed that our time in Rwanda was slim due the long response time from the informants that we wished to interview. This resulted in some missed interview opportunities. We also missed the opportunity to participate in an actual coordination meeting due to the timing of our stay. However, the informants were willing to share interesting experiences and presentations regarding the coordination meetings. Because of the the missed interviews opportunities, we may have missed on important information about information use and data quality practices that influences the decision-making.

7 | Conclusion

This thesis set out to answer the following research question: *What information use and data quality practices enables informed decisions within the healthcare sector in Rwanda?*

At the facility level, there has been an ongoing effort to incorporate data quality checks that aligns with the information use practices. For example, data managers does not only bear the responsibility of handling data and generate reports to the higher levels. They are continuously monitoring the outputs from the data using DHIS2 dashboards to catch up on any discrepancies that might appear. This action is also supported by other tools such as Excel and WHO DQ App.

At the national level, data quality interventions such as the DQR meeting are conducted bi-annually to further assure the credibility of what is being reported from health facilities across Rwanda. The DQR meetings follow the principles of The DQR toolkit developed by the WHO.

Thirdly, these practices are supported by having an organization, HISP Rwanda, that supports health facilities with the implementation of DHIS2. The HISP Rwanda team provides expertise in every aspect of DHIS2 and they are often sending out DHIS2 implementers to health facilities and health centers around the country to assure that health facility workers are provided with the necessary support in regards to information use practices.

A key contribution to my work is to explore the relationship between information use and data quality. I argue that they should be seen as an interrelated concept as this perspective facilitates a sense of ownership in the data for those who do not necessarily work on both data collection and data analysis. Without a strong information culture, health facility workers will not see the value in collecting health data. This might lead to a vicious data cycle. To ensure a virtuous data cycle, data quality practices need to be incorporated into daily information use practices at the facility level. This will ensure that the national level

will be provided with high quality data and further generate informed decisions that can be trusted.

7.1   Further research

This thesis suggest that further research should take a thorough look at what information use practices that enables informed decisions in a less mature DHIS2 user country. Furthermore, it would be interesting to see how those practices might differ compared to a mature DHIS2 user country such as Rwanda.

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A | NSD research approval

Sikt

Meldeskjema / DHIS2 metadata packages / Vurdering

Vurdering av behandling av personopplysninger

Referansenummer	**Vurderingstype**	**Dato**
636596	Standard	14.09.2022

Prosjekttittel
DHIS2 metadata packages

Behandlingsansvarlig institusjon
Universitetet i Oslo / Det matematisk-naturvitenskapelige fakultet / Institutt for informatikk

Prosjektansvarlig
Johan Ivar Sæbø

Student
Daniel Nguyen

Prosjektperiode
09.10.2022 – 15.06.2023

Kategorier personopplysninger
Alminnelige

Lovlig grunnlag
Samtykke (Personvernforordningen art. 6 nr. 1 bokstav a)

Behandlingen av personopplysningene er lovlig så fremt den gjennomføres som oppgitt i meldeskjemaet. Det lovlige grunnlaget gjelder til 15.06.2023.

Meldeskjema ↗

Kommentar
OM VURDERINGEN
Personverntjenester har en avtale med institusjonen du forsker eller studerer ved. Denne avtalen innebærer at vi skal gi deg råd slik at behandlingen av personopplysninger i prosjektet ditt er lovlig etter personvernregelverket.

Personverntjenester har nå vurdert den planlagte behandlingen av personopplysninger. Vår vurdering er at behandlingen er lovlig, hvis den gjennomføres slik den er beskrevet i meldeskjemaet med dialog og vedlegg.

VIKTIG INFORMASJON TIL DEG
Du må lagre, sende og sikre dataene i tråd med retningslinjene til din institusjon. Dette betyr at du må bruke leverandører for spørreskjema, skylagring, videosamtale o.l. som institusjonen din har avtale med. Vi gir generelle råd rundt dette, men det er institusjonens egne retningslinjer for informasjonssikkerhet som gjelder.

TYPE OPPLYSNINGER OG VARIGHET
Prosjektet vil behandle alminnelige kategorier av personopplysninger frem til 15.06.2023.

LOVLIG GRUNNLAG
Prosjektet vil innhente samtykke fra de registrerte til behandlingen av personopplysninger. Vår vurdering er at prosjektet legger opp til et samtykke i samsvar med kravene i art. 4 og 7, ved at det er en frivillig, spesifikk, informert og utvetydig bekreftelse som kan dokumenteres, og som den registrerte kan trekke tilbake. Lovlig grunnlag for behandlingen vil dermed være den registrertes samtykke, jf. personvernforordningen art. 6 nr. 1 bokstav a.

PERSONVERNPRINSIPPER
Personverntjenester vurderer at den planlagte behandlingen av personopplysninger vil følge prinsippene i personvernforordningen om:

- lovlighet, rettferdighet og åpenhet (art. 5.1 a), ved at de registrerte får tilfredsstillende informasjon om og samtykker til behandlingen
- formålsbegrensning (art. 5.1 b), ved at personopplysninger samles inn for spesifikke, uttrykkelig angitte og berettigede formål, og

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ikke viderebehandles til nye uforenlige formål
- dataminimering (art. 5.1 c), ved at det kun behandles opplysninger som er adekvate, relevante og nødvendige for formålet med prosjektet
- lagringsbegrensning (art. 5.1 e), ved at personopplysningene ikke lagres lengre enn nødvendig for å oppfylle formålet

DE REGISTRERTES RETTIGHETER
Personverntjenester vurderer at informasjonen om behandlingen som de registrerte vil motta oppfyller lovens krav til form og innhold, jf. art. 12.1 og art. 13.

Så lenge de registrerte kan identifiseres i datamaterialet vil de ha følgende rettigheter: innsyn (art. 15), retting (art. 16), sletting (art. 17), begrensning (art. 18) og dataportabilitet (art. 20).

Vi minner om at hvis en registrert tar kontakt om sine rettigheter, har behandlingsansvarlig institusjon plikt til å svare innen en måned.

FØLG DIN INSTITUSJONS RETNINGSLINJER
Personverntjenester legger til grunn at behandlingen oppfyller kravene i personvernforordningen om riktighet (art. 5.1 d), integritet og konfidensialitet (art. 5.1. f) og sikkerhet (art. 32).

Ved bruk av databehandler (spørreskjemaleverandør, skylagring, videosamtale o.l.) må behandlingen oppfylle kravene til bruk av databehandler, jf. art 28 og 29. Bruk leverandører som din institusjon har avtale med.

For å forsikre dere om at kravene oppfylles, må dere følge interne retningslinjer og eventuelt rådføre dere med behandlingsansvarlig institusjon.

MELD VESENTLIGE ENDRINGER
Dersom det skjer vesentlige endringer i behandlingen av personopplysninger, kan det være nødvendig å melde dette til oss ved å oppdatere meldeskjemaet. Før du melder inn en endring, oppfordrer vi deg til å lese om hvilke type endringer det er nødvendig å melde: https://www.nsd.no/personverntjenester/fylle-ut-meldeskjema-for-personopplysninger/melde-endringer-i-meldeskjema Du må vente på svar fra oss før endringen gjennomføres.

OPPFØLGING AV PROSJEKTET
Personverntjenester vil følge opp ved planlagt avslutning for å avklare om behandlingen av personopplysningene er avsluttet.

Kontaktperson hos oss: Markus Celiussen
Lykke til med prosjektet!

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B ┃ Interview guide

Interview-guide

Unstructured and semi-structured interviews will be used. Predetermined questions are typically asked of each interviewee in a consistent order, but the interviews are permitted to probe far beyond their answers to our prepared and standardized questions. The flow of the conversation will eventually decide the order of asking questions.

Developer and/or maintainer of local DHIS2 instance:

- What is your role in the use/development/maintenance of DHIS2 in your country?

- What DHIS2 metadata packages have you implemented in your country?

- How has this package been modified to fit the existing metadata in your instance?

- What is your general impression of the WHO standard package initiative, and its value to your country's health data management

Regarding each package:

- What is your impression of the value your country receives from this package

- What if anything would you modify in the package

- What dashboards have been implemented?

DHIS2 users:

- What is your role in the department?
- How is DHIS2 related to your work?
- How often do you report to the system?
    - What type of data are you reporting?
    - How do you report it?
    - How is the data prepared for data entry?
- Do you have any challenges/issues regarding the system?
- Any improvements or new features you would like to suggest to make DHIS2 easier to use?

C | Informed consent

Are you interested in taking part in the research project "Country Impact of DHIS2 Metadata Packages"?

Purpose of the project
You are invited to participate in a master's thesis project where the main purpose is to examine the DHIS2 metadata package usage in Rwanda and Tanzania. The metadata packages have been an ongoing initiative to develop and provide ready-made content to DHIS2. The research questions that will be addressed are about how the metadata packages have contributed to more and better information use in the country, and how they shape and are shaped by the context in which they are deployed.

In collaboration with the Norwegian HISP Centre and local HISP groups, a group of students will try to uncover how, or if, metadata packages have contributed to more and better information use. We aim to explore the development, dissemination, implementation, and impact of these metadata packages in different countries. HISP can combine the findings from the different thesis into a collective case study. This way they can compare and learn from many cases, look at similarities and differences, and make out patterns.

Which institution is responsible for the research project?
The University of Oslo is responsible for the project (the data controller).

The project is led by the Norwegian HISP Centre, or the Health Information Systems Program, an interdisciplinary centre that promotes research and innovation in digital global health and related areas. In 2017 HISP UiO was designated as a WHO Collaboration Centre for Innovation and Implementation Research for strengthening health information systems. The metadata packages being researched in this project have been developed in cooperation with WHO.

Why are you being asked to participate?
You are asked because you are fitting the selection criteria, working with DHIS2 health information systems in your country.

What does participation involve for you?
Interview, observation, sound recordings
Participation involves taking part in unstructured or semi-structured interviews, and participant observation, where information will be recorded electronically through audio and written researcher notes.

Participation is voluntary
Participation in the project is voluntary. If you chose to participate, you can withdraw your consent at any time without giving a reason. All information about you will then be made anonymous. There will be no negative consequences for you if you chose not to participate or later decide to withdraw.

Your personal privacy – how we will store and use your personal data
We will only use your personal data for the purpose(s) specified here and we will process your personal data in accordance with data protection legislation (the GDPR).

- Only the master's student and the project leader will have access to your data
- Participants will not be recognizable in any publications
- Your name and contact details will be protected from unauthorized access by codes which will be stored separately from the rest of the collected data
- Participants may be mentioned by organizational role (e.g. developer, health worker) in the master's thesis
- Names, emails, or other identifiers will never be published

What will happen to your personal data at the end of the research project?
The planned end date of the project is June 15, 2023. All stored personal data along with recordings will be securely deleted at the end of the project. Only anonymized data might be stored after the master's thesis is published.

Your rights
So long as you can be identified in the collected data, you have the right to:
- access the personal data that is being processed about you
- request that your personal data is deleted
- request that incorrect personal data about you is corrected/rectified
- receive a copy of your personal data (data portability), and
- send a complaint to the Norwegian Data Protection Authority regarding the processing of your personal data

What gives us the right to process your personal data?
We will process your personal data based on your consent.

Based on an agreement with the University of Oslo, Data Protection Services has assessed that the processing of personal data in this project meets requirements in data protection legislation.

Where can I find out more?
If you have questions about the project, or want to exercise your rights, contact:
- The University of Oslo via Johan Ivar Sæbø, by email: (johansa@ifi.uio.no) or by telephone +47 22 84 08 95.
- Our Data Protection Officer: Roger Markgraf-Bye, by email: (personvernombud@uio.no) or by telephone +47 90 82 28 26.

If you have questions about how data protection has been assessed in this project, contact:
- Data Protection Services, by email: (personverntjenester@sikt.no) or by telephone: +47 53 21 15 00.

Yours sincerely,

Project Leader   Student
(Researcher/supervisor)

Consent form
I have received and understood information about the project **Country Impact of DHIS2 Metadata Packages** and have been given the opportunity to ask questions. I give consent:

- ☐ to participate in an interview
- ☐ to participate in participant observation
- ☐ for information about me to be published in a way that I might be recognized through my organizational role
- ☐ for my personal data to be stored until the end of the project

I give consent for my personal data to be processed until the end of the project.

(Signed by participant, date)