Managing scaling of HIS: Implementation of DHIS2 in Sudan

Master’s Thesis

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ABSTRACT
The purpose of this case study was to investigate the implementation and scaling of DHIS2 in Sudan. DHIS2 is a software package used for collecting, validating, analyzing and presenting health data. In this thesis I shed light on the challenges of implementing a routine health information system (HIS). Furthermore, I elaborated on the strategies used for facilitating a comprehensive and integrated national HIS. The empirical part of this study was conducted through fieldwork in Sudan between mid-October and mid-November 2014. The Federal Ministry of Health (FMOH) supported my involvement with the implementation.

The study used qualitative research methods, including semi-structured interviews, which I recorded on audiotape and later transcribed. In addition, I participated in meetings and training collected relevant documents for analysis, which helped me in mapping the health information situation in Sudan. Consequently, I was recruited because DHIS2 was requested in Arabic. Therefore, bringing me on helped considering my fluently and communication ability in Arabic. This is in turn, made me a middleman on the ground for communicating between the consultants and the FMOH, along with conducting my study.

Theoretically, I drew upon strategies for scaling HIS according to various measurements, such as data quality and completeness. Specifically, I elaborated on the health metrics network, a framework to support strengthening national HIS.

This study focuses on the scaling issues arising when implementing and integration HIS. On the basis of the results and findings of this study, it can be concluded that the HIS being fragmented and lacking resources. The first problem of fragmentation gave consequences of information sharing and finding information easily. The latter, demonstrates the influence on scaling when lacking local human capacity, short of funding and limited capacity building.

In addition, Sudan HIS benefits of implementing DHIS2 in matter of improving data quality and completeness. However, DHIS2 itself, or the technology, will not contribute in changing work routines and practices. Therefore, I argue that highlighting issues of resources, fragmentation, regular reporting and using the data gathered for analysis, contribute in scaling of DHIS2 in Sudan.
ACKNOWLEDGEMENTS

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# TABLE OF CONTENTS

1. INTRODUCTION

1.1 Research Background 2

1.2 Research Focus 3

1.3 Motivation 4

1.4 Structure of Thesis 5

1.5 Research Objectives 5

2. RELATED LITERATURE: UNDERSTANDING ROUTINE HIS 7

2.1 Routine Health Information Systems 7

2.1.1 Fragmentation 12

2.1.2 Achieving Interoperability 13

2.2 Hierarchy of Data Standards 15

3. THEORETICAL FRAMEWORK 17

3.1 Scaling of Health Information Systems 17

3.2 Strategies Central to Successful Scaling 21

4. BACKGROUND 23

4.1 Sudan - Country Profile 23

4.1.1 Socio-economic Profile 25

4.1.2 Structure of Health System 27

4.1.3 Current HIS in Sudan 28

4.2 Overview of Implementation Project 29

4.2.1 Project Development Approach 31

4.2.2 DSDM Methodology 33

4.2.3 Project Structuration 34

4.3 Summary 36

5. RESEARCH METHODOLOGY 37

5.1 Case Study as a Research Method 38

5.2 Data Collection Techniques 38

5.2.1 Field Work 39

5.2.2 Interviews 40

5.2.3 Document Analysis 40

5.2.4 Observation 41

5.2.5 Training 42
LIST OF TABLES

TABLE 1 REASONS FOR INCOMPLETE INFORMATION (Lippeveld, 2001) .................................................................9
TABLE 2 VERTICAL AND HORIZONTAL SCALING ..................................................................................................21
TABLE 3 RESPONSIBILITY STRUCTURE (FMOH, 2012; PID, 2013) .................................................................35
TABLE 4 DOCUMENT ANALYSIS ..........................................................................................................................41
TABLE 5 SUMMARY OF FINDINGS ........................................................................................................................62
TABLE 6 REVISED TABLE DESCRIBING VERTICAL AND HORIZONTAL SCALING ACCORDING TO SUDAN (ORIGINALLY FROM CHAPTER THREE) .........................................................................................80

LIST OF FIGURES

FIGURE 1 HMN FRAMEWORK COMPONENTS (FMOH, 2012) .............................................................................11
FIGURE 2 DATA COLLECTION IN SUDAN (FMOH, 2012) .........................................................................................12
FIGURE 3 THREE LEVELS OF ACHIEVING STANDARDIZATION AND INTEROPERABILITY (BRAA AND SAHAY, 2012) ........14
FIGURE 5 BALANCE BETWEEN THE DIMENSIONS OF SCALE (SHAW ET AL., 2007) .................................................20
FIGURE 6 SUDAN MAP (UN, 2015) ..........................................................................................................................24
FIGURE 8 PROJECT STRUCTURE (PID, 2013) ........................................................................................................32
FIGURE 9 DSDM PROCESS (PID, 2013) ..................................................................................................................33
FIGURE 10 PROJECT ORGANIZATION STRUCTURE (PID, 2013) ...........................................................................34
FIGURE 11 REVISED HIS REFORM STRATEGY (FMOH, 2012) ...............................................................................47
FIGURE 12 REVISED DATA FLOW (FROM SECTION 6.1) .........................................................................................68
FIGURE 13 REVISED FIGURE IN ACCORDANCE TO SUDAN SITUATION. ORIGINAL FIGURE BY SHAW ET AL. (2007) ....79
# ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tr>
<td>CPD</td>
<td>Continuing Professional Development</td>
</tr>
<tr>
<td>DHIS2</td>
<td>District Health Information System 2</td>
</tr>
<tr>
<td>EPI</td>
<td>Extended Program on Immunization</td>
</tr>
<tr>
<td>FMOH</td>
<td>Federal Ministry of Health</td>
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<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>GI</td>
<td>Global Infrastructures</td>
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<td>GIS</td>
<td>Geographical Information System</td>
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<td>HIS</td>
<td>Health Information System</td>
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<td>HISP</td>
<td>Health Information Systems Programme</td>
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<td>HIV</td>
<td>Human Immunodeficiency Virus</td>
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<td>HMN</td>
<td>Health Metrics Network</td>
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<tr>
<td>ICT</td>
<td>Information Communication Technology</td>
</tr>
<tr>
<td>IMCI</td>
<td>Integrated Management of Childhood Illness</td>
</tr>
<tr>
<td>MDG</td>
<td>Millennium Development Goals</td>
</tr>
<tr>
<td>MOH</td>
<td>Ministry of health</td>
</tr>
<tr>
<td>NGO</td>
<td>Non-Governmental Organization</td>
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<tr>
<td>NHIC</td>
<td>National Health Information Centre</td>
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<tr>
<td>OPD</td>
<td>Out Patient Data</td>
</tr>
<tr>
<td>PHC</td>
<td>Primary Health Care</td>
</tr>
<tr>
<td>PID</td>
<td>Project Initiation Document</td>
</tr>
<tr>
<td>RH</td>
<td>Reproductive Health</td>
</tr>
<tr>
<td>SMOH</td>
<td>State Ministry of Health</td>
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<td>TOT</td>
<td>Training of Trainers</td>
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<td>WHO</td>
<td>World Health Organization</td>
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1. Introduction

Good health information systems are crucial for addressing health challenges and improving health service delivery in developing countries (Abouzahr and Boerma, 2005). World Health Organization (WHO) considers the health information system (HIS) as one of the building block for the health system (WHO, 2014). The availability of valid, accurate, timely, reliable, and relevant health data and information is a key input for informed public health action and evidence-based health policies and decision-making (FMOH, 2012). However, many developing countries lag behind developed countries in the production, coordination, sharing and utilization of health information.

The health information system programme (HISP) is a global network of people, entities and organizations, which through the Department of Informatics at the University of Oslo developed a district health information system (DHIS2). DHIS2 includes reporting, analysis and dissemination of data for all health programs. This thesis is considered as part of the research group for Global Infrastructures (GI) at the Department of Informatics of the University of Oslo. Moreover, this thesis is based on a case study on implementing DHIS2 in Sudan, with a main goal to deliver a digital collection and data reporting system to meet the needs of Sudan Ministry of Health (MOH). DHIS2 is primarily intended to function on places of little or poor infrastructure. Most importantly, the DHIS2 is open source software that anyone could use. DHIS2, which has been implemented in over 40 countries, function as an integrated data warehouse for important health information, which is essential for proper action and decision-making.
This chapter presents a brief background of the reported research, within which the motivation, the problem context and questions are presented. The next section presents the document structure, before introducing the research objectives of the thesis.

1.1 Research background

Sudan is currently undergoing an infrastructure building process after the independence of South Sudan, as a result of referendum in 2011. The Sudan health information system have always had a reputation for being good and structured, dating back data collecting to 1902 in all health units serving the military troops during the invasion of Sudan. The Sudan HIS is one of the oldest health systems in the region, as the central unit for documenting annual reports started in 1921. As a consequence of this, the Federal Ministry of Health (FMOH) was founded in 1955. The FMOH had insights and updates of neighboring countries health status, thus early considering new outbreaks, on a weekly basis.

Sudan has a data-reporting rate of only around 30-40% from Primary health care (PHC) facilities (FMOH, 2012). This varies significantly between states, where some has 100% reporting rate, while other only have 10-15% reporting rate. This indicates issues in the infrastructure, not only in the inequity between states, but rather national wide. Moreover, another inequity is that Khartoum state has significantly more cadres than other states as some have only five cadres (ibid.). Not only are there issues in the national infrastructure, but also inequity in distribution of human resources and distribution of health staff.
1.2 Research focus

To start with, the research focus and scope was hard to narrow down to a specific research question. There have been several attempts to initiate a specific area to research. First, there was an inquiry from Iraq on implementing DHIS2 to strengthening their national health information system. Considering that the country has been through diverse wars the last four or five decades, Iraq’s infrastructure is unbearable in matter of both health and political situation. Therefore, they saw this as an opportunity to boost their health situation and mapping in the country. Sadly, the ongoing security issues had a huge impact on the project, and resulted in suspending the project I was recruited in. Followed by these circumstances, there was a request on helping Turkey, more specifically southern part of Gaziantep, with mapping the Syrian refugees fleeing to their border because of security issues. In December 2014, it was reported that there were over 1.6 million Syrian refugees in Turkey (UNICEF, 2015). Sadly, the reason of shortage in funds from external actors and donors suspended the project. Consequently, the recruitments from both Iraq and Turkey came as a consequence of that DHIS2 was requested in Arabic. Therefore, bringing me on helped, considering my fluently and communication ability in Arabic.

Finally, there was a legit request from FMOH of Sudan in collaboration with an international development consulting firm located in Switzerland, on helping the Sudanese government on implementing DHIS2 across their 18 states, this to have a system specially designed to assist in the management and planning of efficient evidence-based decision-making to gain better health in Sudan. As mentioned earlier, my communication abilities in Arabic gave me the opportunity to participate and understand the HIS in Sudan.
This is in turn, made me a middleman on the ground for communicating between the consultants and the FMOH, along with conducting my research. It is noteworthy to have in mind that Sudan introduces DHIS2 into their health system as the first Arabic-speaking country in the world. Consequently, this introduces new name conventions and issues of naming data elements. In addition to being middleman, my contribution dealt with helping translating training material to Arabic.

1.3 Motivation

As I get this opportunity of contributing in making the health situation in a developing country better, and in particular Sudan, is an motivation in it self for me personally. I intend to do this by investigating the current health information system along with doing in-depth study and analysis of the findings.

During my stay on my first field trip in Khartoum, one health information officer from the FMOH said to me:

“Sudan need to strengthen its health system and give opportunity to talent so they can help and be a resource to all mothers and children”.

She continued explaining to me that:

“You should use your talent and knowledge to improve the quality of care that mothers and children receive here in Sudan. By doing this, at the very least, you will honor those of Sudan who died earlier than they should have.”

This left a huge impression on me, giving me a boost in motivation in each of the interviews and observations I had during my stay. While being aware that there are
limited resources regarding this study, I decided to contribute as much as I can in the implementation of DHIS2 in Sudan.

1.4 Structure of thesis

Following this chapter of brief introduction, the thesis is structured as follows. The second chapter gives a presentation of relevant literature and concepts used. In chapter three, I start with Sudan’s HIS background and introduce the case description. The fourth chapter gives an overview of the methodological approach and methods for collecting and analyzing data used in my thesis. My findings and analysis will be presented in chapter five. Further, I discuss my findings in chapter six. Finally, I give my conclusion remarks along with potentially future work in chapter seven.

1.5 Research objectives

In light of issues stated above, I aim to explain my overall research objective in this section. While working closely with and in cooperation with the implementation team and the technical assistance team, I will try to elaborate the following objective:

- Contributing while studying the implementation and integration of DHIS2 in the case of Sudan, while looking at challenges, which may occur in the implementation phase(s).

To concretize the above research objective and to approach this from the right angle, I will shed light and elaborate on two research questions.
• What are the challenges of implementing a routine health information system in Sudan?

• What scaling strategies are used to facilitate comprehensive and integrated routine health information systems in Sudan?

To answer the following research questions, I will relate the empirical findings in Sudan to relevant literature. The relevant literature and concepts, which will be used, are presented in the following chapter.
2. Related literature: Understanding Routine HIS

This chapter presents relevant literature for my thesis. First, I describe routine health information systems, regarding data collection routines. Furthermore, I focus on the health metrics network, a global initiative to support strengthening national HIS (Braa et al., 2007). In the second section, I will present literature about fragmentation, after that I touch upon achieving interoperability. Finally, I will focus on the approach of hierarchy of standards that elaborates on information needs and standards of each level in a health system, thus basing data collection on information needed for action (ibid.).

2.1 Routine health information systems

According to Lippeveld (2001), the main cause of weak linkage between individual care and public health systems is the poor use of information for evidence-based decision-making. Braa and Hedberg (2000) argue that routine health information systems are intended to provide useful information for decision-making, surveillance, and statistics. Furthermore, Lippeveld (2001) argues that: "Routine health information systems have the major role of facilitating integration between individual health and public health interventions". Linking this to Sudan, and according to FMOH (2012), the data-reporting rate from PHC facilities is less than 30%. Lippeveld (2001) argues that routine health information systems are inadequate to provide necessary information to support the integration of the two interventions, individual and public health.
Furthermore, he states that data. Following this, Lippeveld (2001) mentions two strategies to improve the use of routine health information:

- Decentralization of information management
- Manage the restructuring process

First, decentralization of information management is important toward the district level because they are the ones actually collecting the data. Lippeveld (ibid) emphasizes that the linkage of routine and nonroutine data collection happens at this level, implying that when data collection methods are changed, it effective of facilitation aggregated data to higher levels. Second, carefully manage the routine health information system restructuring process. In most cases, routine health information systems are implemented in complex and resistant environment. Therefore, Lippeveld (ibid.) suggests emphasizing on leadership building and consensus building, this by involving key actors early in the process. The latter can be useful in training and during implementation of routine health information systems.

Lippeveld and Sauerborn (2000) explains that, the level of quality data from routine information systems is questionable and should be weighed against other means of data collections, especially in developing countries. According to Lippeveld (2001) routine health information systems in most countries provide incomplete information necessary to individual care and public health activities. Furthermore, he mentions four reasons for this:
The data on individual health care activities are irrelevant and of poor quality, frequently data is excluded and the focus tends to be on disease reporting. Reasons for this are lack of consensus between users of the data and the data collection staff.

<table>
<thead>
<tr>
<th>Irrelevant and poor quality of data</th>
<th>Mostly, the information on health care interventions is not linked to a reference population, causing inaccurate population denominator that prevents identifying underserved populations and utilizing the needs for the population.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information not linked to reference population</td>
<td>By providing outdated information from district levels, the planners and managers in higher levels face issues in decision-making. This causes information system management to often be heavily centralized, because data processing and analyzing slow down the feedback to lower levels.</td>
</tr>
<tr>
<td>Centralized information management</td>
<td>Health information system infrastructure is inadequate in most developing countries, lacking essential equipment like forms for data collection and electricity supply.</td>
</tr>
<tr>
<td>Poor health information system infrastructure</td>
<td></td>
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</table>

Table 1 Reasons for incomplete information (Lippeveld, 2001)
Data are transferred among interdependent actors. However, in order to ensure accurate administrative, political, and management decision, this has to be based on the best available information (Lippeveld and Sauerborn, 2000). Furthermore, they emphasize the important dimensions of data quality, which is further described in four dimensions:

- **Relevance**
- **Completeness**
- **Timeliness**
- **Accuracy**

Relevance is achieved by comparing data collected against the management information needs. Completeness is measured in two ways; (1) by making sure filling in all data elements in the facility report form, and (2) the percentage of facilities reporting in a province or district. Timeliness is normally assessed by comparing date of when report were submitted and by the previously agreed upon final deadline.

Finally, accuracy can be measured in two ways. One way, is by comparing data between facility records and reports, and secondly, a comparison between facility reports and administrative area databases. Lippeveld and Sauerborn (2000) argue that users must feel ownership to the data and trust its validity, and it must be aggregated and customized.

The Health Metrics Network framework, or HMN, was created in purpose of strengthening HIS in developing countries and information use (WHO, 2008). There are two main reasons for the establishment of HMN. First, and as (AbouZahr and Boerma,
2005) explains, that there seems to be a considerable consensus on the need for consolidation, integration and collaboration in health information systems globally. Secondly, the need for using a country data warehouses to approach health information system integration (Sæbø, 2013). The establishment of the HMN can be seen as a direct consequence of these needs. Furthermore, the HMN describes its “data warehouse” as a place where aggregated data from sub-systems get collected and integrated and made accessible in a national data centre. Later the “data warehouse” got changed to “data repository”, simply to not intimidate users with little knowledge of this area, which sometimes gets confused and describe it as a database.

![Figure 1 HMN framework components (FMOH, 2012)](image)

The HMN framework consists of six components, which describes the standards needed for a successful HIS. These six components are further divided into three subgroups; (1) inputs, (2) processes and (3) outputs. Inputs touch upon the resources for HIS, and are crucial prerequisite for a HIS to be functional. Furthermore, resources, addresses issues of planning and coordination along with handling with financial-and human resources. The latter is highly relevant, as it elaborates on training and capacity building.
The second subgroup explains the *processes*, which addresses on how indicators and data sources are selected, and when selected; how data is collected and then managed. Data source collection is further divided into two categories, as illustrated in the figure below:

![Diagram showing categories of data collection]

The information produce the *outputs*. Consequently, outputs should be relevant, accessible, and useful, this in order to be basis of evidence-based decision-making (WHO, 2008).

### 2.1.1 Fragmentation

Fragmentation and lack of coordination of health information systems is a major cause of providing quality information. This information is normally used to improve decision-making in the health sector (Braa and Sahay, 2012). Fragmentation is reduced through integration.
Shaw (2005) agrees, but advocates and says that vertical programs occur when managers of health programs demand information, without taking other health programs in consideration. Involvement of different vertical health programs, when not satisfied with the national HIS, leads to further fragmentation (Braa et al., 2007). Shidende (2005) argues that fragmentation results in lack of information sharing, duplication of workflow and data, poor use of information and presents a severe bottleneck in health care service provision. Sæbø (2013) adds to this and argues that because of inherent fragmentation, the different health programs develop its own data collection routines independently, which leads to duplication.

Lack of policy frameworks helps in looking at different aspects of fragmentation. However, (Kimaro and Twaakyondo, 2005) explains that this makes it difficult for health managers to put emphasize on the use of information, along with dealing with human resources issues. Sæbø (2013) argues that changing the culture of information use is a long-term process.

2.1.2 Achieving interoperability

Drawing upon Carlile’s (2004) strategy for standardization at several levels, Braa and Sahay (2012) describe how one can manage interoperability the best way. Standardization takes place in everyday practice and is the backbone for integration and interoperability (ibid). Interoperability is the ability to exchange data between systems. In contrast, when considering integration there is some sharing of data between the systems without the use of standards. Both, integration and interoperability builds on the use of standards (Braa and Sahay, 2012).
The problem of achieving interoperability is divided into three levels; pragmatic, semantic, and syntactic level. Korvald (2013) explains that de facto of this pyramid model is the increasing complexity and different viewpoints from the bottom level, the syntactic level, to the top level – the pragmatic level.

Starting from the bottom at the syntactic level, which involves technical functionality and issues, the complexity is relatively small. The semantic level has insights in shared data definitions and indicators that lead to increasing complexity along with differences in views among the programs. In contrast from the bottom level, the pragmatic or organizational level introduces standardizations complications, as the different programs or agencies struggle to agree as they always favor their own views and interests (Braa and Sahay, 2012).
By sharing the same interests, the earlier mentioned actors have to share meanings as well. Agreement is required to share data and control of data and the information (ibid).

2.2 Hierarchy of data standards

The idea of the hierarchy of standards model is that the lower levels collect the data that is required, as earlier mentioned, based on a minimal data set (Braa et al., 2007). However, the facilities can also add the data that are relevant for their own use (Thorseng, 2008). The focus on information needs to vary with the different level of administration in the hierarchy (Braa and Sahay, 2012). In other words, both the higher levels, e.g. district level, and the health facilities gain from this by preventing collection of irrelevant and unnecessary data being transferred up to the higher levels. Braa and Hedberg (2002) argues that inscribing flexible standards in the software used for an HIS allows a “hierarchy of standards” to ensure flexibility and demanded information of all levels.

Figure 4 Hierarchy of standards (Shaw, 2005)
Furthermore, Braa and Sahay (2012), implies the models as a bottom-up approach, saying that the lower level require most disaggregated data, while on the other hand, the higher levels require more aggregated data. The hierarchy of standards model emphasizes that flexibility is established by allowing for “freedom” in the horizontally axe which represents the earlier mentioned “essential data sets”. However, it is crucial that the vertical standards are maintained as well (Braa and Sahay, 2012). Furthermore, Braa et al., (2007) explains that normally a case is built around the use of flexible standards as attractors. In other words, this means that if the standards are well defined and simple, that will play a huge role in how they adapt to the frequent changes that can be experienced in a health environment.
3. Theoretical Framework

This chapter presents the theories for my thesis. Thus, intended to be used in a theoretical framework to use in analyzing my empirical findings. First, I will give a short description of scaling health information systems in general, and more specifically that scaling addresses heterogeneous network, which consists both of social and technical aspects. In the second section, I touch upon strategies central to successful scaling. Finally, I will focus on the three flexible standards crucial for scaling HIS.

3.1 Scaling of health information systems

Successful scaling-up requires the systematic use of evidence to guide the process and incorporate new learning (Simmons et al., 2007). According to Sahay and Walsham (2006), scale does not only concern the size or scope of an information system or a process. But also considering the same information or process in another setting and then expanded, the latter which describes incorporating with other settings. Here we have to distinguish between scale and scaling. The first refers to the earlier mentioned size and scope, while scaling could imply the expansion of a system, or a process (ibid). Sæbø (2013) argues that any change to a system’s extent or use will contribute to a change of scale. Furthermore, several authors emphasizes that scaling takes place on multiple dimension; system functionality and complexity, user maturity and learning processes including adapting to new contexts (Sahay and Walsham, 2006; Sahay et al., 2013). Sahay and Walsham (2006) argue further that the focus should include dealing with social issues, giving human resources capacity as a brief example of enhancing the scope. Scaling is thus addressing questions in expansion within other contexts.
Therefore, scaling is not only a technical question, but also rather a scaling of a heterogeneous network, which consists both of social and technical aspects (Braa et al., 1995; Thorseng, 2008). Latour (1999) helps in giving a perspective by using an example of airlines and says: “airplanes do not fly, airlines do”. In terms of involving different actors, the example explains, that in order to fly an airplane, you need more than a pilot, emphasizing the need for involvement of different actors, such as pilots, runway staff, air-traffic-control towers etc. These actors are inter-connected and create a heterogeneous socio-technical network. This heterogeneous and complex network requires scaling, which is not just a technical or economic issue (Sahay and Walsham 2006).

Braa and Sahay (2012) argues that scaling of HIS can retains its flexibility to other contexts, and explains that scaling takes place in different dimensions, by seeing this along two axis. The first axis describes the vertical scaling, and the second axis describes the horizontal scaling. Vertical scaling is associated with different granularities of data and information needs. According to Braa et al., (2007), vertical scaling is the main cause of fragmentation, implying that reasons for this is inconsistencies in definitions and procedures as data gathering creates this. On the other axis, we have the horizontal scaling, which refers to the scope of services (Braa and Sahay, 2012).
This includes for instance the geographical coverage, the functional areas, and new health programs. Braa et al. (2007) argues that one should respect historical influences in horizontal scaling and incorporate this in the scaling process.

Based on Latour’s (1999) concept of circulation (Sæbø, 2013), Sahay et al. (2013) introduces three key concepts of global scaling. The first concept concerns multi-dimensionality, which signifies the different phases that scaling encompasses. The second concept, non-linearity, describe scaling of an HIS, thus the irregularities in both expansion and growth. The third concept emphasizes the translation of how scaling takes place. Notion of this is the constantly changing socio-technical configurations, which is the base for shaping the process of scaling. Sæbø (2013) emphasizes that this translation is crucial for local adaption to fit the new context, while further explaining that this is an action of unanticipated users’ use of a technology. Like, Latour (1999), Sahay et al. (2013) argue that, in order to understand the concept of “circulating translation” we have to distinguish between the relation of what exists and what is left behind as a part of a scaling process. The notion is the outcome of a scaling process, which in this case is the learning process. Shaw et al. (2007) suggests three strategies for successful scaling of health information systems, as illustrated in the figure below.
Figure 5 Balance between the dimensions of scale (Shaw et al., 2007)

First, they highlight mindfulness in order to balance available human resources, building upon a flexibly strategy as earlier mentioned by Braa et al. (2007). Second, to have access to technology in order to increase efficiency of data use. Finally, the volume of data collected has to be taken into consideration because it’s beneficial for use for better evidence-based decision-making and strengthening the health information system (Lippeveld 2001; Shaw et al., 2007).
The table above summarizes the dimensions and forms of scaling according to the different authors, as mentioned earlier in this chapter. The dimensions, vertical and horizontal, describe the type of scaling that takes place. The authors argue that horizontal scaling should address the issue of scaling geographically, thus adapting to new contexts in a rapid and changing environment. Moreover, vertical scaling concerns users knowledge and different types of users. In addition to this Sæbø (2013) elaborates further on that user maturity is across different levels of the HIS infrastructure. Braa and Sahay (2012) emphasize the focus on data collection procedures as crucial for successfully scaling HIS.

### 3.2 Strategies central to successful scaling

In order for successful scaling of health information system, the approach has to be incremental, by taking small steps while always having in mind flexibility and change (Sahay and Walsham, 2006; Braa et al., 2007). However, there are three flexible standards that are identified as being critical to the scaling of health information systems. According to Shaw et al. (2007) these are:
• Essential data sets
• Technical level
• Cultivation process

The first is the concepts of essential data sets. This concept takes into consideration an essential set of data, which is identified and agreed upon at the national level to be collected by every level of the health system. Furthermore, by giving the lower levels flexibility to actually add data elements for their own local needs, this increases the degree of flexibility (Braa et al., 2002; Braa et al., 2007). The second concepts are in the technical level, and represent the scalable process of information collection. Notion of this level is creating a gateway between the new digital system and old paper-based system, working to interface each level in the hierarchy (Shaw et al., 2007). A gateway can be seen as a link between different elements (Hanseth 2002).

Finally, the third level is the cultivation process that includes various ways to develop and facilitate increased use of information (Braa and Hedberg, 2002). In contrast to this, Shaw et al. (2007) elaborate this and argues that for HIS to have a successful scaling, it has to be accompanied by a local cultivation process that balances the spheres. Furthermore, they (ibid.) explain that this involves the volume of data, human capacity, and access to technology. On the other hand, Braa and Sahay (2012) emphasize the importance to develop flexible standards as they contribute to sustainability of health information systems. The next section addresses the hierarchy of standards and its characteristics.
4. Background

This chapter presents the setting where I conducted my research and found the main issues. The first section of part one explains the country profile of Sudan. Further, I give a brief introduction of the socio-economic profile. The third section explains the structure of the three level health system of Sudan.

The second part elaborates on the implementation project I participated in. The first section in part two includes scope and prerequisites of the project. Then, I explain the project structuration. Finally, I give a brief of the methodology in the project, before I give a summary of the background chapter.

4.1 Sudan - country profile

Sudan is the third largest country in Africa, covering an area of 1.9 million km². Sudan consists of 18 states (*Wilayaat in Arabic*) each divided into localities (*Mahaliyaat in Arabic*). As a starting point, 8 of the states will be used in the training of the trainers, and then later, the last 10 states will be evaluated. The northern part of Sudan is an extension of Sahara desert, while the central part is a dry area; the southern part has a tropical rainforest climate. The population of Sudan is approximately 34.1 million people in 2012, of these, 68% live in rural areas (Global Fund, 2012).
Sudan is considered as lower-middle income country, as 47% of the population is living below the poverty line. Sudan’s GDP was US $63 billion in 2014. GDP, or gross domestic product, “measures the value of all final goods and services produced in a country over a given period” (A-Rahman and Jacquet, 2013). In other words, the GDP measures the size of the economy of a given country.

Figure 6 Sudan map (UN, 2015)

4.1.1 Socio-economic profile

In addition to high burden of disease from inadequate water, sanitation and hygiene in low- and middle-income settings, Sudan is victim to both natural-and manmade diseases (Prüss-Ustün et al., 2014). According to Global Fund, the burden of communicable diseases such as tuberculosis, malaria, and HIV are the main causes for morbidity and mortality in Sudan. In addition to this, there have been several outbreaks, civil conflicts and generally poor conditions in rural areas, which have contributed in increased urbanization in the country.

Although 65% of all funding in Sudan is from private sources, the health service delivery system is provided by both non-profit and profit providers. In most of the conflict-affected areas the non-governmental organizations (NGOs) have played a huge role, by providing health service delivery.

Sudan has been through several civil wars in the southern and eastern areas. This ethnicity and cultural difficulties has affected the health situation in Sudan. As a result of a referendum in January 2011, Sudan separated from the now-named South Sudan. After this, there has been a process of stabilizing its socio-economic status, while there is still conflict in states such as Darfur, South Kordofan, and Blue Nile (WHO, 2014). These unstable and difficult conditions have contributed Sudan to suffer of poor economy, with a fall in oil prices along with loosing important oil resources in the South. In addition, there are continuing sanctions and trade embargo against the government of Sudan. Generally, the health sector infrastructure in Sudan has been severely damaged by the impact of the civil war in Southern Sudan.
Sudan has made progress towards the Millennium Development Goals (MDG), with reduction in child mortality by 30% and reduction in maternal mortality by 60%, in the last 20 years. In terms of MGD, it is a globally agreed development agenda, which is monitored through reports. The MDG poses a prerequisite to achieve stability in Sudan. Stability is achieved when eliminating problems such as inadequate allocation of funding, the low literacy level in the country, and inadequate implementation of infrastructure services in Sudan. However, and according to UN (2013), Sudan will not be able to reach the MDG for 2015. The delay is mainly due to the long civil war the country has experienced.
4.1.2 Structure of health system

Sudan health system is divided into a multi-tier network: federal, state and locality. First level, federal, where I did most of my research, with key responsibilities such as development of national health policies, plans and strategies, overall monitoring and evaluation health system activities in Sudan. The State Ministries of Health (SMOH) are responsible for formulating policies along with following federal guidelines from federal level for elaborating plans and strategies. Moreover, SMOH are responsible for planning of funding and implementations, besides of having rural hospitals under their management. Finally, the third level is the locality level. Locality level is mainly responsible for data gathering, data collection, and data processing as different partners and programs provide health services. It is in the locality level that implementation of the national and state policies and service delivery happens. In addition to this, other partners provide the health services as well. The central actors in health service delivery are the armed forces, universities, the private sector and civil society. The private sector involves profit and non-profit organizations. Many of these actors operate in silos, which further results in fragmentation, bad coordination and poor guidance.

The overall condition of the structure of the health system in Sudan is poor, as there are different levels of rigidity in different levels. Moreover, lack of coordination and structural ground rules between the departments, play a huge role in successfully structuring the health system. As a consequence of this, Sudan experiences the shortage of health personnel along with lack of human resources. In view of resources, they are not equally distributed as there are gaps between the different health facilities in the country, were some areas and communities are underserved.
The organizational structure is described as “inequitable distrusted, low quality, poorly planned and ineffectively managed” (FMOH, 2012).

4.1.3 Current HIS in Sudan

The current health information system in Sudan is paper-based and fragmented. The aggregated data flows between the levels, from the health facilities in the bottom to the top national level. Mostly, the limitations of this system are a result of detailed data getting lost on its way up to the top national level. The written information from the lower levels is normally difficult to read, and the timeliness of data is normally associated with delays.

![Figure 7 Current HIS in Sudan (FMOH, 2012)]
As Streveler (2011) explains in his plan to modernize the HIS in Sudan, that the problem of manipulation of data can happen in each movement of the data upwards the hierarchy. Furthermore, he elaborates on the “detail data” that is lost when aggregated, resulting in difficulties when demand for data analysis is required from higher levels. Seen on the basis of this obstacle, the lack of adequate feedback back down to the chain and absence of comprehensive basis for decision-making, are some examples of the characterizations when addressing the current paper-based health information system in Sudan.

4.2 Overview of implementation project

The project initiation came as a request from the FMOH in Sudan for creating a project for digitizing its Health Management Information System (HMIS). As mentioned earlier, given my background and the ability to communicate in Arabic, in addition to reading and writing, was highly relevant to this project. I was involved in parts of the implementation project, more particularly the translation of various data sets and supporting of overall DHIS2 understanding.

In order to be aware of the project goals and development, there were main objectives that had to be addressed beforehand. The main objectives of the project work are (PID, 2013):

- Improve accessibility to timely, relevant health information to users across the FMOH.
- Provide a robust, scalable Data Warehouse platform, supporting fast, flexible access to data from multiple sources unconstrained by the format of data source.
• Increase the quality of and coverage of routine data collected across the health system.

• Increase the scope of data available to users at all levels of the health system through the Data Warehouse and HMIS platform(s).

The digital HMIS and HDW will support the following key goals for the FMOH (PID, 2013):

• The provision of easy to use reporting tools to programme managers, monitoring and evaluation officers and other users.

• The flexibility to meet emerging federal reporting requirements of both the FMOH and other national or international partners.

• The integration of information held on various data systems across the FMOH and elsewhere (e.g. population data, surveillance inputs, tracking data for special programs, human resource data, financial data etc.).

• The improvement of data quality (e.g. through elimination of layers of manual aggregation at State and Federal levels).

• The automation of recurring reports.

The project scope is to achieve a robust, customized data collection and reporting platform to meet the needs of an HMIS and a federal level. In addition to donors such as Global Fund, the project requires involvement from FMOH and WHO country office, and the technical assistance team. The main purpose of this is to achieve close collaboration and coordination among the involved actors in the project.
4.2.1 Project development approach

The project development approach, “time-box” approach is used for ensuring most efficient use of available resources. A time-box is a fixed length of time, which is agreed upon for a given unit of work\(^2\). As figure 8 illustrates, the project will run over four stages in a time-box approach, and while there is some flexibility in the allocation of resources, the total time will be within the limits proposed following this structure:

\(^2\) [http://www.dsdm.org/content/13-timeboxing](http://www.dsdm.org/content/13-timeboxing)
Figure 8 Project structure (PID, 2013)
4.2.2 DSDM Methodology

Dynamic systems development methodology, or DSDM methodology, implies focusing on delivery of business requirements, rather than focusing on delivering IT and code. Regarding the benefits of DSDM, the predefined strategic goals and focus upon each delivery makes the roadmap clear both for business side and end-users. Moreover, the DSDM creates quality systems that are fit for purpose.

**Figure 9 DSDM Process (PID, 2013)**

Requirements are prioritized and development is split into a number of “time-boxes”. Each and every one of the time-boxes has an agreed set of requirements that is delivered within a period. On the other hand, the DSDM approach creates ownership to the implemented digital system, as the involvement of FMOH is throughout the whole process. Functionality and progress of project is reviewed jointly, along with always adjusting according to earlier delivery in previous time-box.
4.2.3 Project structuration

The core project team consists of people from FMOH the suppliers’ side. I was part of the initiated team for helping with this customization and implementation of DHIS2. The team is organized in four sub-groups as follows:

Figure 10 Project organization structure (PID, 2013)

This project requires two project managers. The two project managers, one from FMOH and one the supplier of the technical assistance, have the overall responsibility for the implementation of DHIS2 in Sudan. The FMOH project manager is responsible for the accomplishment of the project, along with providing the team with support, this in matter of guidance and resources.

The supplier project manager is responsible for reporting on a regular basis to FMOH project manager on status and progress of the project. This includes all deliverables and especially after each “time-box” stage. Team members can participate and contribute in more than one sub-group, and their responsibilities are structured as follows:
<table>
<thead>
<tr>
<th>Group/Sub-group</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core team</td>
<td>To ensure that the project is delivered according to the project plan. Report, coordinate and take actions throughout the implementation Ensuring the knowledge-transfer happens from FMOH to supplier Maintain an active issue log, and have a continuous dialog with supplier.</td>
</tr>
<tr>
<td>Data structure</td>
<td>Examine national health indicators and data elements, by mapping the linkage between them Ensure naming conventions for data elements are valid. Determine the health facility hierarchy, this to prepare the GIS module with its boundaries and layers for states and localities</td>
</tr>
<tr>
<td>Reporting</td>
<td>Help determine key standard reports, based on the work done by the data structure sub-group. The standard reports and dashboards are for all the health programs, but might be prioritized.</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>Ensure of installing of server infrastructure for hosting DHIS2. The plan is to use the national data centre. Ensure connectivity and computer equipment in the training sessions. Later updating connectivity at all the localities.</td>
</tr>
<tr>
<td>Training/Roll-out</td>
<td>Make sure for preparing the TOT events, both for state and national level. Resourcing and training data entry and reporting staff at state and national level. Planning and initiating the pilot projects.</td>
</tr>
</tbody>
</table>

*Table 3 Responsibility structure (FMOH, 2012; PID, 2013)*
4.3 Summary

This chapter presents research setting where I conducted my research. The chapter is divided into two parts. I start the first part by giving an introduction of Sudan’s country profile, both the demographic and the socio-economic profile. Then I gave a brief introduction of the structure of the HIS along with the current status of todays health information system in Sudan. Finally, in part two, I introduced the implementation project and the different actors involved.
5. Research Methodology

In this chapter, I will discuss the methodology used for obtaining data in my thesis. Most of the data collection took place in Sudan in mid-October to mid-November 2014. The method used for collecting evidence is case study with participant-observation. Yin (2013) includes participant-observation when describing the six principles of sources when collecting evidence to case study. The quality increases by incorporating participant-observation with sources such as documents, archival records, interviews, direct observation, and physical artifacts into a case study. One typical issue of participant-observation says Yin (2013), is the fact that bias can occur due to participant-observer's manipulation of events. Silverman (1998) argues that it is not how people see things, but rather how they do things, and this results in more valid findings. Subsequently, Silverman (2004) explains the aim for achieving more valid findings, thus primarily by thinking critically about qualitative data analysis.

According to my observations, the health staff is really ambitious and excited about DHIS2, and its contributions to their overall health system. Therefore, and drawing upon this, it is important to experience the reality of the potential issues regarding scaling of health information systems in Sudan. I will elaborate on the latter in the coming section.
5.1 Case study as a research method

According to Iacono et al. (2009), a case study is a research strategy, which focuses on understanding a phenomenon within its natural setting. Yin (2003) approves this and argues that generally a case study is an empirical inquiry when it’s:

- Investigating a contemporary phenomenon, in its real-life context
- The line between phenomenon and context are not clearly evident and,
- More than one source of evidence is used.

Furthermore, he states that the mentioned principles help deal with problems of composed or fabricated validity and reliability. Baxter and Jack (2008) add to this, and say that case study research enables the researcher to answer “how” and “why” type questions. In addition to this, case study takes into consideration how the phenomenon is predominated by its context. As for critics associated with case study, there is a weakness when it comes to researchers attempt to answer a question that is too broad (ibid), resulting in lack of quality data and evidence for the case study (Yin, 2013). To answer this critics, Farquhar (2012) argues that one should be able tell people what their research is about in a single sentence.

5.2 Data collection techniques

I will in this section explain the several data collection techniques used in my thesis. As a starting point, I wanted to have a flexible strategy for data collection, hence the fast change of circumstances and potential opportunities.
Despite this, I decided beforehand to set some goals for my data collection during my field trip to Sudan, both when it comes to observing and participating in training. I also wanted to collect some memories throughout my stay in Sudan and take several photos, which will be added in this thesis. In addition to this, I wrote a daily diary of my observations and thoughts. This helped my to keep track during my stay.

According to Silverman (2004), it is crucial to use a combination of different data collection methods, this in order to maintain data validity. Yin (2013) argues that case study findings is more convincing if based on several different sources of information. Building upon this, I study data from different sources that were gathered through fieldwork, interviewing, document analysis, observation and training. I will now elaborate on each of the data collection methods used.

**5.2.1 Field work**

The study was conducted in Khartoum, Sudan form mid-October to mid-November in 2014. My field trip to Sudan lasted for 4 weeks, which gave me enough time to try and investigate and answer my different questions I had before the trip. The main focus was to work with the National Health Information Centre team with customization of the forms and participate in the training of the trainers. Other than that, I wanted to have a flexible strategy on which data to collect and what to investigate.

Prior to the field visit I did a search of the HIS and the health situation in Sudan. Yin (2013) explains that, an Internet search can produce invaluable information.
My main work in Sudan started out with the customization of DHIS2, where I prepared many of the forms and translated them to Arabic. It was planned that I did this two weeks before the other consultants arrived to the country to help with the training, as was their main task. The other consultants had a previous visit to Sudan in November 2013, in order to introduce talks on the project and formulate task list for the coming year.

5.2.2 Interviews

The interviews were helpful in mapping the health situation in Sudan, especially seeing it from different angels. I interviewed a technical health advisor from the National Health Information Centre (NHIC), which had been working there for more than 10 years. According to Yin (2013), such interviewees can provide shortcuts to the prior history and help identify relevant sources of evidence. I also had some semi-formal interviews with other team members from the NHIC, which I recorded and later transcribed. All the interviews were in Arabic, in order to use it in my thesis I had to translate while transcribing these. I also used my fellow consultants as a source, and asked them some questions as well, as I was new to the project. The consultants in my team are DHIS2 experts; head of HMIS in Zanzibar and head of HMIS in Rwanda.

5.2.3 Document analysis

Most of the documents gathered were through NHIC team, as they had the main responsibility for accumulating the strategy documents and manuals. My fellow consultant and project manager shared a Dropbox with me containing background documents for the initiated project and the overall structural details for the project. Below is a table listing all documents including a short description and release year.
### Table 4 Document analysis

<table>
<thead>
<tr>
<th>Actors</th>
<th>Name of document</th>
<th>Year</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMOH</td>
<td>HIS reform strategy in Sudan 2012-2016</td>
<td>2011</td>
<td>Brief situational analysis on current HIS in Sudan, along with main issues and challenges.</td>
</tr>
<tr>
<td>FMOH</td>
<td>Sudan Health Sector Strategic plan 2012-2016</td>
<td>2012</td>
<td>Overview of health system status, including strategic and priority directions. Emphasizes the evaluation and monitoring process.</td>
</tr>
<tr>
<td>Assistance team</td>
<td>Sudan DHIS2 TOT Manual</td>
<td>2014</td>
<td>Provides the participants with a detailed guide on how to navigate DHIS and access its features</td>
</tr>
</tbody>
</table>

Other documents made available to me were documents such as data entry forms from different health programs, along with old and new forms for out patient data (OPD). In view of document analysis, Yin (2013) argues that the most crucial use with documents is to corroborate and augment evidence from other sources. Mostly, the old and new OPD forms were used for comparing issues and irrelevant data, which was gathered.

### 5.2.4 Observation

The observation I made was mainly seeing the participants use the new and old system, but also observing the NHIC team when we were working on DHIS2 customization. In addition to this, I participated in training of the trainers in paper forms where the representatives from the states and health programs gave their input on each new data entry form.
The NHIC teams were the ones who introduced the new forms over projector. During the presentation, a lot of questions and interesting discussions took place. The observation took place of the “case” or in the natural setting, thus giving the opportunity for direct observation (Yin, 2013). The motivation and the ambitions of the participants were surprising, sometimes so much that they talked past each other.

Regarding other meetings I attended, I also participated in WHO meetings at the office to map the situation, along with debriefing the WHO representatives on current status of the project. We also debriefed Officer-in-Charge (1) the last day of our stay in Sudan.

5.2.5 Training

There were two primary courses of training. The same participants attended both training courses. First, the introduction to the new paper forms. Further, the training and introduction of DHIS2 software. During the training on DHIS2, I helped the other consultants to facilitate training materials, this included USB with video guides handed to the participants of the training, along with a 20 pages guide with screenshots of basic user cases. Other than that, I helped in translation from English to Arabic of some of what the consultants said to the participants of the training. After that, we went around and helped the participants in the tasks they were given. This included some basic computer support and software updates for the participants.
5.3 Summary

To answer my research questions regarding scaling of health information systems in developing countries, a case study approach seems appropriate. The research project has been conducted through various ethnographic methods such as observation and participation as well as through interviews and document analysis. This strengthens the choice of research method used in this thesis, as mentioned by Yin (2013).
6. Research Findings

This chapter presents the key findings from my research on the health information system in Sudan. The research involved different key actors in the project, which was the national team at the FMOH, WHO country office and the technical assistance team.

The practical work engaged was to deliver the train-the-trainer and customization of DHIS2 according to Sudan health information system standards. The first objective was to understand the challenges of implementing a routine health information system in Sudan, and covering potentially upcoming challenges. The second objective elaborates on the type of scaling strategies that are used to facilitate such routine health information system. To present this the best way, the findings will be based on the mentioned objectives, and divided into four sections. Following this brief introduction, section 6.1 examines issues relating to the HIS reform process, where as subsection 6.1.1 will put FMOHs role on the map of the implementation process. Next, in section 6.2 findings regarding the train-the-trainer events will be presented. Later in 6.3, I will elaborate on rollout strategy and the coordination of this. Finally, findings relating to capacity and resources will be presented in section 6.4.
6.1 HIS reform process

In Sudan, there are inequitable distribution in human resources and distribution of staff, especially between each state. As an example, the health information centre in Khartoum state has a cadre of 40, however other states have only five cadres available. The lack of availability and distribution of staff reflects the lack of leadership, resulting in both inadequacy and inequity. Moreover, these conditions encounter not only in state level but also at locality level, whereas the similar inequitable and uneven distribution of the health workforce exists. According to FMOH (2012), there are about 814 staff members positioned in Khartoum state, whereas respectively only 202 staff members in Blue Nile state, 190 in Gezira state, and 57 in Sinar state. The outcome of such inequity and varying of dispersal of workforce will be described in detail in the next chapter.

In terms of addressing the issue of HIS strengthening in Sudan, the reform process effort started early involving as much as many actors. The practical work in Sudan was collaboration between the actors of national FMOH and WHO country office, supplied by the technical assistance team. In comparison to other African countries in the region that have earlier implemented DHIS2 successfully (Sahay et al., 2013), Sudan has the advantage of having human resource capacity and a working infrastructure. The development of different data elements, such as the new set of national health indicators and facility, along with hospital and locality registers and summary forms were already successfully reformed. Therefore, the HIS reform process could easily be started and initiated. As mentioned earlier, the health programme representatives had already validated the new indicators and data elements, which could contribute in significantly reduction in time by which a digital pilot would be ready to deploy. The technical assistance team has also provided national FMOH with technical
documentation that will simplify the piloting of DHIS2 in Sudan. Although this, there are no formal documentation or mapping between the now-used indicators and data elements in the old paper-based system.

The health information in Sudan is based on health facility reporting supplemented by surveys, resulting in limited data quality assurance, as the data management and analysis is done manually. Even though data management and analysis was done, there tend to be limited use of the data analyzed in sub-national levels. Furthermore, the sources of health data include also annual statistical reports, health surveys, and FMOH records. At the end of each month, or quarter as in some states, there is conducted a summary report in the facilities, which is then sent to SMOH and then assessed to national FMOH. Given the received annual and quarterly reports from SMOH, the national FMOH arranges a yearly meeting with representatives from all states for feedback. Each state receives individual feedback and supervision, along with a visit at least once a year by representatives from national FMOH.

The data flow of the current HIS in Sudan reflect the fragmentation described earlier. The figure below shows the inefficient data flow, which also reflects the poor frequency of reporting and accuracy of reporting; this in term of data needs from each level.
In addition, there are also many forms in this data flow. Specifically, there are forms for the different disease specific health programs, such as Expanded Programme on Immunization (EPI), Reproductive Health (RH), Nutrition, and outpatient facility records (FMOH, 2012).

6.1.1 FMOHs role in the implementation

The national federal ministry of health, or FMOH, is supposed to collect and compile data and reports coming from all states, both quarterly and annual reports. These reports are based on monthly reports from the localities. The localities aggregate these data from reports gathered directly the health facilities (PHC). However, not all the PHC facilities report regularly. According to FMOH (2012) only 30% of PHCs report on a regularly basis to higher level.
Considering this low rate of reporting, there are several root causes raised by FMOH team. One of them is the knowledge of the health staff, resulting in incorrect reporting. The health staff which reports have inaccurate or insufficient knowledge of the forms they use for reporting. FMOHs goal is to deliver health services at all levels, with the participation of communities, thus delivering equally in-service health care to all localities. The inaccurate reporting and low knowledge-level of the health staff makes this difficult. However, FMOH is aware of these kinds of issues. One health officer explains that:

“Problems are easier to identify at locality level, and especially when we are around. The lower barrier can help the health staff in locality level communicate more easily about problems and concerns.”

– Health officer, FMOH

In terms of feedback, FMOH reports back using annual national reports along with detailed statistical reports, which they once a year show to the SMOHs for feedback. This reports is not exclusive for health data, but also data from other sources such as demographic data, survey data and vertical program data. The statistical report format are standardized and distributed. Computers are used only in referral hospitals, states, and federal level. Hospitals report their statistical reports manually using paper, and data forms are developed by the national FMOH is done manually using software such as Microsoft Excel. These mentioned reasons indicate an existence of fragmentation.
“We had to spend some time on training the national team on using Excel, but now they can do it blindly. But the data [integration] at locality level is a huge problem, and this results in not collecting [data].”

– National health officer, FMOH

In relation to this, FMOH team engage in developing and updating different data forms such as; EPI, Reproductive health, nutrition, and Integrated Management of Childhood Illness (IMCI), and outpatient facility records. Seen on the basis of this, and because of FMOHs full overview over the data forms and their content, they can easily contribute in dialoging and relating to the issues addressed by users in training for instance, thus designing better paper forms. The next section elaborates on how the new paper forms were presented.

6.1.2 Introduction of new paper forms

As mentioned in chapter 2, it is crucial to involve key actors early in the process. In order to make sure that all participants understood the new paper forms, the first time they were presented was in plenum. By observing the presentation of the new paper forms, which sometimes evolved to become a heated debate, it was covered that there are too many disease categories in the OPD form. It was a clear unified agreement suggesting that the OPD form needs to be simplified. Therefore, the reform (or redesign) process aimed at cutting some of the indicators and data elements. Following a participatory design approach, the collaboration resulted in reducing some issues that came to surface, such as reduction of age groups and reduction of the diseases listed. This finding shows the importance of including future users along with the different health programs in discussing the content and structure of the future paper forms. The
discussions involved general issues and more detailed ones; like age-brackets in the OPD forms. The FMOH suggests consensus building in the HIS reform strategy (FMOH, 2012), this to ensure understanding of the newly designed paper forms and succeeding. By succeeding, this signifies that the FMOH responds to the information needs of all the health service levels, and in particular community level. This was discovered during a small talk with some representatives from diverse health programs during a break between the presentations.

The HIS in Sudan is naturally influenced, not only by the technical aspects and complications that can arise, but also other various factors. These factors can be external actors involved for instance, which in turn can influence both HIS structure and also the reform process. One influence is the potential of end of funding, or pressure on pushing certain paper forms earlier than others, although practically and in reality their priority is not the same.
6.2 Training of trainers

There were initiated two sessions for the training of trainers (TOT) in Sudan. In an attempt to get first hand knowledge of issues that might be discussed in the training, I participated in both training sessions. The trainings were held in the Continuing Professional Development (CPD) facilities. The CPD was set up in 2006 by FMOH, for the reason to have structured training sessions on federal level, with sufficient availability of connectivity and equipment needed for the training sessions. The main aim is to enhance and sustain the knowledge and skills of the health professionals attending training sessions.

The training sessions was held by representatives from both the FMOH national team and the technical assistance team. The training was intended to be a centralized training, as the time frame for the training did not allow any delays. Furthermore, this meant that there was a certain need to engage the different representatives from all states and health programs, in order to make sure that they understood the training material. The DHIS2 training was held by the consultants, which had earlier experience with HMIS in Rwanda and Zanzibar among other countries. My contribution to the training sessions was only additional, as my aim was primarily to observe the participants and the trainers.

6.2.1 TOT approach in Sudan

Related to scaling, two issues are worth highlighting in this section. The first issue is the lack of consideration when it comes to training and capacity building. The core for initiating and improving the staff performance, hence the quality of health data, is by taking training and capacity building into better consideration.
The main issues for achieving this, has been the inadequate training for the trainers, both in competences regarding health informatics and support so the participants understand the root cause of the problems they face in their daily work. In an interview with a health officer at the national health information centre, it was suggested that:

“We should send set of questions or a survey to the participants of the coming to training then we will be sure they will understand what will be trained. This is for us to map their computer skills and known concepts too.

Health officer (FMOH)

The TOT approach was intended not only to minimize costs, but also to slowly transfer ownership of the materials introduced. This in turn, would increase the quality of learning. The increased quality of the training will simplify the learning of new material and concepts. As mentioned earlier, the training was divided into two sessions. First, the participants from the eight states and representatives from the health programs got introduced to the new paper forms with a set of predefined indicators for each paper form. The second TOT session was for introducing the digital system (DHIS2) for the participants, so they can see live demonstration of data input, processing, and analyzing of real data. The latter were highly relevant, as this made the practical exercises easier to put to relevance when put into specific and real-life user stories. Furthermore, there were some misunderstandings due to language issues during the presentation of DHIS2 was in English, therefore one team member from FMOH had to translate what the consultants said and demonstrated. Nevertheless, having noticed this, it was still a lot of laughing and good atmosphere among both the trainers and those who were trained [trainees].
The second issue concerns the process of improvement and simplification of the paper forms. Although this process was done as a collaborative work, there were still some issues raised by the representatives from the different health programs. In addition, although the indicators and fields in the new paper forms was decided beforehand, still some discussions were occurring. An issue regarding the OPD paper form was raised. Training participants from some of the health programs wanted the form to have reduced age-bracket categories along with reducing the disease list. The national team took this into consideration when further customizing and simplifying the paper forms. Towards the end of the training period, the participants were divided into groups consisting both trainers and trainees. The trainees spent two days in the field at health facilities in Khartoum state. The main purpose for this was to practice the use of the new paper forms with real data from the health facilities. Besides, by seeing the paper forms in action in the field, the trainees can experience the relation between the information gathered and the root causes for the chosen design of the paper forms.

6.2.2 Predicted issues for further training:

As earlier mentioned, there were some language issues, as some of the participants had a hard time understanding the English accent some of the trainers spoke. This happened as a consequence of the poor mapping of English skills on participants attending training. In addition, the interface of DHIS2 was not fully translated to Arabic; this should be done before using DHIS2 in lower levels in the future. Mainly, this has to be in place to ensure understanding of the content presented, and allowing for easier linkage to real-life problems.
As an addition to the in-service support by the FMOH team, it was provided a training package to the participants; this included training manual and video guidelines. The training package was on an USB stick, provided by the consultants. It was intended that the total of 300 USB sticks would be handed out to the TOT participants, and further to participants in locality training at state level. This content should also be fully translated to Arabic. In association to this, there is clearly a need for extending the training material to explain simple browser use, such as clearing cache, login-logout, and other elementary computer issues and troubleshooting. One of the Health Officers elucidated during an interview that:

“Some people at locality level (participants) have never used a computer”.

ImPLYING that the need for mapping the participants of training is central to success of TOT. Therefore, suggesting a survey or somehow trying to map the situation. Further it was explained:

“We should know the answer to questions like; what type of computer skills do the participants have? Have they used a computer at all, and include a description of each participant?

The Health Officer suggests that, in order to map the status of the participants, there is a need to send something beforehand the training sessions to do a briefing of who is coming to the training, and include description of each participant.
By mapping their computer skills, one can raise the level of the TOT and make it more efficient.

“How can one that doesn’t know how to use a computer be a train-the-trainer?”

“Its important because he or she represents a whole state”.

His last point is crucial to the implementation of DHIS2, and can influence the knowledge of potential future users. Mainly, because if the trainers are not fully confident about the material he or she is teaching, then the transfer of competence will be both inaccurate and ineffective. This will in turn, affect the health data and its quality, thus giving an unstable base for decision-makers.
6.3 Planning for rollout

There was indicated that the rollout strategy is affected by the fund-oriented approach for rollout and implementation of DHIS. In addition, there is no review of the integrated paper forms. Everything is untested and unpiloted, making room for inevitably adjustments to the rollout of both the paper forms and DHIS2. Customization of the latter is not finished, and will not be ready for all modules of DHIS2. Implementing these customizations later will be costly, considering rollout to eight states at one time.

The initiated reform process in Sudan is well provided when taking in consideration funding and technical assistance. Despite, funding was still threatened in being reduced or in worst case ended. In an interview with a statistician at FMOH it was explained that:

“DHIS2 was supposed to be rolled out in two states, but the constraint is the time because funding is insufficient”.

These time constraints create pressure on the FMOH team, making them work with only what they have available in matter of resources and capacity. It was intended that the piloting of the new paper forms would only begin in two states, before rolling out DHIS2 to further two states. The rollout strategy would be constrained to the rate at which the new forms were introduced across Sudan. In the same regard, the health officer stated that:

“This fund-driven approach put huge pressure on FMOH team”

Health officer, FMOH, November 2014
Although DHIS2 will be running online in Sudan and updated automatically through new builds, the training participants has to learn the new implementations, thus the training material has to be updated. By being aware of this beforehand, the customizations will be more complete, preventing last-day changes to the training material. Another issue is the rollout of DHIS2 to eight states at one time. This is not advantageous in this case, as there are not enough trainers and not enough skills among trainers. To achieve such rollout there has to be some degree of separation of the two processes of learning. As mentioned earlier, there are different factors, which impacted the implementation differently. On one hand, factors such as untested rollout strategies and lack of understanding of the new paper forms can impact the rollout of DHIS2. The learning of DHIS2 platform happens simultaneously with learning the new paper forms, creating too much information income towards the participants of training. On the other hand, the participants have to deal with DHIS2, which is currently unfinished in the matter of Arabic translations. This issue will be more shown in the training of localities, where less and less people have good English language understanding. Not only are there language issues in locality level, there are also indications of issues in competence level of the statisticians. In an interview, it is explained that:

“We have to change statisticians from [being] data entry clerks to information officers. They have to start analyzing the data”.

Health officer, FMOH, November 2014
Considering this, there are also reasons to believe that there are concerns in terms of access to the reported data. One representative from a health programme indicated that:

“National level can only view the reported data in lower levels, because they can cook data”.

*Statistician, Vertical health programme, 2014.*

The fear for higher levels to cook data is a highly relevant issue. Especially in terms of the higher levels aim is to show a better side of the HIS just to please the need of different stakeholders. The need for managing such issues is crucial in order for the DHIS2 to be implemented successfully. There is no point in reporting data at locality level, when it will be changed when arrived at higher levels.
6.4 Capacity building and resource capabilities

There is a huge advantage of creating a practical approach for transfer of competence. In Sudan, the FMOH team did this where they trained the participants, which represents each state and health programme. They, in turn, will be seen as a ‘focal person’ and train care providers and health professionals. Considering that state level resources are unclear (FMOH, 2012), the technical assistance team is not participating in the next phase of the rollout planning. The technical assistance team was central in planning and enable for change in the first phase, as they held most of the training and provided the material for further learning. This is also recognized in the reform strategy created by national FMOH team. Further, it is addressed that some states does not have IT resources such as connectivity or a working stationary computer. Influenced by the earlier mentioned lack of resources, the capacity building will not be as efficient as it should be, therefore preventing of successful scaling. This issue is also referred to by a health officer at FMOH:

“Build the capacity to really BE a information officers, and not just another name tag”.

Health officer, FMOH, November 2014

As earlier mentioned in this chapter, one of the limitations is that the HIS is still manual and paper based with no data quality assurance and auditing system. The information officer, mentioned in the interview, is a crucial middleman when it comes to information gathering and processing. An information officer is responsible for requesting consistent information needed to provide accurate reports to higher levels (FMOH, 2012). By observing the introduction of the new paper forms, the addressed
issue was also highlighted by several representatives from different states. Further, and in the same interview it emerges that:

“Technical support is important, but the FMOH [team] will be working as a support team. We don’t have one specific team for support”.

Health officer, FMOH, November 2014

The urgency for creating a helpdesk is exposed in interviewing the health officer. The fact that the participants can rely on having a call-center for simple support with high availability and fast response, contributes to acknowledge DHIS2 in Sudan. Another issue predicted, which concern and impact the implementation of DHIS2 negatively, is to not follow up the implementation with feedback workshops. The health officer explains:

“To have feedback workshops are important. As information go one direction, they have to have feedback on this and that. Also involve people from the health programs.”

Health officer, FMOH, November 2014

In terms of feedback, there is also a clarification that needs to be addressed, which involves the funding of resources in locality level regarding the data entry. The fact that someone will be responsible for data entry into DHIS2, is something that also needs to be clarified. These questions were raised during the training sessions held in the CPD (November 2014). Moreover, Sudan has the resources capabilities to successfully implement DHIS2 nationally. This, in comparison with other countries that have successfully implemented DHIS2 (Sahay et al., 2013). Furthermore, Sudan is significantly well placed in terms of the capacity assets on a national basis such as the
National Health Information Centre. Despite this, there have been some issues in ordering technological equipment from abroad, such as servers and computers. The main reason for this is the complicated political issue that faces Sudan as a result of the sanctions on the country. One example was the time it took the FMOH to receive three servers to their server cluster. During an interview with a health officer, it was found that the servers had to be shipped through Zimbabwe and Uganda, and that the whole process took approximately eight months before finally installing and running them in the national data centre. This example is an illustration of many issues that faces the national FMOH team in implementing DHIS2 in Sudan.

Associated with the example illustrated, there have also been problems in capacity building in the FMOH. The FMOH team has been trying to attend DHIS2 academy for four times without succeeding. As a result of them being prevented attendance by diverse reasons, they had to wait for their introduction of DHIS2 until after the TOT was held. It would be in advantage of the TOT participants if the FMOH team had been introduced and practically exercised on DHIS2 beforehand, as they would have had some experience and in addition other settings to relate to other than Sudan's health setting. This limited capacity mapping is a main drawback and hindrance of the HIS performance.

6.5 Summary

In this section I will summarize the learned findings through my research on the HIS in Sudan. Below is a visualization of the summary of this chapter; this to make things more clear. I do this by showing the findings and description of each issue, along with linking to the activities/sections involved.
<table>
<thead>
<tr>
<th>Findings</th>
<th>Details/Description</th>
<th>Activity/Section involved</th>
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<tbody>
<tr>
<td>Fragmentation of HIS</td>
<td>- Lack of information sharing and finding information easily.</td>
<td>- HIS reform process</td>
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<td>- Planning for rollout</td>
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<td></td>
<td></td>
<td>- Capacity building and resource capabilities</td>
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<tr>
<td>Lack of leadership</td>
<td>- Ineffective providing good quality information (awareness for decision-making for managers and upper levels).</td>
<td>- HIS reform process</td>
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<td></td>
<td>- Little time frame for train-the-trainer and rollout to the different states.</td>
<td>- Training of trainers</td>
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<td></td>
<td>- Fund-driven development/implementation/work.</td>
<td>- Planning for rollout</td>
</tr>
<tr>
<td></td>
<td>- Lack of working infrastructure.</td>
<td>- Capacity building and resource capabilities</td>
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<tr>
<td></td>
<td>- Insufficient ICT and mostly no connectivity in both states and localities.</td>
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<td></td>
<td>- Technical capacity and sustainability issues</td>
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<tr>
<td>Lack of dispersal of responsibilities from lower to higher levels</td>
<td>- Feedback to lower levels is major problem, and makes the IS really ineffective.</td>
<td>- Planning for rollout</td>
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<td></td>
<td>- Focal person for training both in state and locality level.</td>
<td>- Capacity building and resource capabilities</td>
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<td></td>
<td>- Sustainability and ownership of all the programmatic activities at the state levels.</td>
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<tr>
<td>Involvement of different actors has a negative impact on the implementation and rollout.</td>
<td>- Parallel reporting among the different health programs.</td>
<td>- HIS reform process</td>
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<td>- Planning for rollout</td>
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<td>- Capacity building and resource capabilities</td>
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Table 5 Summary of findings
Some of the findings elaborated on, tend to be repeated and are involved in several activities. The main issues were found through observation in both training sessions and interviews. The issues and findings elaborated on in this chapter can be summarized in four activities. The first finding describes the fragmentation of HIS in Sudan. Consequently, the information use and sharing is affected by the fragmented HIS. The second activity is the lack of leadership, which describes the current HIS being fund-driven, unstable and insufficient regarding situation of ICT in the country. Third, the lacking of dispersal of responsibilities from lower levels to higher levels, affecting sustainability, ownership and feedback. The last finding is the impact by involvement of different actors in the implementation process, as different health programs use their own reporting systems resulting in parallel reporting.

The linkage between the findings and the theory will be fundamental for the implications and strategies for successful scaling of routine health information systems in Sudan. Moreover, the implications for improving data quality are central when linked to issues and findings addressed in this chapter. The next chapter discusses the findings based upon the relevant literature and theory presented in chapter two and three.
7. Discussion

This chapter will discuss findings from my research based upon the theoretical framework presented in chapter two, along with challenges and finding presented in previous chapter. Theoretically, this study draws upon successful scaling of routine health information systems, or DHIS2 in this manner. Within the perspective of scaling, I mentioned earlier in chapter two the strategies for achieving successful scaling. I will therefore elaborate on implications on this in this chapter, by drawing on the issue of fragmentation and managing the reforming process of HIS the best way.

Following this brief introduction to this chapter, the rest of this chapter is organized as follows: Section 7.1 will elaborate more on implications for scaling HIS. Next, in section 7.2, I discuss the issues of scaling HIS in accordance to different dimensions. The strategies for scaling DHIS2 rollout will be outlined in section 7.3. Then, in section 7.4, I present the necessary preparations and facilitations according to DHIS2 environment, touching upon standardization efforts along with routines for feedback. Finally, I provide a practical recommendation in section 7.5.
7.1 Implications for scaling HIS

In order to scale a HIS and have quality data, there has to be changes in processing practices and daily routines of data collection. Routine health information systems tend to have a reputation of being the source for producing low-quality data, this by various reasons. Braa and Hedberg (2002) argue that routine HISs is intended to provide useful information for decision-making, surveillance, and statistics. Furthermore, there are several authors addressing this issue of routines of data being not unified, although mostly, it is the main source of data. Therefore, the HIS needs to be designed in collaboration with care providers and peripheral managers, this to achieve a responsive HIS to certain objectives (Lippeveld and Sauerborn, 2000). First, by imposing the HIS from national level, there are risk of not taking into account health problems of communities and their information needs at locality level. Information needs implies that there are a number of specific indicators unique to certain communities (ibid). In order to achieve successful scaling of HIS, there has to be a degree of restructuring in the information system management structure. According to Lippeveld and Sauerborn (2000), scaling of HIS requires a certain matching between the management functions with the various components of the HIS structure. As a consequence of this, necessary restructuring of HIS contributes in generating data that normally will not be captured by routine systems. Instead, the routine HIS should have the ability to be more responsive to the data needs of all levels in the hierarchy.

In Sudan, there is vast number of duplication incidents in different data forms. Therefore, in order to avoid this, three approaches are highlighted by Lippeveld and Sauerborn (2000); (1) the need for commitment to HIS restructuring process, (2) cope with risks necessary to take, and finally; (3) obtain the right political connections and
relations. The first approach addresses the need for committing to HIS restructuring process. Implying, that in order to follow through this implementation, some degree of commitment from the national FMOH team side is needed. The national FMOH team needs to be “the man in the middle”, that unites the actors (health programs) and addressing their needs. As a potential result of this, production of appropriate data quality and day-to-day information culture will be practiced and exercised.

Moreover, the scaling needs to base upon the information-generating process (ibid). Information-generating imply using the data for better decision making at all level in the health service system, and especially at the health facility or community level (Lippeveld, 2001).

The scaling triggers an expansion of the HIS, which then simultaneously integrates with what already exists. Aanestad (2003) argues that integration can be seen as a process of bringing together different aspects such as services, data sets, data collection tools and even people. Therefore, scaling is seen as multidimensional, thus integrating technical and organizational aspects of an information system. In the case of Sudan, there is already a system for reporting and processing data collected at health facility level. The system is highly fragmented and paper-based, which gives room for errors in data entry process. By taking into consideration the existing socio-technical arrangement, or current data collection system, this can be used as a potential departure point for change. The change is regarding scaling based on existing socio-technical arrangement, which consists of regulations, routines and both formal and informal rules.
The HMN framework presented in chapter two, purposes in strengthening HIS and processes for information use. The process itself starts with data capturing and recording at the service level.

Manually based, and with help by locally developed programs and simple excel sheets; the capturing is processed towards higher levels of the hierarchy. The different disease-specific program has own data forms, for which nothing is standardized. Implying, that the scaling of HIS is met by bottleneck already in the service level. The lack of consensus building and the non-existing same-speaking data language, points to the need for an approach for collective and collaborative work on each disease-specific program, thus each data set. In addition to contributing in consensus building, this increases learning in training and contributes in promoting teamwork.

As the probability of scaling the current HIS data flow is not an option, the natural emerge of a new data flow is inevitable. The result in changing of these routines increases the data flow in being more efficient, in term of frequency of reporting and quality of the reported data. Mostly, because each level of the hierarchy has its data needs relevant to its mandate and functions. The current data flow, as illustrated in previous chapter, summarizes the issues of duplication, fragmentation, inefficiency and inconsistency. Instead, the data flow should have a data warehouse approach, using integrated and decentralized approach for information sharing, as illustrated in figure 12 below:
The outputs are the component of the HMN framework describing the data retrieval. As the current data retrieval is manual, the new regulations and routines have to be well taught to the national FMOH team, with regard to transfer of competence to future users. Furthermore, when addressing the issue of access and availability of integrated data, the coming establishment of the data warehouse is crucial for the success of this project. The data warehouse benefits various users and actors, as it will gather data from all data sources. Particularly, data from population-based and institution-based sources (FMOH, 2012).
The main concern is the issue of streamlining the project, when taking into account Sudan’s vision for HIS, and at the same time takes advantage of the resources available for this project. Associated with this, the capacity of the national FMOH team is very limited, causing in limitation and drawback for HIS performance. Especially, when considering that current practice of extracting data is relying on manual methods for data processing, compilation and analysis.

Fragmentation, which is defined as the lack of coordination and integration among subsystems, is highly visible in current HIS. Moreover, whereas in this case, each disease-specific program runs their own data collection system with no regard to integrating with the overall HIS (Braa and Sahay, 2012). As mentioned earlier, the highly fragmented HIS in Sudan lack interfacing with current routines for data collection and processing, which then in turn can affect the new routines that new paper forms and DHIS2 introduces. However, by standardizing the paper forms and further engaging integration of the disease-specific programs, as they usually have their own data collection tools and forms, one can increase the possibility of successful DHIS2 in Sudan. In Sudan, the FMOH preferred starting the customization process with the data forms: Expanded Programme on Immunization (EPI), Reproductive health (RH), and Nutrition. This gave the vertical programs an opportunity to be included in the process. By including the disease-specific programs early, the FMOH increased their motivation for using DHIS2. This could play a key role in contribution to successfully implementing DHIS2 in Sudan, as previously done in several African countries such as Kenya and Ghana (Sahay et al., 2012).

Another implication, which often was mentioned both in training sessions and various documents conducted by national FMOH team (FMOH, 2012), was the fact that the
screen of DHIS2 should look similarly to the actual paper forms. As a potential positive consequence of this, when doing data entry, the data will be entered in the right cell and therefore belong to the right data element. Hence, fulfilling one of the important dimensions of data quality, which is accuracy (Lippeveld and Sauerborn, 2000). In order to match the paper forms, the process of transforming and customizing the data entry forms in DHIS2 is still an ongoing process, which is imagined to take considerable time to finish.

This might result in not filling in all data elements in the correct facility report form. Moreover, this addresses another dimension of data quality dealing with the issue of completeness (ibid.)

One of the main issues in training was the right-to-left structure of the DHIS2 when using Arabic language. This comes as a consequence of DHIS2 not being fully compatible with the fact that the Arabic language writes from right-to-left. In order to scale DHIS2 to all states in Sudan, the Arabic language has to be incorporated in the whole system. Both in data entry forms and in the user interface. A key learning from this, also observed in the in-service done during the training sessions, is to improve completeness of DHIS2 in matter of customization. Data quality is seen as one of the most important success factors of scaling (Lippeveld, 2001), as dimensions of data quality include measurements such as relevance, accuracy, completeness and timeliness is fulfilled. However, by doing in-service training, the distance between data quality and use is shortened. The future users entering the data collected into DHIS2, will see the easily creation of analysis and information use.
Besides, contributing in more efficient information use, hence improving data quality assessment. Further and in terms of ownership, also mentioned by Sæbø (2013), the users needs to feel ownership to the data and trust its validity. Therefore, if data is not standardized it will probably would not be used, thus no focus on ownership. This implication will be elaborated more on in the coming section.
7.2 Scaling HIS according to different dimensions

Slowly transfer of ownership is achieved by involving future users in the customization and implementation process (Sæbø, 2013). In Sudan, training of DHIS2 was scheduled directly after introducing the new paper forms. This was later seen as a major issue, because the participants would have too much income of information at a very short time of period. Therefore, it was moved with aim to have a week between the two training sessions. In relation to this adjustment, the main reason for choosing to do the trainings consecutively was to reduce the costs of training. Therefore, it is crucial to have a substantial budget when discussing the issue of managing capacity building. By increasing capacity building efforts, all levels of the health organizational can benefit. Whereas the importance of generating reliable information is crucially needed.

Scaling can be in different dimensions, as a change in one direction can be an adjustment or improvement in another dimension (Sahay et al., 2013). In this manner, the user maturity can be seen as scaling in one dimension, meaning that the information use will be improved in another dimension. Furthermore, this implies that scaling different components of the HIS will result in increased amount of users. The more knowledge users have of the new system, the more sophisticated and advanced is the use, especially when having in mind scaling across eight states in Sudan. In the same manner, scaling of user maturity implies moving health staff from being data entry assets, and instead using them to analyze data captured. A significant way for improving performance of HIS in Sudan, is by training staff at the health facility level on how the data that they routinely collect could be used for management decision-making. The possibility to learn together as a collective is essential, and is more useful than individual learning, giving that the likelihood of strengthening the HIS is more common
if done collaborative. Together, the enrichment of the learning process is achieved and the ownership is slowly transferred.

The TOT approach, though lack of funding and time allocation, had an incremental approach for introducing the new paper form to representatives from disease-specific (vertical) health programs. Using this opportunity, the national FMOH team could then continue the on-going approach of TOT, while introducing the new data standards and new paper forms to TOT participants. The local facilitation, or the existing socio-technical arrangement, is actually the impetus of the implementation process. Therefore, when addressing the concept of cultivation, the main strategy for successful scaling of DHIS2 in Sudan, is to build upon this local facilitation. The main argumentation for this, also elaborated on by Sæbø (2013), is the fact that the number of trainers is less than the people being trained. Therefore, this has to be taken into account when talking about scaling DHIS2 nationally, as the number of users will eventually grow.

Another aspect of the training sessions was the fact that I participated in the training and was not just an observer. This was done mainly because the training, especially DHIS2 introduction, lacked people speaking both Arabic and English. Arabic was used to communicate with the participants, and English used to translate the issues that were addressed by the trainees to the consultants. In addition, not all of the training materials were translated to Arabic; therefore I had to translate some on the fly. As a resolution to this, on one hand, there should be a number of selected staff fluent in Arabic and English. On the other hand, there should be a number of selected statisticians with high knowledge on the current public health system as well as experience in health planning, so that they will be central in utilizing the training to future users.
In the same manner, the learning process had an unanticipated turn when addressing
the issue of me being a participator of training and not only an observer. This may have
had both positive and negative impact on training.

From the start of the project, there were indications that the funding was a central part
of the impetus in implementing DHIS2 in Sudan. Initially, signifying that this project is
rather more fund-driven, than action-driven. The funding available for the
implementation appears to be available for the coming phases, but the actors involved,
in order to assure the fund receivers, should further confirm this. Regarding plan for
funding, there should be supplied an asset to identify and make certain that gaps in
funding of the HIS is non-existent. Another aspect of delineation of funding, is clarifying
the resources required at locality level, mostly regarding to whom will be responsible
for the data entry at the service level. Furthermore, this initiation will result in clearer
communications if any changes where to happened to disaggregation of categories in
external systems, such as the earlier mentioned age-brackets issue. The issue of age-
brackets, along with disaggregation by sex and age groups, is very common for a lot of
statistical health data (Sæbø, 2013).

The importance of highlighting and reflecting these issues in the data collection
mechanisms is crucial, especially in matter of disaggregation. In association with this,
the process of common naming conventions, initiated by the national FMOH team, made
it possible for including national indicators and key data elements needed by the
vertical health programs. This resulted further in focusing more on the interfacing to
various components, or data sets, in DHIS2. An example of this is the focus initiated on
customizing DHIS2 to being the central routine reporting system in Sudan.
While the practice of data reporting would still be the same, new facility and hospital reporting templates and forms are developed as part of the process of reforming the HIS. Various data sets and components should be examined and customized before added to DHIS2. In order to customize and maintain DHIS2 properly, the scaling process is obliged to have available capacity at national level. Hence, bear in mind human resource requirements, equipment requirements, training requirements, and timings.

By recognizing the concern of maintaining DHIS2, this includes knowledge on how to define standard data collection forms and reporting outputs. Scaling is not only addressing questions in expansion within the same contexts, but other contexts as well. Therefore, scaling is not only a technical question, but also rather a scaling of a heterogeneous network, which consists both of social and technical aspects (Braa et al., 1995; Thorseng, 2008). The context addresses the infrastructure of the potentially eight states that DHIS2 is supposed to be rolled out to. There are clearly differences in the current infrastructure of these states, varying from being very weak to very strong. Although this is certainly expected in such extensive rollout, there still must be allocated resources. An unfortunate circumstance of this could be negatively impact on the rollout. Moreover, this entails that these contexts has less technical experience, different prioritization locally, and an inconsistent monthly reporting (Sæbø, 2013).

An implication that might solve the issue of lacking experience is by enabling health staff from both national and state level to attend academies for teaching the principles of DHIS2. Training should be conducted so that both facilitation of workshops and on-site training is made possible. Therefore, to learn this best, it is suggested that people at higher levels to attend DHIS2 Academy.
Through an intensive training program in DHIS2 Academy\(^3\), attendees learn the principles of DHIS2. This in matter of maintaining, support, and providing understanding of available tools along with best practices. The establishment of DHIS2 Academy has been central to facilitation of such activities in countries where DHIS2 has been implemented previously. The DHIS2 academy is held in four regions annually, including South Asia, Latin America, East and West Africa. The DHIS2 academy, first held in 2011, is key in sharing experiences on DHIS2 implementation, improvement and best-practice reform strategies with other implementers and users from various countries. The DHIS2 Academy aims to build a community of DHIS2 users; therefore it will be exceptional for Sudan HIS health staff to attend such academy. Furthermore, when addressing the issue of scaling HIS, the DHIS2 academy takes into account scalability by enabling for developing capacity of the participants. This in turn, opens the door for conducting training them, so transfer of competence is achieved. Sadly, the national FMOH team has tried attending this academy several times without succeeding, because of insufficiencies in fund and other reasons, among them political reasons. They (FMOH team) finally succeeded, when they attended DHIS2 academy in late November to early December held in Zanzibar 2014. This information income and sharing of experience on previous and current deployments of DHIS2, adds momentum and motivation to national FMOH team. Moreover, this contributes in nationally successful scaling of DHIS2 in Sudan. The coordination of DHIS2 rollout will be elaborated more on in the coming section.

\(^3\) [https://www.dhis2.org/academy](https://www.dhis2.org/academy)
7.3 Strategies for scaling DHIS2

In order to achieve a successful rollout, the coordination of DHIS2 has to be thorough as there are small factors determining success or failure. Therefore, each stage of the implementation process has to be thorough, along with making room for unanticipated outcomes. Each of the participants of training, along with national FMOH team, will be seen as a ‘focal person’ as they will be the ones answering questions from future users and doing the on-hand training. Therefore, I argue that, the smaller the changes of the implementation process, the higher change of success.

Lippeveld (2001) explains that poor HIS infrastructure is weak and poor in most developing countries, lacking essential equipment for HIS success. Therefore, Sudan has to be aware of the importance of the project and implementation environment, which is essential in developing a successful national data warehouse based on DHIS2. As mentioned in previous chapter, there were found some issues regarding connectivity, mostly because of using online DHIS2 in training. This created some sort of unanticipated use, however, this was already foreseen as a scaling issue by the assistance team, considering their previous experience with poor infrastructure in other African countries. Therefore, it was suggested using mobile 3G modems in state level training to assure everyone connectivity to Internet. This decision came as a result of a unified advice for scaling, provided not only by the assistance team and national FMOH team, however also expressed by participants from all health programs as well. Consequently, the unified decision to use mobile 3G modems to connect to the Internet came as a learn-by-doing approach.
The hierarchy of standards mentioned earlier, central in whether scaling of DHIS2 will be successful or not, is argued for by several authors (Braa et al., 2007; Shaw et al., 2007; Thorseng, 2008). The allowance of some leeway to each level of the hierarchy to define their own needs, or “freedom” as Braa et al. (2007) suggests, is a crucial step in creating a bottom-up approach of mapping data requirements. Flexible systems are required to accommodate differences and changes (Braa et al., 2007). The scaling takes place when the national level gives the opportunity to lower levels to define their own information standards. By considering participation approach for successful scaling, this using data requirements, it benefits both the national level and levels below with a flexible strategy for standards.

Nevertheless, when introducing DHIS2 to eight states at one time, it naturally will be issues facing FMOH in such implementation process. The national FMOH team is under quite pressure when it comes to funding, preventing less leeway in prioritizing and contributing in how the implementation process should be processed best. It was suggested earlier to scale down the rollout strategy, thus rolling out DHIS2 in two states at each phase of the project initiated. By doing this, the first rollout will be seen as a piloting phase, by being the reference point in future phases, whereas this pilot will contain a pool of experiences and best-practices. Therefore, the scalability of DHIS2 in Sudan needs to mirror these issues. Having in mind the two axes that scaling can be viewed along, the horizontal and vertical axis, rollout has to reflect the number of states that this scaling can handle (Braa et al., 2007) The horizontal axis reflects the scaling process across geographic areas, which is in this case the number of states to rollout to. There is also a strong indication that the decision to rollout to eight states was centralized, and processed without taking into account the intense and fast change of process when scaling to that many states at one time.
On the other hand, the vertical axis is described through increasing the technological sophistication of the HIS. In Sudan, this is by the introduction of DHIS2 components and integration towards different actors involved. Having in mind the three need for balancing available human resources, ability to access technology, and importance of amount of data collected (Shaw et al., 2007), it is crucial to understand that scaling of HIS is multidimensional.

Figure 13 Revised figure in accordance to Sudan situation. Original figure by Shaw et al. (2007)

Shaw et al. (2007) argues that this multidimensionality is achieved by ensuring quality in data, equity in resources and sustainability when addressing the issue of ownership. In Sudan, the balance between the three spheres is not achieved, as illustrated in figure 11 above. The human capacity and the data collecting requirements does not mirror each other, resulting in health staff gathering much more data than anticipated considering the manpower available. Furthermore, the lack of technology prevents effectively managing and processing the scaling and strengthening of HIS in Sudan.
Particularly, this imbalance between the three spheres affects further the project approach, prioritization, and more importantly incorporate the different health programs.

As earlier mentioned in chapter three, there are two axes for scaling, which is vertical and horizontal scaling. Consequently, when addressing the issues of scaling, the changing of behaviors has to be elaborated on. The table below shows mapping of Sudan situation when addressing the issue of successful scaling in matter of vertical and horizontal scaling:

<table>
<thead>
<tr>
<th>Vertical scaling</th>
<th>Horizontal scaling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shaw et al. (2007)</td>
<td>- Human resources - Types of users - User maturity - Different levels of infrastructure</td>
</tr>
<tr>
<td>Sæbø (2013)</td>
<td>- Geographical scaling (width and depth) - Functional scope - Technological capacity amount</td>
</tr>
<tr>
<td>Sahay and Walsham (2006), Sahay et al. (2013)</td>
<td>- User maturity and learning process</td>
</tr>
<tr>
<td>Braa and Sahay (2012)</td>
<td>- Adapting to new contexts - Information needs - Data collection procedures</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sudan scaling</th>
<th>Vertical scaling:</th>
<th>Horizontal scaling:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Amount of data collected</td>
<td>- Connectivity and adequate ICT</td>
</tr>
<tr>
<td></td>
<td>- Learning process of reporting</td>
<td>- Scaling in eight states in Sudan (geographical scaling)</td>
</tr>
<tr>
<td></td>
<td>- User maturity</td>
<td>- DHIS2 functionality and complexity</td>
</tr>
<tr>
<td></td>
<td>- Minimal data set (unified among health programs)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Human capacity building</td>
<td></td>
</tr>
</tbody>
</table>

Table 6 Revised table describing vertical and horizontal scaling according to Sudan (Originally from chapter three)
In Sudan, the issues of reporting concerns skills and incompetence of health staff doing the actual reporting. On one hand, this is because the health staff at service level (locality) lacks proper training and feedback from higher levels, and on the other hand, because the human capacity is insufficient as a consequence of weak leadership. Given the context in Sudan, and unstable funding, these issues have to be addressed nationally and by including all disease-specific health programs.
7.4 Scaling of DHIS2 environment in Sudan

The aim for the HMN framework reflects its motto, which says: “better information, better decisions, better health”. Associated with this, is the implementation of DHIS2 in Sudan. Seen on the basis of Sudan’s vision and goal for DHIS2, their aim is to implement a digital HIS, thus to create standards in both forms and information flow in order to achieve better decision-making. This in turn, plays a key role in benefiting Sudan’s population in accurate, available and valid health information. Braa and Sahay (2012) argue that in order to have a successful implementation, there has to be a good match between both the anticipated and real needs of future users. Meaning, that the needs and requirements have to mirror the users day-to-day work routines. Interesting to understand, is that these needs will not be final, as new requirements will always emerge and come to surface by the disease-specific health programs. This comes a consequence of the health programs wanting to push for their own interests in the HIS.

Previously, there have been several examples of successful scaling of DHIS2 in African countries, such as Kenya and Ghana. The main recipe for achieving this success, were the participatory and collaborative work done in joint between health programs and national level (Sahay et al., 2012). As a consequence of the joint collaboration, the scaling of DHIS2 gets more efficient, which then creates propulsion in the successful scaling and implementation. By using this driving force as a springboard, it drives the current HIS in Sudan away from the existing decentralized information management and fragmented HIS. Instead, emphasize should be more on the linkage between the routine and nonroutine data collection. In Sudan, this happens in the locality level. The staff of locality levels is the ones who actually collects the data, and facilitates the aggregation of data to higher levels. This is where potential bottlenecks can be exposed,
and in turn solved by using evidence-based decision-making (Shaw et al., 2007). There has already been a process, where the aim was to initiate processes for agreeing on minimal essential data sets, along with revising the indicators. The notion of participatory design is to slowly transfer ownership to local future users. Not only will the users get a user friendly representation of their data and analysis, by having a convenient graphical user interface. This opens the door for using modules such as the geographical information system (GIS) and graphs in the pivot table, in hand with easier access to data and to be proud of their health data. This in turn, will motivate the future users in using their data in different ways, and support different dimensions of information use. Implying, comparing data with other localities or health facilities, to encourage and inspire each other (Sahay et al., 2012).

7.4.1 Implications on standardization effort of HIS

Considering the reforming of HIS in Sudan, a natural consequence of this is re-organizing of the organizational structure, so that shared standards are achieved. Instead of having each state using different data sets, definitions and standards, there now can be more comprehensive national standards for data collection. Consequently, contributing in strengthening the routine health information system in Sudan. Mainly, this benefits the HIS by agreeing on one standard, instead of having different gateways between each of the systems involved. Moreover, the aim is to arrive at an agreement of shared standards and achieve interoperability. As mentioned earlier in chapter two, interoperability is the ability to exchange data between systems. Therefore, standardization and interoperability goes hand in hand, considering that the three levels of standardization describing the increasing differences and complexities, and the needs for common understanding (Braa and Sahay, 2012). In Sudan, the aim is to move
from the current fragmented and centralized HIS, to more of a decentralized integrated information system.

Hence, creating a data warehouse for all data being reported from all level of the HIS, so that all health programs and external actors can base their decision-making upon reliable and valid data. In order to achieve this, the standardization requires a uniform and a minimal data set. Therefore, the health facilities and other levels of the hierarchy need clear definitions on what is considered key information needed for each level. Using a participatory approach for consensus building of data sets, the health programs has the ability to affect the design and content of such data sets. As a potential outcome of this participatory approach, more simple, integrated and decentralized information system is achieved (Braa and Sahay, 2012). First, the simple indicates reducing the number of data elements to report on. The integration describes the incorporation of these data elements into a dataset or a form, which stems from various health programs, and to be part of routine reporting. Therefore, the focus should be by means of using and analyzing the data gathered, unlike focusing on the data collection process itself. The decentralization is achieved by reducing the amount of data to be collected, thus reducing the workload of the data collectors and health staff (ibid.). Still, the relevance of data collected is high. Accordingly, because each level includes their own information needs, suiting their standards. However, they are still obligated to report according to the needs of higher and above level. The lower level in the hierarchy requires additional and more granular data. In contrast to lower levels, the higher levels usually requires more aggregated data demanded for evidence-based decision-making, resulting in a bottom-up approach for facilitating local needs and relevance in actions. When it comes to receiving monitoring data instead of evaluation data, several authors have expressed the same argumentation.
They (authors) agree upon the fact that it is easier to translate the needs to action (Braa and Sahay, 2012; Sæbø, 2013; Sahay et al., 2013).

According to Braa and Sahay (2012), there are two efforts to integrate data reporting; (1) the development of a new paper form that included parts of other forms and datasets, and (2) using a computer database for capturing data. The existing HIS in Sudan is characterized by being fragmented, overlapping and inconsistent.

Therefore, a major effort is needed in designing the new data forms, having in mind all data needs and inconsistencies in the data collecting process. The national FMOH team has already started the process of shaping new data collection forms and integrates the needs from all disease-specific health programs. The data warehouse approach aims to unify the reporting process. In order for this to work, it means that all disease-specific health programs have to let go their parallel reporting systems. This is crucial when addressing the issue of duplication, which then have an impact on the HIS as a whole. As a result of this, the DHIS2 will become an attractor (Braa and Sahay, 2012), resulting in being an approved system which meets the requirements of dimensions of data quality; completeness, relevance, accuracy, and timeliness (Lippeveld, 2001). By increasing data completeness, this triggers other change to the HIS such as feedback to lower levels, capacity re-mapping, and an overall acceptance of new routines for data collection.
7.4.2 Routines for feedback

Another implication that seems relevant in the case of scaling DHIS2 in Sudan, especially and certainly in later phases of the implementation, is the unsorted question about handling with feedback from users. This is assumed to be coming as a chain reaction of introducing the first-ever digital system for aggregating, analyzing, and processing health data in Sudan. The DHIS2 has already an in-built feedback system, which supports online messaging, thus enabling both users (e.g. health staff) and developers (or national team) to communicate with each other and solve each other’s problems. However, the national FMOH team seems to be underestimating the need for structuring and set a side capacity in order to deal with such demand, as the need can come “out of the blue”. This is referred to as functional scaling (Shaw et al., 2007; Thorseng, 2008).

7.5 Practical recommendations

If the plan of piloting DHIS2 in Khartoum State goes as planned, it is crucial to raise awareness when considering specific requirements. Therefore, it is important to have in mind the three concepts for successful scaling of HIS (Shaw et al., 2007). In practice, have in mind human resources, volume of data collected, and the technological accessibility. Furthermore, essential requirements could be such as human resource requirements, equipment requirements and training requirements. In order to scale and facilitate the implementation of DHIS2, the piloting should be complete and ready for full deployment. This in turn, requires installing DHIS2 with all instances (test and production), customize the forms and reports in alignment with the reformed HIS, and examine collaboration between paper-based environment (health facility level) and
DHIS2 environment. In addition, this gives *access to technology* in the implementation environment.

The DHIS2 implementation benefits Sudan in improving completeness and quality of data. However, the technology or software itself will not change work practices or routines, instead, by highlighting the issue(s) of resources, regular reporting and using the data gathered for analysis, scaling of information systems can be achieved in Sudan. Therefore, the last concept addressed by Shaw et al. (2007) makes sense when focusing on amount of data to collect, or the *volume of data*. 
8. Conclusion

This section sums up my findings in relation to the research objectives I introduced in the beginning of this thesis. This study was conducted in Sudan and looks at the implementation process that were mainly based on interviews and observations in training. I might have overlooked some indication to challenges, especially in training mainly because of the degree of my participation. On the point of participating in training, I also engaged in customizing and translating several data sets to Arabic. My overall research objective was:

- **Contributing while studying the implementation and integration of DHIS2 in the case of Sudan, while looking at challenges, which may occur in the implementation phase(s).**

In order to concretize the above research objective, I chose to elaborate on two research questions. The two questions intend to map the now existing and future challenges in implementing DHIS2 in Sudan. Furthermore, I wanted to discuss strategies for scaling and implementing DHIS2. Therefore, my first research question intend to address the challenges that arises:

- What are the challenges of implementing a routine health information system in Sudan?

The procedures for data entry and analysis can be reformed using DHIS2 software. However, the main sources of complications facing Sudan HIS is not related to software challenges, they are rather an issue of fragmentation of reporting and limited resources.
Therefore, the software itself will not contribute in implementing effective day-to-day routines in Sudan. DHIS2 contributes in resolving some problems, nonetheless, it will not solve important issues like lack of resources or frequency of reporting, if the motivation of health staff is not present. However, by incorporating small routine adjustments, like initiating joint review meetings with all levels or conduct feedback meetings, this ensures evaluation and further discussions between all actors involved. Furthermore, strongly consider initiating reports which focuses on training of health staff, particularly improving for capacity building.

By examining the capacity building issues in chapter six, this clearly shows that it requires involvement and support from the technical assistance team, and of course having the team in country helping with hands-on tasks. The hands-on work implies doing competence transfer and performing refreshing TOT sessions.

The main sources of problems in Sudan HIS indicated that reports are fragmented along with lack of availability of human resources. Ineffective and centralized information integration, leads to lack of scaling and expansion of the new HIS. Furthermore, insufficiency of resources could contribute in constraining different activities crucial for such evolving of HIS in Sudan. Emphasizing the need for training health staff in computer skills, data entry and basic analysis using DHIS2.
The second research questions addressed the strategies for successful implementation of DHIS2:

- What scaling strategies are used to facilitate comprehensive and integrated routine health information systems in Sudan?

A potential post-situation of implementing DHIS2 in Sudan, is enabling for different sources to easily base their analysis of data using data warehouse approach. By integrating and including all health care institutions, such as private health sector. In addition to private health sector, other actors such as armed forces and universities should be included. This can help in bringing integration of data collection one step closer, and raise the earlier mentioned reporting rate of critically 30% at health facility level in Sudan. Simultaneously, there are some obstacles that still needs to be further addressed and inspected, such as technical issues, data flow of information, and process of collaboration between involved. The latter should especially be emphasized, whereas many of these actors operate in silos. Therefore, enhancing collaboration between the actors result in avoiding fragmentation, bad coordination and poor guidance of the national HIS. However, when using the analytical capabilities in DHIS2, the visibility of problems and gaps in the HIS will be easier to pinpoint. This in turn, creates a momentum for external actors to be stronger impressed, convinced and motivated for using DHIS2 as national system, thus encourage a standardized data warehouse strategy and equivalent content level of the HIS.
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