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Health Information Systems in West Africa

Implementing DHIS2 in Ghana

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Abstract

Health Information Systems (HIS) are a critical component of a health system, but have often been neglected in most developing countries. The Health Information Systems Programme (HISP) tries to remedy this, by working closely with end users to improve HIS and thereby increasing the use of information. Its main vehicle for this is the District Health Information System, version 2 (DHIS2), a flexible open source software tool based on web technologies, that can be used for collecting, validating, analysing and presenting health data.

The objective of this thesis is to study how a complex information system like DHIS2 can be implemented in a developing country. My main focus is West Africa, where I have spent about four months doing fieldwork. Most of the time I have been in Ghana, assisting and studying the implementation of DHIS2 there. As part of this, I have evaluated the Ghana health information system in general, and participated in the implementation of DHIS2 there. While Ghana is the main focus of my research, I have also worked with other countries in the region, in particular with Liberia. Consequently, I also discuss and evaluate the situation in terms of health information for the region as a whole.

I show how the internet can play a huge for the ICT development in Africa in the coming years. Contrasting the implementations in Ghana and Liberia, the former using the internet and the latter using standalone installations, demonstrates the many benefits internet can have when implementing a system like DHIS2, for example by increasing the possibility of user participation in the design of the system and reducing the need for local human capacity to support software installations.

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Abbreviations

CDC	Centre for Disease Control
CHIM	Centre for Health Information Management
CSV	Comma Separated Values
DHIMS	District Health Information Management System
DHIS	District Health Information Software
DRG	Diagnostic Related Grouping
DWICAMS	District Wide Computer Assisted Management System
ECOWAS	Economic Community of West African States
ERP	Enterprise Resource Planning
GHS	Ghana Health Service
GIS	Geographical Information System
HIO	Health Information Officer
HIS	Health Information Systems
HISP	Health Information Systems Programme
HMN	Health Metrics Network
ICD-10	International Classification of Diseases, 10th Revision
ICT	Information and Communication Technology
IGF	Internally Generated Funds
IHIA	Integrated Health Information Architecture
II	Information Infrastructure
IME	Information Monitoring and Evaliation
IS	Information Systems
ISDC	Information Systems in Developing Countries
JICA	Japanese International Cooperation Agency
LMIS	Logistics Management Information System
MDG	Milennium Development Goals
NACP	National Aids Control Programme
NHIS	National Health Insurance Scheme
ODBC	Open Database Connectivity
PD	Participatory Design
PPME	Policy Planning, Monitoring and Evaluation
RCH	Reproductive and Child Health
TB	Tuberculosis
VPN	Virtual Private Network
WAN	Wide Area Network
WAHO	West African Health Organisation
WHO	World Health Organisation
WYSWYG	What You See Is What You Get

Chapter 1

Introduction

The Health Information System (HIS) is a critical component of a health system. However, it is an area that has been neglected in most developing countries for years. For various reasons, the quality of the data being collected is often poor, and consequently the health sector is managed "in the dark" without any information to back up decision making.

In recent years, there has been an increased focus on this area of the health sector. International donors, powerful actors in the developing world, have focused more on supporting the national HIS rather than setting up their own parallel reporting systems. Furthermore, the World Health Organisation (WHO) set up the Health Metrics Network (HMN) in 2005 in order to support and improve national HIS (World Healh Organization, n.d.).

The University of Oslo has, through the Health Information Systems Programme (HISP), been involved in HIS reform since the mid 1990s, with the District Health Information Software (DHIS2) currently being at the core of this involvement. DHIS2 is a data warehouse software for health data, with tools for data collection, analysis and presentation. The software is used in the health information systems of many countries in both Africa and Asia, including several West African countries.

In 2010 Ghana decided to use DHIS2 as the platform for its HIS. The country already had a national, computerised health information system, but this system had many problems. The HISP group at the University of Oslo signed an agreement with the Ghana Health Service, under which the university agreed to train GHS staff and support the DHIS2 implementation. DHIS2 was rolled out in Ghana this year. 2010 was also the year Liberia decided to upgrade its software from DHIS1 to DHIS2, rolling out the system in the autumn of 2011. These are examples of a regional trend, with many countries considering or using DHIS2.

1.1 Motivation

I have always been interested in both technology and international development, first taking a Bachelor's degree in International Studies, then a Bachelor's degree in Mathematics, Informatics and Technology.

My main reason for not continuing with international studies was that I felt it was difficult to use it to make any real contributions to those in need. Now, working on a master's degree in informatics with HISP, I can finally study both international and technological issues, and at the same time make a positive contribution to a part of the world where it is needed. The work HISP does in promoting the use of information in the management of health systems across the world can have a real impact, and is a true attempt to use Information and Communication Technologies (ICT) for development. For me, studying this topic is therefore a fantastic opportunity.

My first practical involvement with HISP was when I became involved with the implementation of DHIS2 in Ghana in the first half of 2011. At that point, the customisation of the system had begun, but was far from finished. Since then, the Ghanian system has gone through many changes, and the team of implementers has faced many challenges that I have been lucky to take part of and learn from. I have also had the opportunity to work with other West African countries, both at workshops, over email, and, in the case of Liberia, through a visit to the country. Through these experiences the research objectives of this thesis have developed.

1.2 Research Objectives

The overall issue that I want to study in this thesis is how a modern HIS can be implemented in a developing country context, and how the implementation can be sustained. Furthermore, I want to look at this as a concrete example of if and how ICT can be used for development. Under this wider theme, I have four more specific research objectives

- Evaluate the Ghana HIS in order to understand how it works at the various levels.
- Study the implementation of DHIS2 in Ghana.
- Compare the DHIS2 implementations in Liberia and Ghana.
- Look at how West Africa can benefit from the increasing interest in DHIS2 in the region.

The first research objective, evaluating the current Ghanian HIS, is important for several reasons. Knowing the current system is important when incorporating a new major component like DHIS2. With knowledge of some of the history and background of the health information system, it easier to avoid remaking previous mistakes. Furthermore, evaluating the current Ghanian HIS makes it possible to make later comparison of the system before and after implementing DHIS2, to see if there are improvements.

The second objective concerns how DHIS2 can be successfully implemented in Ghana, and what the benefits will be. The focus will be on how the implementation can be made with close involvement from users, using

participatory design approaches. Understanding the DHIS2 implementation in Ghana gives valuable insights into the implementation of complex information systems in developing countries in general, and how users can be involved in the design of a complex system *in the cloud*. This is highly relevant, as a large number of countries are currently considering implementing DHIS2 or are in the process of doing so, and a number of countries that have already implemented DHIS2 consider moving their systems to the cloud.

The third research objective is to compare the DHIS2 implementations in Liberia and Ghana. Both countries have rolled out DHIS2 within the last year. Ghana is leveraging the internet for its implementation, while Liberia has not had the infrastructure for this and is using standalone installations. I will discuss the consequences of this difference, looking at how it can be a concrete example of how the internet can be leveraged for development.

Finally, the last research objective deals with the international and regional developments around HIS and DHIS2, and how West African countries can contribute to and benefit from these. Several West-African countries use or consider using the DHIS2 software, and the West African Health Organization (WAHO) has shown interest in supporting the region in this effort. Can networks be built in order to help sustain DHIS2 implementations in the region over time, and facilitate the process for countries currently implementing it?

1.3 Structure of the Thesis

After this brief introduction, the thesis is structured as follows. The next chapter will give an overview of the relevant literature and theories. In chapter three, the methodology and methods used in this thesis will be discussed.

Chapter four, five, six and seven presents the empirical data. Chapter four gives a background of HISP, West Africa and Ghana. In the fifth chapter, I present my findings on the functioning of the Ghanian health information system. Chapter six concerns the implementation of DHIS2 in Ghana, and is followed by a chapter on the implementation of DHIS2 in Liberia. In chapter eight I present the overall situation and developments with regard to HIS in the West African region.

Chapter nine is a discussion of the problem statements, in light of the theory and empirical findings. Finally, I give my conclusions in chapter ten.

Chapter 2

Literature Review

In this chapter, I will review literature and theory relevant to this thesis. I start by looking at literature on ICT in developing countries, and on research of ICT in developing countries. I then continue by reviewing literature in information systems development and implementation in developing countries. The HISP theory of "networks of action is then presented. Finally, I look at the literature on health information systems.

2.1 ICT in Developing Countries

HISP aims at improving health information systems, which is one example of using ICT for development. In this section, I review literature on the use of ICT for development. I first look at the concept of the "digital divide", then the discussion on if and how ICT can promote development.

2.1.1 The Digital Divide

The exact origins of the concept of the digital divide is unknown, but it emerged in the mid 1990s (Mutula, 2008). According to Hilbert (2011), there is no clear definition of the "digital divide", as its use and meaning varies according to the discussion in which it is used. However, at the core, the digital divide describes the difference between those with and those without access to ICT. In recent years, the concept has been expanded somewhat to also consider the *quality* of the ICT - what Mutula (2008) calls the "new digital divide" or "quality digital divide". Mutula (2008) cites the World Bank, which reports that the digital divide is closing rapidly. However, he argues that the *quality* digital divide is not decreasing.

The digital divide exists both within and between countries. Between countries, the divide runs mostly along the lines of the developed and developing world. In fact, some authors argue that the digital divide is nothing more than the ICT aspect of the more general development divide (Torero and Braun, 2005). However, there are also substantial differences between countries in the same income categories (James, 2006). Within countries, it is generally the rich, educated and urban population that has access to ICT, while the rural and un-educated are left out (James, 2006).

Looking at the sources of the digital divide, Torero and Braun (2005) argue that economic and policy issues are the main culprits. The importance of policy is illustrated by the big difference in growth of mobile phone usage between similar countries with different policies governing the telecommunication industry (Torero and Braun, 2005). Adam and Wood (1999) also emphasise the importance of policy makers in promoting ICT growth.

The Parliamentary Office of Science and Technology (2006) lists six factors that contribute to the digital divide within countries:

- Few products are available that fit the developing country context.
- The cost of ICT is too high for large parts of the population.
- People lack skills in using ICT.
- Many ICTs require literacy and knowledge of english, which parts of the population does not have.
- There is limited human capacity to support ICT, and skilled ICT personnel often migrate to developed countries.
- Poor or non-existing ICT policies limit uptake of ICTs.

Mutula (2008) agrees to several of these points, and emphasises illiteracy and the diversity of languages as especially big challenges in Africa. Other distinct features that influence the digital divide in Africa include large differences between urban and rural areas, poor infrastructure and large physical distances.

When attempting to bridge the digital divide in Africa, Mutula (2008) argues that the above characteristics must be addressed. He suggests using outdoor advertising and integration of local content to promote ICT awareness; improving the infrastructure, including electricity; and making sure technology is adapted to local languages and cultures rather than being transferred directly from the developed world. In terms of internet infrastructure, he emphasises the importance for African countries to get access to fiber optic cables that are linked to other continents, to reduce the reliance on slow and expensive satellite links (Mutula, 2008).

The Parliamentary Office of Science and Technology (2006) offers several other suggestions to bridging the digital divide. First, open source software can contribute by providing a catalogue of software free of charge. Second, the invention and diffusion of new technologies can be a factor. A recent example of a relatively new technology making an important impact is the mobile internet. Third, international initiatives are suggested as a contributor. Examples of such initiatives include the Millennium Development Goals (MDGs) and New Partnership for Africa's Development (NEPAD). According to Parliamentary Office of Science and Technology (2006), ICT is considered a mean of achieving many of the MDGs, and NEPAD has identified ICT as a prioritised area. Finally, both James (2006) and Parliamentary Office of Science and Technology (2006)

point to the importance of human resources and education in bridging the digital divide.

2.1.2 Using ICT for Development

In the late 1990s, some researchers argued that developing countries could use ICT as a way of leapfrogging stages of industrial development, becoming "information economies" (Adam and Wood, 1999; Osterwalder, n.d.). Some of that optimism is gone today, but most authors seem to agree that ICT *can* contribute to development (Parliamentary Office of Science and Technology, 2006; Mutula, 2008; James, 2006; Osterwalder, n.d.). Sein and Harindranath (2004) argues that ICT can contribute to development in four ways. ICT can:

- be a commodity
- support development activity
- be a driver of the economy
- support specific development projects

The main challenge seems to be that access to ICT is limited in many parts of the world, as shown above, and as Adam and Wood (1999) argues, that even where the technologies are available, they are under-utilised.

While a consensus has emerged that ICT can contribute to development, there is less agreement as to what extent ICT should be *prioritised* as a way of promoting development. Mutula (2008) points out that people will not prioritise access to computers or the internet over access to clean water or health services. Similarly, Adam and Wood (1999) argue that ICT cannot solve the overall problem of development. However, according to the Parliamentary Office of Science and Technology (2006), many researchers now inreasingly see issues of health, food, sanitation, economic growth and so on as linked to ICT. Thus rather than choosing to prioritise for example either health *or* ICT, both are seen as being tied together. This view is supported by Osterwalder (n.d.), who argue that ICT today is a requirement for development: ICT underpins all other sectors that are important for development, and can increase the efficiency of these.

What is required for ICT to promote development? One important aspect of ICT is infrastructure, both ICT-specific infrastructures such as telecommunication links for telephone and internet access, and general infrastructure such as electricity that is required for most ICT. Calderon and Serven (2010) argue that infrastructure should be the top priority for development. However, Torero and Braun (2005) argue that while there is a link between ICT infrastructure expansion and growth, this link is very limited when looking at the lowest (and highest) income countries - thus, for the poorest countries, very large investments in the area are needed before any economic growth can be expected in return.

Policies and policy makers are critical to make ICT conducive to development. Policy makers that have the ability to meet challenges of

social, political, infrastructural and technical nature are needed, according to Adam and Wood (1999). They also argue that it is critical to take the local context of the society into account when introducing ICT in developing countries, something that is also emphasised by James (2006) and Mutula (2008). A more detailed discussion of this issue with regard to software is presented later in the chapter, in the section on "IS Implementation Success and Failure".

Local human capacity to make use of the technology is important, according to Adam and Wood (1999); Osterwalder (n.d.) and James (2006). Osterwalder argues that three human capacity issues must be address for ICT to be used successfully:

- Local capacity to maintain the required infrastructure.
- Local capacity to make local content and applications available.
- Local users that understand the content and applications.

Thus human resources is critical in order for ICT to contribute to development.

2.2 Researching ICT in Developing Countries

The growth of the internet and the creation of the International Development Goals (later the Millennium Development Goals, MDGs) in the 1990s created much enthusiasm for using ICT for development (Heeks, 2008). However, many of the initial efforts to leverage ICT for development failed, leading researchers to focus on the sustainability, scalability and evaluation process of information system (IS) projects (Heeks, 2008).

In this section, I will look at the literature on research concerning ICT and IS implementations in developing countries. I first look at the various discourses within the literature on information systems in developing countries (ISDC). Next, I present an article discussing what issues should be addressed in literature on ICT in developing countries. Finally, I present a theory by Akrich on how technology can be analysed.

2.2.1 Researching ISDC

In her review of research on ISDC, Avgerou (2008) argues that there are three discernible discourses in the context of ISDC research:

- transfer and diffusion discourse
- social embeddedness discourse
- transformative ISDC discourse

Authors writing in transfer and diffusion discourse study how IS innovation can help developing countries catch up to the industrialised

world by transferring knowledge, technologies and institutional practises. They argue that general research and methods in the field of information systems can be used and adapted to developing countries, but that the context of use must be taken into account (Avgerou, 2008).

Researchers working within the social embeddedness discourse argue that IS innovation is the product of a "locally constituted process of technology construction and organizational change" (Avgerou, 2008, p. 135). In other words, the subject of study is primarily local actors and organisations, and how they function.

The focus of the transformative ISDC discourse is the various social, economic and political processes around development occuring in developing countries, and how IS innovation takes place in this context (Avgerou, 2008). It is in some ways similar to the social embeddedness discourse, in its concern for the local social and political processes, but with more focus on how ICT influences these processes (Avgerou, 2008).

Avgerou (2008) argues that the ISDC discourse focuses primarily on IS innovation and the consequences of this, leaving out issues concerning resource limitations that affect this innovation. She also points out that the literature is generally preoccupied with IS failure. The reason is both the high opportunity cost of IS failure in developing countries, and the high expectations that have been attributed to many IS projects in the developing world (Avgerou, 2008).

In general, research has been focused on three types of IS failure: scalability, where limited implementations fail to scale to full operation; sustainability, where seemingly functioning implementations wither away over time; and assimilation problems, where IS becomes embedded in poor organisational practises rather than contributing to improving them (Avgerou, 2008).

2.2.2 Relevant Issues for ICT in Developing Countries

Whilst some earlier research on ICT in developing countries discussed *if* ICT could be beneficial for development, Walsham and Sahay (2006) state that the question is now *how* ICT can benefit development. To address this issue, they argue that research concerning ICT and development should alway address four topics:

- what "development" implies
- what the key ICT issues under study are
- the theoretical and methodological stance of the research
- the level and focus of analysis of the research (Walsham and Sahay, 2006)

The first topic is what the "development" that ICTS should contribute to actually is. This is often ill-defined in ICT for development literature, or is only defined implicitly. Walsham and Sahay (2006) argue that clearer

definitions should be given, and that these definitions could benefit from drawing on definitions from other disciplines such as development studies or economy.

The second topic is what the key issues are that are being studied. Some issues are common, such as local adaption and cultivation, but other topics have been neglected. This includes scalability and sustainability, e-governance technologies, open source software, large scale infrastructures such as telecommunications, and society-based issues like HIV/Aids (Walsham and Sahay, 2006). They thus disagree with Avgerou (2008), who claim scalability and sustainability *are* common research topics.

Third, Walsham and Sahay (2006) argue that the theoretical and methodological stance of the research should be made clearer. Furthermore, they claim that more studies should be of a critical nature, and that there is need for more action research and longitudinal studies.

The final topic that needs to be addressed is that of level and focus of analysis. There are several possible levels of analysis, including the individual, group, organisation, national, and international. The authors argue that the individual level is underrepresented in current literature, and that this should be addressed in future studies. In terms of focus, they argue that focus on communities is currently rare compared to research focusing on the private and public sectors. Finally, Walsham and Sahay (2006) argue for more research outside the english-speaking world, for example in China.

2.2.3 Analysing Technology

Technical objects make up networks with both human and non-human actors. In order to study technical objects, one must therefore look at both social and technical aspects (Akrich, 1992). Akrich (1992) argues that for every technology or artefact, the designer or inventor makes decisions about what tasks should be delegated to the user and what should be done by the technology. This creates a "geography of causes" or responsibilities, a script for the user inscribed in the technology, which in turn lays premises for how the technology should be analysed (Akrich, 1992).

According to Akrich (1992), we must look at both the script and the real world when analysing technological objects and how they function, using both the designer's and the user's perspectives. She dubs the analysis of the relations and adjustments between the technology and the user, from the perspective of the world as envisaged by the designer, for "description". This has some similarities with Heeks, who also discusses the difference between reality and the world as imagined by the designer. This will be discussed later in this chapter.

Technical objects not only define human and non-human actors and their relationship in the first place. To continue functioning, Akrich (1992) argues that the technology must stabilise these relationships and the network between technical and non-technical components. This stabilisation only occurs if the script is "acted out" according to how the designer created it.

2.3 Information System Development in Developing Countries

In this section, I review literature on the topic of how information systems should be developed, implemented and sustained, especially in a developing country context. I start by looking at participatory design, then a theory trying to explain why IS implementations succeed or fail, before finally discussing information infrastructure (II) theory.

2.3.1 Participatory Design

Participatory design (PD) has its roots in work by Scandinavian researchers in the 1970s. PD is an approach to design where various stakeholders participate in the design process, and has strong links to the action research methodology. From the beginning, PD had a political agenda and links to labour unions. The workplace was seen as inherently in conflict, and PD researchers wanted to empower and protect the workers in this environment (Bødker, 1996).

One example of early PD was the UTOPIA project in the 1980s. UTOPIA aimed at using PD to develop a software system for printers and typographers, as a means of strengthening their position and protecting them against new technologies being introduced in the printing business. This was done in collaboration with the printers and typographers union (Bødker, 1996; Kensing and Blomberg, 1998). As unions have lost some of their influence, the traditional link between PD and unions have weakened (Kensing and Blomberg, 1998). However, the goal of empowering users remains in the PD school of thought.

According to Kensing and Blomberg (1998), PD can take place at three arenas:

- The individual project arena, where the focus is on designing a specific system.
- The company arena, with focus on diagnosing and reorganising organisations.
- The national arena, negotiating legal and political frameworks.

Recently, the individual project arena has been the main focus. However, researchers have argued for more projects linking all three arenas, as was often done in the early PD projects (Kensing and Blomberg, 1998).

Participatory Design in HISP

Traditional PD projects were aimed at empowering workers at their workplaces, and Braa and Sahay (forthcoming) argue that PD in HISP seeks to empower users across the health system by making sure they are not left out of the technology development and by giving ownership of the HIS to

communities and users. These ideas were well received in post apartheid South-Africa, were HISP was started (Braa and Sahay, forthcoming).

According to Braa and Sahay (forthcoming), HISP PD is currently in its fourth phase. In the first phase, 1997–2002, the DHIS software was developed in South Africa using traditional PD methods: designers and users in the health districts worked closely together, using rapid prototyping. At the same time as the software was developed, the HISP team worked actively to reform the datasets used for reporting, also using participatory design approaches involving both users and managers at higher levels (Braa and Sahay, forthcoming).

The second phase, from around 2002 to 2006, saw HISP expand outside South Africa, primarily through educational programmes where master and PhD students worked on DHIS projects in various countries. It became clear that the PD approach aiming at empowering users did not work well in all contexts. For example in the highly centralised Cuban system, where empowering users locally was seen as a threat rather than a goal. In fact, most projects in this phase failed to scale and sustain over time, leading to the idea of "networks of action" discussed later in this chapter (Braa and Sahay, forthcoming).

From 2006 to 2010, DHIS2 brought a new technological paradigm to HISP, being based on open source web technologies. While this made it easier to adopt DHIS2 and led to increased interest in the system, the software was more complex. Changes in the software was thus now limited to the core developers. PD in HISP became less about designing the DHIS software and more about designing a *system* based on DHIS. Consequently, DHIS2 implementers took an additional role as mediators between users and developers (Braa and Sahay, forthcoming).

Braa and Sahay (forthcoming) argue that we are now in a phase defined by systems moving to the cloud, and for HISP this started with Kenya implementing DHIS2 online from 2011. Despite the technology moving further away from the users, they argue that PD and its premise of empowering the user is still realistic. In fact, they argue that using a cloud infrastructure represents an improvement for PD. With the data in the cloud, local access to information can be improved, which can empower the local communities and benefactors of the health system. They point to how PD was used during the cloud-based implementation of DHIS2 in Kenya, when parts of the development team more or less moved to the country. By working closely with the users, new important features were added to DHIS2, such as offline data entry and a small application to facilitate offline storage of data for analysis (Braa and Sahay, forthcoming).

Throughout these phases, there have been several cyclic development processes where PD in HISP have taken place according to Braa and Sahay (forthcoming):

- the development of the *software* - DHIS
- the development of the *system*, including datasets, indicators and data models

- the development of *information for action*, finding ways to make sure information is used

All these cyclic processes are in turn driven by the action research cycle (Braa and Sahay, forthcoming).

2.3.2 IS Implementation Success and Failure

In his article on IS implementation success and failure in developing countries, Heeks (2002) categorises the results of such implementations in three categories:

- total failures
- partial failures
- successful implementations

A total failure is a case where either the IS is never implemented, or the implementation is never used. If the system is only partly implemented, or has unintended side effects, the implementation is categorised as a partial failure. Finally, a successful implementation is a case where the major goals are met and there are none or insignificant undesirable side effects (Heeks, 2002).

This classification may seem straightforward at a first glance, however subjectivity is a major issue, especially for the *partial failures*: while the implementation might have failed in the eyes of one stakeholder, it could be regarded as a success by another. Heeks (2002) therefore argues that any IS implementation evaluation must take this subjectivity into account.

IS implementation failures are a big problem even in the industrialised world, with about one quarter total failures and only a small proportion successes (Heeks, 2002). While Heeks (2002) argues that the literature on the subject in the context of the developing world is limited, the failure rates are likely to be even higher here.

Design-Actuality Gaps

Heeks (2002) has developed a model to explain the cause of IS implementation failures, and how the chance of failure can be reduced. At the core of this model is what is dubbed *design-actuality gaps*. This is the gap between the current reality "on the ground" (actuality) and the future reality as envisaged in the IS design. The bigger this gap is, the more likely the IS implementation is to end in a failure. Because of the focus on design and actuality, system designers and the system users are important factors in the model. Gaps between design and actuality can occur along seven dimensions:

- information
- technology

- processes
- objectives and values
- staffing and skills
- management systems and structures
- other resources (Heeks, 2002)

For example, if the IS design is based on the availability of highly skilled personnel, but there is no skilled staff on the ground, this constitutes a gap and is a threat to a successful implementation.

Two types of gaps are especially relevant in the context of developing country IS implementations according to Heeks (2002): country context gaps, and hard-soft gaps. Country context gaps stem from differences between the industrialised world where most IS are designed, and the context in which they are implemented in the developing world. These gaps can result from various scenarios. An IS could have been designed for use in an industrialised setting, and then transferred to a developing country, or it may be designed for the developing world context but based on a wrong understanding of local conditions. Furthermore, an implementation could be driven by a western agency, like a donor organisation, which might have misconceptions about the realities on the ground. Finally, local organisations can often have key figures with education from the industrialised world, who try to bring "western" ideas into their organisations (Heeks, 2002). All these contribute to creating a gap between the design and the actuality, and thus contribute to IS implementation failure.

Hard-soft gaps are gaps between the hard, rational design common for information systems, and soft political realities of the real world. As opposed to country context gaps, which are seldom introduced on purpose, hard-soft gaps are often intentional as part of efforts to introduce more rational management into local organisation (Heeks, 2002). Nonetheless, hard-soft gaps can be a contributor to failure of implementations.

According to the above model, gaps between system design and the actuality on the ground can cause IS implementation failures. Thus to reduce the chance of failure, the gaps must be reduced. This can be done in two ways: by changing the design, or by changing the actuality through improvisation. Heeks (2002) argues that there are several factors affecting the possibilities of design and actuality improvisation:

- the technology
- the nature of the IS design
- local capabilities
- improvisation techniques

Technology can be either design imposing or actuality supporting. A design imposing technology is deeply inscribed, difficult to improvise over and often results in a large initial gap. Actuality supporting technology on the other hand, is shallowly inscribed, makes improvisation easier and leaves a smaller gap as a starting point. Choosing an actuality supporting technology increases the chances of success, but the technology used in IS implementations in developing countries is nonetheless typically design imposing (Heeks, 2002).

The next issue is the nature of the design. IS designs can be seen as having explicit and implicit components. Explicit components, for example how many computers the system requires, can be improvised quite easily. However, the implicit components, like assumptions about the skill level of the users, are hard to change (Heeks, 2002). Thus a design with many implicit rather than explicit assumptions is harder to change than one with only explicit assumptions.

Another aspect of the nature of the design is the degree of divisibility of the IS. Divisibility has two dimensions according to Heeks (2002): modularity and incrementalism. A design that is modular can more easily be adapted to the local settings through improvisation. Similarly, a system that can be implemented in stages is easier to adapt and improvise over.

A requirement for local improvisation is human capacity. Heeks (2002) argues that so called *hybrids*, people with knowledge in several domains, are especially important. Unfortunately, human capacity in developing countries is often lacking. As a consequence, IS designs that leave little room for local improvisation are often chosen.

To improve the chances of local improvisations to succeed, participative approaches to implementations have been suggested. Here, implementers work with end user in order to close design-actuality gaps. Heeks (2002) argues that such approaches might cause problems as well, however, as these techniques themselves may fail to take the local actualities into consideration.

In all then, this model attempts both to describe how design actuality gaps can explain the frequent IS failures in developing countries, and also suggest how these gaps can be reduced.

2.3.3 Information Infrastructures

To better understand the complexities of health information systems, the literature on information infrastructures can be useful. In this section, I will first look at how information infrastructures can be defined, before looking at the recommended principles for building an II.

Information infrastructures are defined by Hanseth and Lyytinen (2010) as a "shared, evolving, heterogenous installed base of IT capabilities among a set of user communities based on open and/or standardized interfaces" (p. 208). While IIs can have similarities with information *systems*, they are more complex and heterogenous, build on existing infrastructures and evolve over time to meet requirements not known at the time they were conceived (Hanseth, n.d.).

According to Hanseth and Monteiro (1998), information infrastructures have six defining aspects. IIs are

- enabling
- shared
- open
- socio-technical
- interrelated
- build on an installed base

Enabling implies that IIs have a supporting or enabling function that opens up for new and possibly unintended activities and functions. That an II is *shared* means that the same infrastructure is used by a group of users, and that the infrastructure is irreducible: different groups of users cannot use the information infrastructure independently. That IIs are *open* means that the number of stakeholders, users, components and areas of use is unlimited, and the consequence is that the activities, requirements and conditions change over time. Information infrastructures are *socio-technical*. They include not only the technical components and software, but also the information, organisations and users related to it. An II is not one monolithic structure, but is rather a set of interrelated sub-infrastructures and networks that can be layered on top of each other. Finally, information infrastructures are never designed from scratch, but build upon an existing *installed base*. IIs are always connected to or built upon something existing (Hanseth and Monteiro, 1998).

Hanseth (n.d.) argues that there are three main classes of IIs:

- global universal service infrastructures
- business sector infrastructures
- corporate infrastructures

The first type has one prominent example, which is the internet. The internet is also the most important foundation for the other two other types of infrastructures. *Business sector infrastructures* are infrastructures shared among several organisations within a sector or community, for example among actors in e-commerce or telemedicine. *Corporate infrastructures* are internal to corporations or organisations. However, these systems often traverse geographical and organisational borders within the organisation. A typical example is Enterprise Resource Planning (ERP) systems.

Based on the above definition and classification of information infrastructures, it is interesting to look at how the literature describes development and evolution of IIs. According to the literature, IIs must be *cultivated*. Ciborra (2000) describes cultivation as being about "interference with and support for a material that is in itself dynamic and possesses its own logic

of growth" and goes on to describe technology "as a drifting system and as an organism to be cultivated" (pp. 31–32). The concept of cultivation is based on the notion that IIs are always part of an installed base. Consequently, IIs cannot simply be designed or constructed: the installed base limits what changes are possible at any given time. Any design or construction must take into account the installed base, and it thus acts both as a limiting and enabling factor (Hanseth, n.d.).

With II design, Hanseth argues that there are two main dilemmas. The first is how to bootstrap the II, the second is how to avoid technology lock-ins (Hanseth and Lyytinen, 2004). In the following, I will discuss the proposed procedures for how to overcome these dilemmas.

Bootstrapping

An information infrastructure generally has little value until it gains a critical mass of users, at which point its growth will be self-reinforcing. Thus the first dilemma of II design is building a self-reinforcing installed base: bootstrapping (Hanseth, n.d.). Hanseth and Lyytinen (2004) suggest three design principles to manage this:

- design initially for usefulness
- use existing installed bases
- expand the installed base fast by persuasive tactics

Designing initially for usefulness is a result of the fact that the first users do not benefit from a large installed base, unlike later adopters. Consequently, the design should let the early adopters benefit immediately, without large costs or high learning curves (Hanseth and Lyytinen, 2004).

The second principle is to make use of supporting infrastructures already in use by some of the potential users. This reduces the cost, and the need for training of the initial users, making the barriers to adoption lower. Furthermore, the new infrastructure should be connected to existing networks or infrastructures where possible (Hanseth and Lyytinen, 2004).

Finally, the focus in the early stages should be on expanding the installed base rather than adding new functionality. Since the long term value of the II is hinged on the number of users, gaining users and momentum should be the focus of the bootstrapping process (Hanseth and Lyytinen, 2004). The purpose of these three design principles is bootstrapping the II, starting a self-reinforcing growth process, and thus overcoming the first II dilemma.

Lock-Ins

The second dilemma in II design is avoiding lock-ins. A lock-in is a situation where a technology has been so widely adopted that changing to a different technology or standard is very hard, both in terms of cost and coordination. Hanseth (n.d.) argues that there are two ways to get out

of a lock-in situation. The first is *evolutionary*, changing the infrastructure while keeping backward compatibility. The other is a *revolutionary* strategy, where one starts from scratch. The first one caters for easy adoption, the second for a best possible end result (Hanseth, n.d.).

The key to managing technology lock-ins is flexibility. IIs can be seen as having two types of flexibility: use flexibility and design/change flexibility (Hanseth, n.d.). As the name implies, use flexibility means flexibility in the way the II can be used. If the use flexibility is large, the II can be used in many different ways without any technical changes (Hanseth and Monteiro, 1998).

Use flexibility is important, and is essential for the *enabling* aspect of IIs (Hanseth and Monteiro, 1998). However, design flexibility is the most important aspect of preventing and getting out of technology lock-ins. Hanseth and Lyyttinen present two design principles to avoid technology lock-ins (Hanseth and Lyytinen, 2004). The first is to keep the II design lean and simple, as simple structures are easier to change than complex ones. The second principle is to modularise the II as much as possible, splitting it into independent sub-infrastructures with standardised interfaces. Such loose couplings make it easier to effect changes in one part of the II without breaking other parts.

2.4 Networks of Action

Researchers within the HISP network have developed theories of "Networks of Action" and "Networks of Networks" that are highly relevant in order to understand the dynamics of HIS implementations.

2.4.1 Networks of Action

The "Networks of Action" concept was coined by Braa, Monteiro and Sahay (2004). It is a theory for how HIS implementations and research can be sustained over time and scaled up in scope. Braa, Monteiro and Sahay (2004) define sustainability as making something work over time. In the field of health information system, that implies adapting the system to local conditions, enabling local learning, and institutionalising routines. Scalability is the issue of making a working local solution spread. Local sustainability and success is irrelevant if the solution cannot be scaled. Scaling involves spreading the technology itself, but also spreading people, funding and the learning process required to make the system work (Braa, Monteiro and Sahay, 2004).

The basic argument is that even successful pilot implementations and research at single sites generally fail to scale and sustain over time. The authors argue that to scale and be sustainable, "networks of action" should be developed between the individual research projects and pilot sites. The networks would become a mechanism for spreading of artefacts, ideas, people and knowledge, which is required for sustainability and scaling

(Braa, Monteiro and Sahay, 2004). They use the HISP network and South Africa as an example where scaling and sustainability was achieved.

2.4.2 Networks of Networks

Building on the concept of networks of action, Sæbø et al. (2011b) argue for building "networks of networks" of action. The argument is that through synergy effects, a network of networks adds up to more than the sum of the individual networks. Strengthened legitimacy is mentioned as one example of such synergy effects. A project might have legitimacy locally, but lack national legitimacy. By linking up with a network on the national level, national legitimacy might be achieved.

The authors argue that *attractors* are required for networks of networks to emerge. The article discusses how a network of networks emerged around two attractors during the DHIS2 implementation in Sierra Leone:

- The successful HIS implementation in Sierra Leone.
- Interoperability between software systems (Sæbø et al., 2011b).

The successful implementation of DHIS2 in Sierra Leone, and the parallel process of integrating reporting in the country, created a regional attractor. The implementation was driven by HISP and HMN. The second attractor was the system interoperability demonstrated in Sierra Leone, facilitated by a new Statistical Data and Metadata Exchange for the Health Domain (SDMX-HD) standard, promoted by WHO. SDMX-HD enables interoperability between systems dealing with health data (SDMX, n.d.). DHIS2 and the medical record system OpenMRS both supported this standard, and it was successfully demonstrated that they could work together. The interoperability became an attractor, both for other countries and for other software developers (Sæbø et al., 2011b).

Finally, Sæbø et al. (2011b) present the HISP strategy for creating synergies through networks, which has three main aspects. The first is directional improvisation, implying that while HISP has a direction to which it wants to move, the exact route is open for improvisation should opportunities arise. The second aspect of the strategy is to use technological architectures to create networks, as architectures create networking effects. This was the case with the SDMX-HD mentioned above. The last aspect is to leverage complementaries between networks, making all nodes of the network benefit (Sæbø et al., 2011b).

2.5 Health Information Systems in Developing Countries

Health information systems are the central topic of this thesis, and reviewing the literature on HIS is therefore important. After defining HIS, I will look at typical challenges related to HIS in developing countries and what strategies for improvements and solutions are suggested.

2.5.1 Defining Health Information Systems

HIS can be defined as

> [...]the mechanisms and procedures for acquiring and analysing data, and providing information (for example, management information, health statistics, health literature) for the management of a health programme or system, and for monitoring health activities (Lwanga, Tye and Ayeni, 1999, p. 28).

From this definition, we see that the purpose of a health information system is to *provide information* for management and decision making in the health sector. This entails the whole process from collecting the data at the lowest levels; analysing this data and turning it into useful information; and using this information for management. The use of information for management is not only relevant at the national level, but its relevance cuts across from patient management in the health facilities, all the way up to the international health organisations.

It is also clear from the definition that a HIS is not one clear-cut structure. It is the "mechanisms and structures" for data collection and analysis, and thus entails both the paper forms and registers used to record and report data at the health facilities, the routines and practices of the staff collecting and analysing the data, the computer systems that store that data and the procedures that guide the use of information in decision-making.

2.5.2 HIS Problems

The HIS is a critical component of the health sector, but it has long been a neglected area. Sauerborn and Lippeveld (2000) suggest five typical problems with HIS in developing countries:

- irrelevant data is collected
- data quality is poor
- parallel reporting and duplicate data collection
- poor timeliness and feedback
- low information usage

In this section, I will discuss these five problems, drawing on the relevant literature.

It is a common problem that data collected at the lowest levels is relevant for use only at the higher levels. Thus staff at the facilities spend time collecting and reporting data they have little need for, instead of data that could be used for patient or facility management (Sauerborn and Lippeveld, 2000). In some cases, the data collected is not really useful at *any* level, and the resources going into data collection is completely wasted.

There are several reasons given in the literature for why data quality is often poor. First of all, the personnel tasked with collecting and compiling

the data does not have the skills required to do this work correctly. The medical personnel lacks skill and equipment to give the right diagnosis, and the staff filling the reports and registers have been given little or no training in how to do this (Shrestha and Bodart, 2000). Making this issue worse, the tools used for data collection are often poorly designed and not user friendly.

When information collected at the facility level has little relevance in the daily facility management at the lowest levels, there is little motivation among health workers to ensure good quality (Chatora and Tumusiime, 2004). A negative circle is created, where quality is decreasing because of limited use of the data, and the data is used even less as the quality deteriorates (Braa and Sahay, 2012). This problem is amplified if there is no feedback on the data being reported, as will be discussed later.

One of *the* biggest challenges faced by national HIS in developing countries are the many specialised, parallel information systems that have been set up by various donors and health programmes, often called vertical reporting systems. As pointed out by the HMN, these systems are often established as a result of pressure from international actors that have higher reporting requirements than what the national HIS can provide (Health Metrics Network, 2008). While the rationale for these parallel systems are clear in many cases, for example when international donors require quality data for accountability reasons, they have had a devastating effect on many national health information systems.

Even though the parallel systems are generally run by health programmes or government divisions focused on specific issues, they have a tendency to cause duplicate data collection. While some data is specific for each vertical system, there is also a substantial amount of data that is collected by two or more vertical programmes, and consequently the facilities must report the same data multiple times (Shaw, 2005). The health workers are often overburdened by these reporting requirements, and it has been argued that as the amount of data increases, data quality decreases (Williamson and Stoops, 2001). Furthermore, the more time that is spent on reporting, the less time is spent on treating patients.

Access to data can also be an issue with parallel systems. Because data is collected and stored separately, accessing the information can be difficult - managers will need to request data from several independent systems instead of having one central repository. And if the same data is available in separate systems but the figures are different, it can cause uncertainty as to which, if any, of the figures can be trusted (Sæbø et al., 2011a).

Feedback and timeliness is important for several reasons, yet both issues are often problematic. Timeliness is important because delays in reporting can lead to situations where managers at various levels either use outdated information to support their decisions, or have no information available at all (Sauerborn and Lippeveld, 2000). In such instances, the resources put into producing the information are wasted.

Feedback can first of all help guide health workers and managers at all levels in their work. However, feedback is also important for motivation, and in turn data quality: if the health workers spend hours filling out forms

and sending them to the next level without even a confirmation that the data has been received, this is clearly demotivating and may lead to poor data quality (Rohde et al., 2008).

Feedback and timeless are related issues. If the timeliness is poor, any feedback that *is* sent is likely to be out of date (Sauerborn and Lippeveld, 2000).

Simwanza and Church (2001), in an article on information culture, argue that low information usage is a general problem with health information systems. This notion is supported by Sauerborn and Lippeveld (2000), although they note that there are few studies to back up this sentiment. However, they do refer to three studies[1] that show limited use of information, especially at the district and facility levels, due to the centralisation of the health systems. Thus even in cases where timely, quality information is available, it might not be used to support decision-making.

2.5.3 Improving HIS

Above, some of the typical problems with health information systems were presented. In this section, I discuss what the literature suggests can be done to reform and improve HIS.

Fragmentation is one of the major sources of problems in health information systems. Fragmentation is reduced through integration. Within the HIS field, integration can have different meanings. According to Sæbø et al. (2011a), technical people look at integration from a technological point of view, and imagine large, unified, and overly complex systems that are hard to make work. They therefore warn against integration, and suggest interoperability as an alternative. Health personnel, on the other hand, look at HIS integration as integration of data and information, and procedures used to generate these. In reality, the integration of health information systems entails both integrating the non-technical and technical components, and interoperability between computer systems plays an important role in this.

Braa and Sahay (2012) argue for what they call an Integrated Health Information Architecture (IHIA) to reduce fragmentation. IHIA is an enterprise architecture with three levels. Each depends on the level below it, and all levels are essential to ensure integration (see figure 2.1). The first level is the social system level. This is where the overall architecture is defined, and it includes information needs and use across organisations, procedures supporting the HIS and other organisational requirements. The second level is the application level. Here we find the software and applications that support the information needs and use at the level above it. Finally, we have the data level. This level deals with data interoperability, standards and infrastructures that support the software and applications on the level above.

To achieve HIS integration, Braa et al. (2012) emphasise the critical

[1] (Auxila and Rohde, 1989; World Healh Organization, 1988; Kadt, 1989)

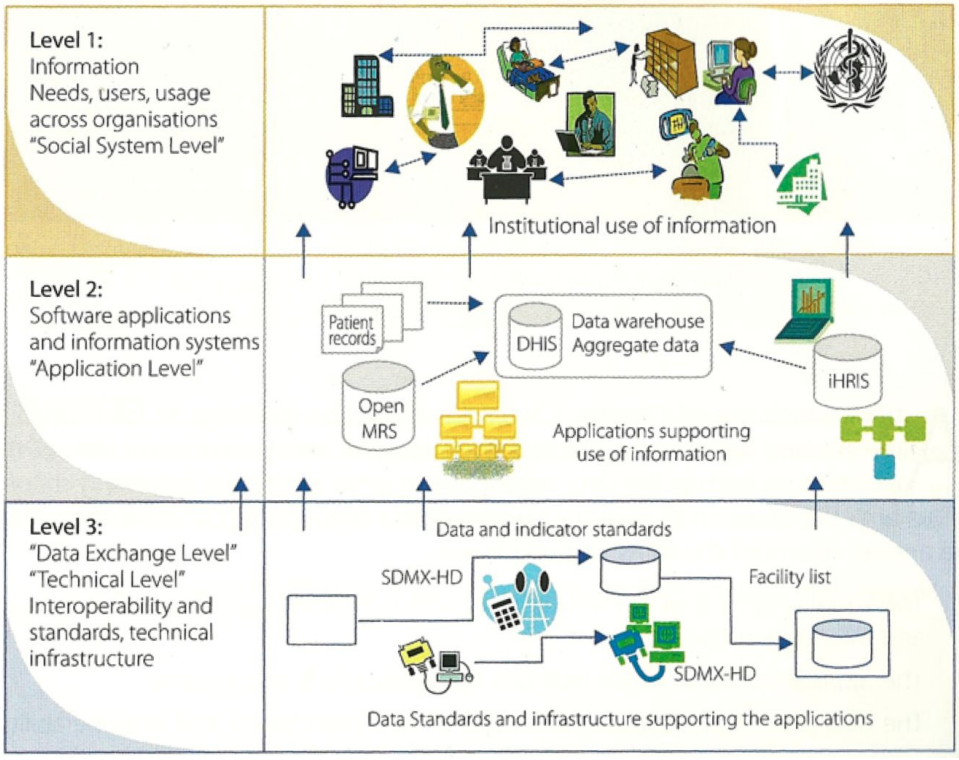


Figure 2.1: Three level Integrated Health Information Architecture. From Braa and Sahay (2012).

importance of using participatory design approaches in which various stakeholders and users can influence the system. They further argue that three important aspects to facilitate this process have often been overlooked. First, a good data warehouse software is needed. Even if there is consensus among all stakeholders to create a data warehouse, it has been a common problem that integration efforts collapse due to sub-standard software. Secondly, the authors argue that standards for data and indicator sets must be developed. Finally, internet should be used where ever possible to ensure that a true data warehouse is created (Braa et al., 2012).

Braa et al. (2012) suggests a three step approach to HIS integration. The first step is to ensure political consensus on the need for integration among all stakeholders in the system. Next, standard data and indicator sets should be developed to enable sharing of information. Finally, data should be integrated at a technical level. Either tightly, through a data warehouse where all data is stored, or loosely, by making data form various sub-systems available in one common portal. Given that most developing countries rely on paper reporting and have a poor infrastructure, Braa et al. (2012) suggest that a tight integration through a data warehouse is preferable. Each of these steps, involving stakeholders, developing an essential dataset and creating a data warehouse is discussed below.

Creating a central data repository or data warehouse in which all data collected from the national and the parallel systems can be stored is one commonly suggested solution to the problem of duplicate data collection and vertical reporting systems (Braa et al., 2007a; Health Metrics Network, 2008; Sæbø et al., 2011a). By having a central data warehouse with all the data available, managers in the vertical programmes might realise that they do not need a separate system in order to access their data. Creating a data warehouse can often be done without altering any of the parallel systems, thus this can be a good starting point for a HIS reform in cases where vertical health programmes are reluctant to give up their own systems (Braa et al., 2007a).

A central data warehouse can also help facilitate access to the collected data on a more general basis. Since all the available data is stored in one location, managers can easily fetch the information they need, possibly even online, independently of who collected or owns the data (Sæbø et al., 2011a).

Overwhelming reporting requirements are one of the main problems of health information systems, affecting data quality and overburdening health workers. To remedy this, several authors argue for the development of a set of *core* or *essential* indicators to track, which all stakeholders agree to (Braa et al., 2007a; Health Metrics Network, 2008). A detailed framework on how to select indicators for the various management functions of the HIS is presented by Bodart and Shrestha (2000).

After defining a minimal set of indicators, the data sources required for calculating these indicators can be identified. Based on these data requirements, integrated data collection instruments can be created. The end result of this is that the total amount of data to be collected is reduced

substantially. Furthermore, because the essential datasets are common for all health programmes, duplication is avoided.

One of the most fundamental recommendations in the HMN framework for HIS reform is to involve stakeholders in the process, and build a broad consensus from day one (Health Metrics Network, 2008). This is especially important because a common goal of HIS reform is to integrate stakeholders such as vertical health programmes in the national system.

Braa et al. (2007a) argue that one way to get stakeholders onboard in HIS reform efforts is to start by creating a data warehouse for data from all vertical programmes. They call this a "maximalist" approach, as opposed to the "minimalist" approach of first developing an essential dataset. Since all programmes can have *their* own forms unaltered in the data warehouse, they have little to loose by joining the process.

As described by Tohouri and Asangansi (2009), this "maximalist" approach can be improved by linking datasets in the data warehouse, so that even though the paper forms used to collect data overlap, identical data is stored only once in the data warehouse. The result is an integrated warehouse without duplication, developed without having to make stakeholders review any of their data collection instruments.

One common problem discussed is poor information usage. If information usage is low even when timely and accurate information is available, it seems clear that use of information must be promoted - but how? Rohde et al. (2008) argue that a "culture of evidence-based decision making" should be encouraged in order to increase the use of information (p. 202). They suggest several ways to promote such a culture. The first is to encourage data analysis and use at the facility level, and among managers at the lower levels in the health system - including setting local targets for selected health indicators.

Many of the same points are echoed by Simwanza and Church (2001), who also emphasise the importance of encouraging use of information locally. They add that although local use is important, the process of institutionalising an information culture often begins at the central level with feedback, review meetings and supervision.

Sauerborn (2000) argues that two issues are important in order to promote information usage: improving the data that is collected, and presenting and communicating it better to decision-makers. He argues that users must feel ownership to the data and trust its validity, and it must be aggregated and customised to fit the user's needs. Information products must be created and communicated to managers and decision-makers in a format appropriate to the situation.

Chapter 3

Methodology

This thesis is based on qualitative, interpretive research. In terms of methodology, it can be seen primarily as participatory action research, but with similarities to case studies. Both participatory action research and case studies will therefore be discussed in the next two sections. I will then continue by describing the field trips I have made to Ghana, Togo and Liberia during the work on this thesis, before finally looking at the research methods used during my research.

3.1 Action Research

Action research (AR), or participatory action research, is a methodology that aims to solve actual, real world problems, while at the same time contributing to theoretical understanding (Myers, 2010). Rather than just observing, the researcher participates and is immersed in the research situation (Checkland and Holwell, 2007). Consequently, the line between researcher and practitioner, and between theory and practice, is blurred (Avison, Lau and Myers, 1999). According to Avison, Lau and Myers (1999), AR is well suited to study information systems, because it gives the researcher an opportunity to understand the complexities of these systems better than other *hard* methods.

In practice, action researchers do not start with a hypothesis they want to test, as is typical for research within the natural sciences. Instead, he or she has a broader theme of interest (Checkland and Holwell, 2007). The action research process itself is iterative, with the researcher going through five main steps in a cyclic fashion, as shown in figure 3.1 (Avison, Lau and Myers, 1999).

The first step is *diagnosing*, where the researcher, together with the practitioners (the researched), identify the problem that needs to be solved. *Action planning* is the second step. Here, a plan is laid out for how the diagnosed problem can be solved. Third in the cycle is *action taking*, which implies executing the planned actions. *Evaluating* the outcome is the fourth step. As the last step before starting the next iteration, the researcher should *specify the learning* that can be gained from the cycle (Avison, Lau and Myers, 1999; Baskerville and Pries-Heje, 1999).

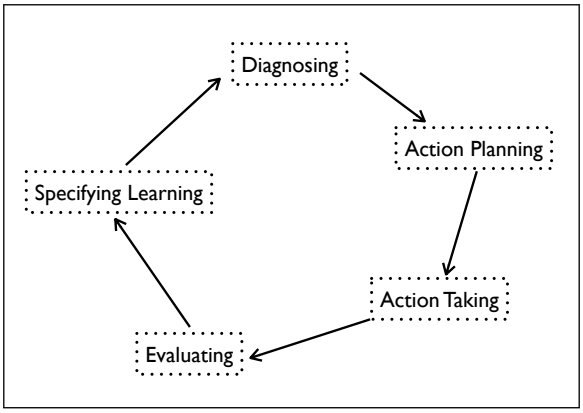


Figure 3.1: The Action Research Cycle. Based on Baskerville and Pries-Heje (1999).

Traditionally in natural sciences, a basic premise of research is that any findings should be repeatable. This is more or less impossible with action research, as the environment of the research will always be different. However, Checkland and Holwell (2007) argue that the research should be *recoverable*. Thus although the exact same research cannot be repeated, the researcher should document the research process well and declare in advance the epistemology - methodology and framework of ideas - the research is based on (Checkland and Holwell, 2007). This will allow others to recover the research process later.

While action research can be immediately useful by solving a concrete problem, it is hardly academic *research* unless there is also an element of contribution to or development of theory. Baskerville and Pries-Heje (1999) suggest using methods drawn from grounded theory in AR theory development. The idea behind grounded theory is to have a close relationship between data collection and analysis, and that theory can be developed by systematic analysis of the collected data through an iterative coding process (Myers, 2010). The three building blocks of grounded theory are concepts, categories and propositions. Concepts are the basic unit of analysis, a conceptualisation of the data. Categories are a higher level unit of analysis, in which concepts can be grouped. Finally, propositions are the relationships between concepts and categories, and between categories (Pandit, 1996). Baskerville and Pries-Heje (1999) suggest using this same data analysis process on data gathered from action research as a way to develop theory from AR. However, they admit that this process will be somewhat biased by the fact that the action researcher is likely to already have some categories and concepts from the data collection phase when starting with the data analysis.

Action research has been criticised for being similar to consultancy. Avison, Lau and Myers (1999) argue that a researcher without a research topic and who is not explicit in following the action research methodology, can easily end up functioning as a consultant. Another issue is how the action researcher can ensure that the knowledge drawn from the action

research can be useful to others.

Lack of critical distance and fresh outlooks can be another danger with action research. Because the researcher is immersed in the research situation for a long time, he or she can fail to discover important issues that someone with an outsider's perspective would see. Furthermore, after developing a close relationship with the practitioners who are under study, it might be difficult to discuss them objectively. The close involvement of the researcher can also dissuade the practitioners from being honest or disclosing information (Walsham, 2006). Finally, action research is very time-consuming, and its benefits must be weighed against less time-consuming forms of research (Walsham, 2006).

3.2 Case Study

A case study, according to Yin (2002), is an empirical investigation of a phenomenon in its real context, in particular when the line between the context and the phenomenon is blurry (cited in Myers (2010)). One typical issue regarding case studies is what constitutes a case. Stake (2005) argues that a case must alway be specific, thus a doctor can be a case, but *doctoring* cannot because it is not specific. Furthermore, he states that the boundary between case and context should always be clear enough so that one can decide whether a feature is part of the case or not (Stake, 2005).

Generally, case studies fall in one of three categories:

- intrinsic case study
- instrumental case study
- multiple case study

With intrinsic case studies, the goal of the research is knowledge of the case itself. The purpose of an instrumental case study is not one particular case, but to gain insights into a particular issue. The case is an *instrument* for obtaining knowledge on a more general level. Finally, multiple case studies investigate a common phenomenon through a number of cases. Thus each of these cases are in themselves instrumental (Stake, 2005).

With action research, the researcher is always deeply involved in the research context, immersing himself or herself in the situation. Researchers doing case studies can also be deeply involved in the context of the case, or they can study it from the outside. Walsham (2006) argues that there is a whole spectrum of involvement that a researcher can have under a case study, from "involved" to "outsider," something that is clearly different from action research.

One typical critique of case studies, especially single-cases, is that one cannot generalise findings from them. Any generalisation from the specific case is often unconscious, both with the researcher and the audience, but it can be difficult to justify scientifically (Stake, 2005). Flyvbjerg (2006) argues that this is not necessarily the case, depending on the case in question and

how it has been selected. Case selection is therefore clearly an important part of a case study, with implications on how the collected data can be used.

3.3 Methodology of This Thesis

From the time it was established more than a decade ago, HISP has been focusing on participatory action research following the so-called "Scandinavian tradition" of participatory design (Braa et al., 2007b). My research, too, is following this tradition of action research. A substantial part of my work can perhaps also be seen as a case study of the Ghana Health Information System and the DHIS2 implementation in Liberia. According to Avison, Lau and Myers (1999), however, there is a line between action research and case study, divided by the degree of immersion and participation in the research context. I believe I am on the action research side of that line.

3.4 Field Work

During my time working on this thesis, I have done a total of four trips to Ghana and one visit to Togo and Liberia. On the trips to Ghana, I worked with the Centre for Health Information Management (CHIM) in Accra, which is an office under the Ghana Health Service (GHS). In this section, I will give a brief description of what I did during my trips to West Africa.

The first visit I made was to Ghana, for two weeks in June 2011. There was initially some talk that there would be a training of trainers in Ghana during this period. However, as the time of the visit came closer it became apparent that the system would not be sufficiently complete for this. Instead, the main focus of these two weeks was to train the staff at CHIM in the reporting functionality of the DHIS2 software. I also made a manual documenting some of the reporting functionality, most of which was later incorporated into the global DHIS2 manual.

My second visit to Ghana lasted for three months, from mid August to mid November 2011. The work during this period falls into four categories. First, as during the first visit, I had training sessions with the DHIS implementers at CHIM. Second, I assisted in the customisation of the Ghana database. Third, I participated in the training of local personnel in a total of four regions around Ghana. And finally, I participated as a facilitator at the "DHIS2 Academy" workshop held in Accra in November.

In January and February 2012 I spent another month in Ghana. Once again, I trained staff at CHIM, worked on customising the Ghana database and participated in the training of one region. During this visit I was also given the opportunity to participate in the field work for a West African Health Organisation (WAHO) HIS evaluation. This included interviewing officers from several health programmes, as well as visiting

health directorates, hospitals, clinics and other health facilities in two different regions.

Together with one of the DHIS2 developers, I went back to Ghana for one week in March 2012. The focus of this week was on making the final preparations of the system, training of CHIM staff, again with a focus on reporting, and getting a handful of users started with DHIS2 as a last test before the rollout in April. We also had meetings at the Policy Planning, Monitoring and Evaluation (PPME) division of the GHS, where we discussed server administration and user rights.

In the last month of April and the first week of May, I participated as one of four facilitators at the "DHIS2 Database Training" in Lomé, Togo, and also spent a week in Liberia, assisting with the DHIS2 implementation there. At the training in Lomé, I worked with the five English-speaking countries that were present, helping with practical work on their country databases. In Liberia, which I visited with the same DHIS2 developer as in Ghana in March, we worked on setting up a server in the Ministry of Health, resolving various issues with the Liberian database, migrating historical data and also demonstrating DHIS2 for the staff in the ministry.

3.5 Methods

During my field work, I have employed many different methods of data collection. These will be presented in this section.

Field Notes

My main data collection method has been extensive field notes taken during all my trips. These notes include observations, thoughts and comments picked up during the course of the time spent in the field. In total, these notes have added up to more than 25 000 words.

Interviews

I have made several interviews during the field trips. These have mostly been unstructured and informal interviews made during the course of work at CHIM, at trainings with end users, or at workshops. For the WAHO evaluation I participated in, some more formal interviews were made, although these were also in an unstructured form.

Observations

The observations I have made have been just as important as the interviews. This has been especially valuable during trainings of end users, seeing how people interact and respond to the system, but also at workshops and when working on DHIS2 customisation.

Surveys

While I have not personally conducted any surveys, CHIM used a survey to get feedback from end-users at DHIS2 trainings. The survey was formulated to get feedback on the training, but users often gave comments on the actual system as well. The survey is found as appendix A. I used these surveys to get a better understanding of end users' perceptions of both the training and the software.

A survey was also handed out to the participants of the "DHIS2 Academy" workshop, giving valuable information from the participants there. This survey along with a summary of the responses can be found as appendix B.

Electronic Communication

Electronic communication has been a valuable source of data. Both email and instant messages between myself and the staff at CHIM, managers in GHS and with the DHIS2 developers, and also communication with users in Ghana through the built in feedback and messaging functionality of the DHIS2 software.

Various Documents

Finally, documents on various aspects of the DHIS2 implementation in Ghana has been valuable. This includes documents from the GHS, GHS partners, the Ministry of Health in Liberia, and the University of Oslo.

Chapter 4

Background

In this chapter, I will give some background information on different topics that are relevant for this thesis. I start by providing details on the Health Information System Programme (HISP), before zooming in on the West African region, Liberia, Ghana and the Ghana Health System.

4.1 HISP

The Health Information Systems Project (HISP) has its roots in post-apartheid South Africa in the second half of the 1990s. It started as a collaboration between researchers at the universities of Oslo and Cape Town, and the aim was to develop a software to support a district-based health information system in South Africa (Braa and Hedberg, 2002). The result was the District Health Information Software (DHIS), a Microsoft Access-based system developed through close user participation. From the beginning, research in HISP has been built upon participatory action research (Braa and Hedberg, 2002).

After DHIS version 1 became the national standard in South Africa in 1999, HISP piloted and implemented the software in other developing countries. In 2004, work on DHIS2 began, spurring further growth. HISP is today a loose network of researchers, universities, implementers and individuals, with several "nodes" across the world (Sæbø et al., 2011b). Among the main nodes are the ones at the University of Oslo, in South Africa, Vietnam and India (Sæbø et al., 2009).

The HISP group at the University of Oslo made an agreement with the government of Ghana, through the Ghana Health Service in 2010, under which the University agreed to support the implementation of DHIS2 in Ghana. My visits to Ghana have been as a part of this agreement.

4.2 West Africa

West Africa is a diverse region, with different peoples, climate, history and colonial heritage. Sixteen countries are normally regarded as making up the West African region: Benin, Burkina Faso, Cape Verde, Côte d'Ivoire,

The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, and Togo (Encyclopaedia Britannica Online, n.d.[b]). In total, 300 million people live in West Africa, half of them in Nigeria. Due to their colonial heritage, all of these countries have either French, English or Portuguese as an official language. Politically, some countries have been peaceful for decades, others, notably Sierra Leone and Liberia, were ravaged by civil wars lasting into the 2000s. Coups are still endemic in parts of West Africa, while relatively free and stable democracies have developed in other countries.

Figure 4.1: Map of West Africa. From World of Maps (n.d.[a]).

With regard to economic development, the differences are also substantial. Using the common measure of Gross Domestic Product (GDP) per Capita, West Africa scores low in general, with figures (2010) ranging from a low of 219 USD in Liberia to 3244 USD in Cape Verde (United Nations Statistics Division, 2012). Looking at the development status more broadly, using the Human Development Index (HDI), West Africa is the lowest scoring region in the world. Only Nigeria, Ghana and Cape Verde is categorised as "average" countries, the rest are in the lowest category (United Nations Economic Commission for Africa, 2010). While there have been improvements since the turn of the century, West Africa is still lagging far behind in terms of development. Mali and Cape Verde are the only West African countries not below the average for Africa in terms of access to health services (United Nations Economic Commission for Africa, 2010).

All West African states except Mauritania are members of the Economic Community of West African States (ECOWAS). The purpose of is to promote economical integration (The Economic Community of West African States, n.d.). However, ECOWAS also has an agency for health related work, the West African Health Organisation (WAHO). Since becoming operational in 2000, WAHO aims to be "a proactive instrument of regional health integration" in West Africa (West African Health Organisation, n.d.).

4.3 Liberia

Liberia has a special history in West Africa, as it has not been colonised by a European power, but became a homeland for freed American slaves in the 19th century. It is a small country, with a population of about 4 million. Life expectancy (2008) is 57.3 for females and 54.3 for males (Encyclopaedia Britannica Online, n.d.[a]). Administratively, the country is divided into 15 counties. In part due to a civil war that ravaged the country between 1989 and 2003, Liberia is among the least the developed countries in the world, faring poorly when looking at indicators such as GDP and HDI (as shown above). In the aftermath of the civil war, substantial humanitarian aid has been provided. A number of different donors and Non-Governmental Organisations (NGOs) are therefore involved in the country, and are important stakeholders within the health sector.

4.4 Ghana

Ghana is a former British colony, and is thus among the countries in West Africa where English is an official language. It became independent in 1957, as one of the first African states. Ghana went through a turbulent period in the 1970s and 1980s, with severe economical problems and political instability. From the 1990s onward, however, economic restructuring have led to a high growth rate, and several peaceful transitions of power have taken place. On the Economist's "Democracy Index" for 2010, Ghana is categorised as a "flawed democracy," the same category as for example France or South Africa (Economist Intelligence Unit, 2010).

Both in terms of population and economy, Ghana is among the more influential states of West Africa. It has a population of about 24.6 million. In the North, muslims make up the majority of the population, while the South is predominantly Christian. Life expectancy is 58.5 years for males and 60.8 years for females. The GDP per capita of Ghana is the second highest in West Africa, behind only Cape Verde, and Ghana was reclassified by the World Bank in 2011 from a low income to lower middle income country (The World Bank, 2011). The country is divided into ten administrative regions.

4.5 The Ghana Health System

The top governing body of the health system in Ghana is the Ministry of Health. The Ministry is the policy maker for the health sector. However, Ghana Health Service (GHS) is the agency responsible for implementing national policies, improving access to health services and managing health service resources (Ministry of Health, n.d.). While the GHS is funded by the government, it was separated from the Ministry of Health to ensure that its employees were no longer under the regular civil service law (Ghana Health Service, n.d.).

Figure 4.2: Map of Ghana. From World of Maps (n.d.[b]).

Administratively, the Ghanian health system has four sub-national levels: regions, districts, sub-districts and community (Ghana Health Service, n.d.). The districts and regions are common for the whole public sector, whilst the sub-districts are unique to the health sector. The sub-districts are generally not staffed, and the sub-district "office" is usually a designated health facility in that area. At the community level, a 1999 initiative for "Community-based Health Planning and Services" was introduced, where the country is divided into zones served by community health workers (Nyonator et al., 2005). However, not all the demarcated zones are yet functional.

In terms of health information, the data flow generally follows the hierarchy of the health system. Facilities and CHPSs report to the sub-districts, where data is compiled. From the sub-districts, both the compiled data and the individual reports from facilities are sent to the district level, where it is compiled again. From the districts, some data is sent directly to the national level and some through the regions.

At the national level, the Centre for Health Information Management (CHIM) is responsible for data collection and management in the GHS. CHIM is under the Information Monitoring Evaluation (IME) department of the Policy Planing Monitoring and Evaluation (PPME) division. It has a staff of about 15 people, and is lead by the chief biostatistical officer of GHS.

Chapter 5

Evaluation of the Ghana HIS

From April 2012 Ghana started using DHIS2 as a core part of the national health information system. To understand the consequences of this introduction, it is important to know how the previous system worked at the various levels, how information was collected and used, the system's strengths and weaknesses. In this section, I present the empirical data on this topic. This evaluation is partly based on knowledge I have gathered through working on the DHIS2 implementation in Ghana over many months. The primary source of data, however, is from the WAHO HIS evaluation I took part in.

I will start by looking at the development of an integrated reporting system in Ghana the last 20 years. Then, I describe the current data flow, before looking at how the current HIS works at the national and sub-national levels.

5.1 A Recent History of Integrated HIS in Ghana

The roots of health data collection in Ghana are long and strong. Campbell, Adjei and Heywood (1996) reports that even in the 1990s, Ministry of Health reports dating from the 1920s could be found. In more recent years, an attempt to make an integrated management information system started in the early 1990s. This was a paper based system meant to integrate and streamline reporting requirements, and improve the use of information. An essential dataset was developed, as well as self-assessment and feedback reports to help users at the lower levels review their performance (Campbell, Adjei and Heywood, 1996). The long term goal was an improvement in health service delivery.

This system was piloted in three regions in the first half of the 1990s, but it failed to scale into a national system (Campbell, Adjei and Heywood, 1996). Thus in the second half of the 1990s, the situation was one in which a large number of different and often overlapping forms were used, some national and some regional.

Work began in 2002 on a new integrated HIS, called the District Wide Computer Assisted Management System (DWICAMS). The work on DWICAMS was led by CHIM. The system was piloted in a total of 20

districts from all 10 regions, but as with the paper based system, it failed to scale. However, DWICAMS eventually morphed into a system called the District Health Information Management System (DHIMS). Development and piloting of DHIMS began in 2004, and in 2008 it was implemented nationwide.

Developed initially with funding from the European Union, DHIMS was based on the Microsoft Access platform. It was installed in all district and regional headquarters, as well as district and regional hospitals. Several GHS divisions and health programmes took part in the process of developing DHIMS and had their reporting formats included in the system. Thus when the DHIMS was rolled out in 2008, it was an important step towards an integrated HIS in Ghana.

5.1.1 Problems with DHIMS

We were told by both district and regional health information officers that problems with DHIMS started to appear soon after it was rolled out. The software was developed by a private company, who had the source code to the application. There was no capacity at CHIM to customise the software. Thus when funding dried up, it was no longer possible to fix bugs, change the reporting tools or otherwise improve DHIMS. While volunteers from Japan International Cooperation Agency (JICA) worked with CHIM to solve these problem, little could be done because the DHIMS source code was lost.

As a consequence of the problems with DHIMS, various divisions and programmes again started with parallel reporting, typically using Excel templates. The Reproductive and Child Health (RCH) division won a large grant from Global Fund and started to develop their own database application. Again, this application failed to scale. An officer in the RCH division explained that it was abandoned both due to technical difficulties and political pressure from within the GHS.

In addition to the more technical issues, there were issues caused by how DHIMS was managed. Only Health Information Officers (HIO) were given training in using DHIMS, and consequently they took ownership of both the application and the data. As one GHS director put it, they became "high priests of the DHIMS". Thus even though there was supposed to be several users of DHIMS in each district, including public health nurses and disease control officers, usage was mostly limited to the HIO only.

Despite these problems, DHIMS was used nationwide from 2008–2011, albeit with much of the data being reported in parallel systems as well. In 2010, GHS started looking at a replacement system. Efforts were made to include as many of the divisions and programmes as possible in this process, and to learn from the problems of DHIMS. It was decided to use DHIS2 as the new application platform, and a memorandum of understanding between GHS and the University of Oslo was signed in late 2010. Work on customising the new DHIMS, called DHIMS2, began early in 2011. This process will be described in detail in the next chapter.

5.2 Data Flow

Before going into detail on how the Ghana Health information system works at the various levels, I will describe the general flow of data in the system. Note that most of the data collection with regard to this chapter was done while DHIMS was still used, thus there might be some changes now that DHIMS2 has been rolled out which is not reflected here.

Data collection starts with the registries and tally sheets at the facilities. There are a number of different registers at each facility, typically one for each service that is provided. At visits in the facilities, I was shown registries for outpatients, deliveries and inpatients, consulting room registries and others. At the hospitals, some of these registers have been computerised. In addition, there are tally sheets for some services, to facilitate the compilation of reports.

Figure 5.1: Studying facility registers in a health centre in Eastern Region.

At the end of each month, or quarter in some cases, summary reports are made at the facilities. This data is taken directly from the tally sheets, or is tallied from the various registers. Some of these forms are quite simple tables with a count, whilst others involve the calculation of coverages and other indicators.

Data from all facilities are normally summarised into sub-district reports. Sub-districts are more of an administrative tool than a functioning administrative office, thus the work of compiling sub-district reports are usually made at a health centre in the sub-district. This was the case in all sub-districts we visited. From the sub-district, both the individual facility reports and the sub-district reports are sent to the district. An exception is the district and regional hospitals. They have DHIMS/DHIMS2 installed locally, and therefore enter their own routine data and send it electronically to the districts. The also enter anonymous patient data on inpatient cases and deliveries into DHIMS, in what is called a line listing.

The district level is where these paper reports are computerised. DHIMS is supposed to be the integrated system in which all data is entered. However, most programmes and divisions have their own parallel

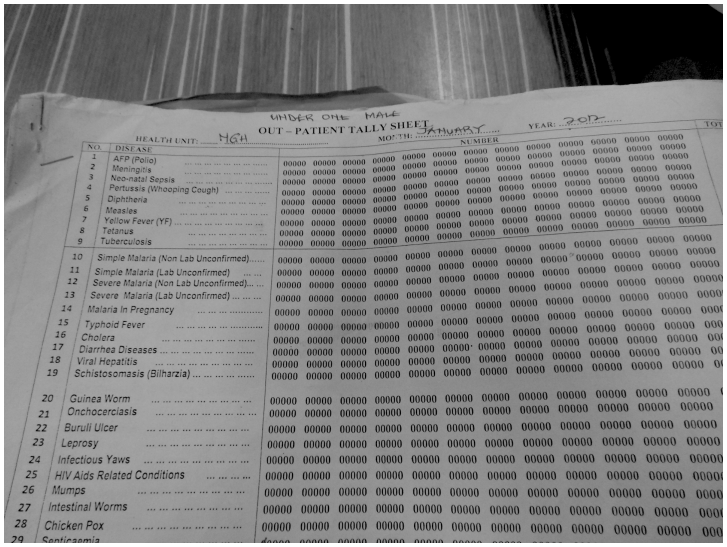


Figure 5.2: Tallysheet for outpatient cases at a district hospital I visited. The image shows parts of the page for male patients under 1 year. In total there are 22 pages like this filled every month for both genders and all age groups.

systems as well. Thus in the district, data is entered from the paper forms into DHIMS *and* other parallel systems. For DHIMS, this work was usually done by the district health information officer, whilst most of the health programmes doing parallel reporting have a so-called *focal person* responsible for that programme doing its data entry.

From the districts, the DHIMS data was sent to the regional health directorate, where data from all the districts were merged into a regional database. For the parallel systems, the data flow varies somewhat with regard to whether it is sent through the region or directly to the national level. At the regional level, no changes to the data in DHIMS were allowed - if inconsistencies were discovered, these had to be corrected at the district level after consultations with the facilities, and the data was then re-sent to the region. The regional staff explained that this was a major cause of delays.

Once data from all districts in a region was merged, the regional database was sent to the CHIM office. There, the DHIMS databases from all the regions were merged into a national database. Data in the parallel systems are sent to the respective national headquarters.

5.3 HIS at the National Level

In this section, I will look at the status of the Ghana HIS at the national level. I will first look at fragmentation and vertical reporting, secondly the availability of resources at the national level. Third, I analyse the timeliness and completeness of the national DHIMS database, and finally present the National Health Insurance Scheme (NHIS).

5.3.1 Fragmentation

As mentioned in the previous section, several divisions and programmes were part of the first integrated DHIMS system. This included important actors like the Malaria programme, the RCH division and the Disease Control division. However, despite being part of the integrated systems, they use parallel reporting systems as well. In interviews, representatives from the programmes said the reason for this was that the timeliness and accuracy of the data in DHIMS was not good enough, as well as the other issues with DHIMS discussed above - notably that there was no capacity to affect changes on the data collections tools.

With the new DHIMS2 being implemented from 2012, several programmes that were *not* in the DHIMS also participate, for example the National Aids Control Programme (NACP) and the Tuberculosis (TB) Programme. However, despite the fact that essentially all divisions and programmes participate in DHIMS2, most express that the parallel reporting will continue until DHIMS2 has been proven to work consistently. One manager in the immunisation programme explained that the data in DHIMS2 will only be used as a validation tool against their excel reporting system for now, and only when the data is timely and equal to the Excel system will they consider stopping the parallel reporting.

One officer working on the DHIMS2 implementation told me on several occasions that he had a feeling that many of the programmes *want* the system to fail, since they have all the resources they need to run parallel systems of their own. Programmes working with issues such as malaria, HIV/AIDS, child health and immunisation are often relatively well-resourced and can therefore afford to have vertical reporting systems. That is not necessarily the case with those working in areas that have received less attention from donors, however. The nutrition department told us that they looked forward to the new system, which has their data collection form included. They have not had the resources to do parallel reporting, and consequently had to rely on others to get the data they need.

A good illustration of the attitude of some of the programmes was given by an officer working in the immunisation programme. He explained that the Disease Control division had decided to build a new office block that would house all the programmes under that division. Today only the skeleton of the building is ready, and no work has been done for the last three years due to disagreements on funding. In the meantime, the NACP programme has spent its own money to build a new office for itself. He argued this was similar to the situation with reporting systems: if the integrated system is not to their liking, programmes will build something for themselves rather than trying to make the common system work.

5.3.2 Resources

From the above discussion it is perhaps clear that resources at the national level is unevenly distributed. Some programmes get substantial funding from external donors and are well resourced, in contrast to those relying

only on internal funding. A case in point is CHIM, which is in charge of both DHIMS and DHIMS2: for periods during the implementation of the *online* DHIMS2, there was no internet access at the CHIM office because of lack of funds to pay the internet bill. On at least one occasion during my time in Ghana, the head of CHIM payed the internet bill out of his own pocket because getting funding from GHS was slow and difficult. And during power black-outs, the staff at CHIM sit in the dark listening to the hum of the generators outside the NACP and Immunisation programmes next door.

Resource issues also have more direct effects on the running of the HIS. For example, I found that patient registers and other data collection instruments have been in shortage in parts of the country due to lack of funding for printing at the national level. And while the staff at CHIM has been strengthened substantially in the last year, funding for monitoring and evaluation as well as review meetings around the country has been limited. When I first came to CHIM, the office had just received a car after being without one for a period. This car, originally donated from the Global Fund, was lent to CHIM by one of the vertical programmes who seemingly had more cars than they actually needed.

5.3.3 Timeliness and Completeness of DHIMS data

The various programmes and divisions gave different explanations as to why they have established parallel reporting systems when we talked to them. But one of the most common reasons given was that the timeliness and completeness of the DHIMS data was not good enough. Giving exact figures on how the timeliness of the data is in DHIMS is difficult, but it does seem as though the data can be up to several months old before it reaches the national level. When I migrated data from DHIMS to DHIMS2, it was not until March that all the 2011 data finally reached CHIM and eventually me.

It is also difficult to give an exact figure for the completeness of the data. While data for the number of reports submitted to DHIMS 2008–2011 is available, it is difficult to know how many reports *should* have been completed. An admittedly *very* rough estimate based only on the general type of facility, not any detailed information on the services they provide, indicate a completeness of 60–70% in 2011 for the most complete datasets. However, when looking at the trend, it is at least clear that the completeness in DHIMS has increased substantially from 2008 to 2011.

5.3.4 The National Health Insurance Scheme

In 2003, the National Health Insurance Scheme (NHIS) was established for the purpose of covering the primary care services in Ghana (National Health Insurance Scheme, n.d.).[1] NHIS insurance claims from the whole country is sent monthly to the NHIS, which thus sits on a substantial

[1] Unfortunately, I have not been able to talk to any representative for the NHIS personally while in Ghana.

amount of data on the morbidity in Ghana. However, there is no link between the NHIS and the data collection done by the GHS, although both institutions collect essentially the same data.

Staff we spoke to in the districts and facilities reported poor coordination between the GHS and NHIS caused the problems. Both institutions require reports based on a set of diagnosis. However, the diagnosis and codes used are not the same. Because NHIS money is now the main source of income for facilities, facilities must make sure the claims are refunded. Thus they must set a diagnosis that is covered by the insurance scheme even when that is not the specific diagnosis given by the physician. Because the diagnosis must be "adapted" to the insurance scheme, data is lost in the reporting done to GHS. One officer explained: "it will be an interesting research to look at the changes in the trend of diseases after the introduction of the Diagnostic Related Grouping (DRG) for insurance claims."

Figure 5.3: vSat dish outside a district hospital in Eastern region.

The NHIS has built up a satellite (vSat) infrastructure connecting the regional and district hospitals across Ghana to a central database (shown on figure 5.3). Despite the resources put into this, the only purpose of the system as of today is to check the validity of insurance cards, and the NHIS has instructed the hospitals that the whole system including the connected desktop computers should not be used for any other purpose. According to staff I talked to at different hospitals, patients rarely show up with expired or false cards. The director of one regional hospital we talked to was very unhappy with the vSat system, and expressed that he thought it was a waste of resources to build such an expensive infrastructure serving no real purpose.

5.4 HIS at the Sub-National Levels

I have looked at the situation at the national level, and now continue to the sub-national level: regional and district health directorates, sub-districts, hospitals, health centres and other facilities. How is the situation here in terms of human and other resources, how is the quality of the data, and is

the data used? Patient data is also relevant at this level. Finally, I will look at the issue of fragmentation.

5.4.1 Human Resources

> We have problems with HR and training, it is not prioritised. When people don't understand the data, quality will be bad (Officer at the regional office in Volta).

Human resources (HR) seems to be one of the major problems at the sub-national level. There are several issues:

- HR for information is not prioritised.
- Duplicate reporting wastes valuable time.
- Understanding of data among staff is poor.

The impression given by staff both in the regions and district was that tasks related to information was not valued. First of all, there is not enough personnel trained in data collection and analysis. While a diploma course for health information has been established, not enough students graduate to cover the needs across the country. Furthermore, some officers at the regional level which we interviewed argued that the training given in the diploma course did not cover many aspects of the typical work of a health information officer.

Those that *are* trained in health information do not feel valued. One regional officer stated "I wouldn't want my daughter to work as a health information officer - there is no way to get up [in the system]": he felt that positions within health information management were not valued, and that there was little room for promotion. As a consequence, the rotation of staff is big.

Worsening the issues of limited HR is the fact that workers spend a lot of time on duplicated reporting. This is the case both at the point of care and at the district and regional levels. At the facility level, health workers reported that they commonly spent one to two days every month on filling out reporting forms. This is time that could otherwise have been spent caring for patients. Many of the reports contain the same information, causing an unnecessary burden. At the district level, this duplication of work continues as the district staff have to type in the facility reports with the duplicate values. Parallel electronic reporting to the region and national level also mean that the paper-based reports from facilities must be entered into both DHIMS and parallel systems.

The third issue with regard to HR is lack of training and poor understanding of the reported data. This is a problem at the facilities in particular. One hospital director told us that traditionally, anyone who could read and write could be hired to fill patient registers and reports. While some training is now given, increasing the capacity of these workers is a slow process. According to some district staff we interviewed,

poor understanding of both information and its importance is especially a problem among community health workers. However, we also saw during our visit community health workers who seemed to both use and understand their registers and the periodic reports.

5.4.2 Other Resources

When it comes to non-human resources, the issues are similar to those at the national level, although the resources of the vertical programmes are less prominent. Both regions and districts have limited resources to go on monitoring and evaluation visits. And because of delays in the printing of forms and registers at the national level, we saw cases where the district stores were running low of such supplies. Other issues included limited computer hardware and accessories, for example external hard drives for backup of DHIMS data. The regional and district health directorates we visited all had some form of internet connection, as did the district and regional hospitals. In health centres and clinics, however, computers were a rare sight.

5.4.3 Data Quality, Timeliness and Completeness

For data to be useful to inform decision making, it has to be timely and of sufficiently good quality. It also needs to be complete. Timeliness seems to be a major issue in Ghana. The main delay is not from the facilities, but at the district or regional level: if there are inconsistencies in the data reported, the facilities must be contacted to reconcile the data. This leads to delays in the onward reporting to the regional level. Although the districts seem to be encouraging facilities to have data validation meetings, and the districts are encouraged to do the same, my impression is that such meetings are often not held. Another cause of delays was DHIMS, which requires all facilities or districts to report before data can be sent to the next level. This was discussed in the previous section.

When it comes to completeness, the districts report that they do get reports from most facilities every month, although they are not always on time. The exception is the private facilities. While private facilities are asked to report to GHS, they cannot be coerced. Many do not report, usually to save money, but in some cases also because they do not want to provide details of their operations. We were told that on occasion, district health directorates have trained staff working at private facilities on data collection, and there has also been talk of the government paying for staff to work on reporting in private facilities. Reporting from religious facilities is generally closer to those that are government owned.

The main impediment to data quality is human resources. As was discussed above, understanding among staff at the lowest level is sometimes lacking, and combined with high reporting requirements this means that data quality suffers. Sometimes, negligence can also lead to poor data quality. For example, one regional officer told us of cases where during outreach immunisation activities the number of children

immunised were not tallied underway, or where the amount of vaccines brought to and from the field were not recorded. Finally, as is the case in any paper-based data collection system, there are always chances of errors being introduced through simple calculation errors.

One final issue in terms of data quality is population estimates. Population data is used to calculate many important indicators, for example immunisation coverages. In the GHS, the lowest level at which population data is used is the sub-district.[2] However, the sub-district as an administrative unit is exclusive to the GHS, thus there is no sub-district census data available. District staff must estimate the sub-district population based on district population data and facility catchment populations. During visits to district health directorates, we saw examples of immunisation coverages computed for sub-districts that were far above 100%, and this was explained by the difficulty of getting reliable population figures.

5.4.4 Data Usage

Data collection serves no purpose unless the data is analysed and the resulting information used for management of the health system. At the facility level, data is needed for the management of individual patients, and for following trends in the utilisation, quality and coverage of the provided services. For higher levels, patient management information is not needed, whilst measuring the impact of the health service becomes increasingly important (Braa and Sahay, 2012).

The paper based system used at the smaller facilities seems to work well, except the issues of duplication in data collection. Registers were kept for the various departments, and books used to allow follow-ups on pregnant women in the communities, children in the immunisation programme, schedules for out-reach visits and so on. While some of these tasks can be quite cumbersome and time consuming to manage in a paper-based system, the management of patients appear to work quite well: the data is used.[3]

Staff at the facilities we visited seemed diligent in tallying the registers and filling the monthly and quarterly reports. Furthermore, tables and graphs showing trends in for example antenatal coverage and immunisations were made and displayed on the walls (see figure 5.4). Facilities have quarterly review meetings at the sub-district level where the performance and issues are presented and discussed. However, while this indicates that information is regularly generated and analysed to a degree, it is difficult to assess if it has any impact on the management of the individual facilities.

[2]Some programmes also use facility catchment population, notably the immunisation programme.

[3]The district and regional hospitals have a somewhat different scale and function in this regard, their specific issues with regard to dealing with patients will be discussed in the section.

Figure 5.4: Information presented on the wall in a rural clinic.

The reports from the facilities are normally aggregated at the sub-district level before being sent to the district. However, since there is normally no staff employed in the sub-districts, little analysis and use of data happens here.

Data usage in the district and region seems to be focused on regular review meetings and fixed reporting formats. In the districts, the performance of the individual sub-districts are presented and reviewed, and in the region districts present their performance. District staff explained that they acted for example if the immunisation coverages were too low, and they assisted facilities if service delivery indicators were poor. Despite this, it seems that the focus of data usage in the districts were more towards the completion of reports and regular meetings than on real analysis and management based on the data. As I will discuss in the next chapter, I was told by the staff at CHIM that most information officers in Ghana only wanted the reports required of them, and had little interest in other reports even if they would be better for analysis.

5.4.5 Data Management at the Hospitals

The district and regional hospitals face some challenges different from those at the smaller health centres and clinics. They deal with a far larger number of patients, have more separate wards and must deal with inpatients in addition to outpatients. On the other hand, they are generally better equipped in terms of electricity, computers and internet access.

The hospitals we visited all had some sort of electronic patient registration, in which the particulars of patients were registered. These did not store any medical information, but were used for administrative purposes - for example, some hospitals used them to link patients with their paper medical records. Hospital staff explained that there was no

clear national policy on how to deal with patient records: how long they should be archived, how to store them and so on. Each hospital had its own system for archiving records, and it seemed the quality of these varied quite a lot. The director of one regional hospital explained that losing up to 10% of the records was not uncommon.

Figure 5.5: Records rooms at two different hospitals. The quality of patient records management was varying from facility to facility.

There is currently no nationally recommended electronic hospital management system in Ghana, however, the majority of hospitals we visited used a software developed in Ghana called HAMS (Health Administration Management System). While this system has many modules that cover various use cases, including as an electronic medical records system, most hospitals we visited only used modules for general registration of patients. There is no national support for implementing such systems, so the hospitals pay using internally generated funds (IGF).

Figure 5.6: Electronic registration of outpatients at a district hospital.

A common topic that concerned staff we talked to at the hospitals was integration of the various electronic patient systems and DHIMS2, as more and more data is registered electronically at the hospitals. No work has yet been done regarding this issue. DHIMS2 supports import of data aggregated from other systems, so this is something that should be dealt with in the near future.

5.4.6 Fragmentation

Fragmentation was discussed at length above with regard to the national level. Is the situation similar at the lower levels? Generally, each programme has an appointed *focal person* in each region and districts, responsible for tasks related to that programme - including health information. At the district level, one person is often focal person for more than one programme at the same time.

Cooperation between the focal persons was reported to be good in the districts and regions. One regional officer explained that while problems with cross-programme cooperation at the national level was mostly due to politics, any problems that might occur at the lower levels were likely to be for personal reasons.

Health information staff at the district level expressed that they were tired of the duplicate work caused by the vertical reporting. In areas such as RCH, malaria control and immunisation, data must be entered both in DHIMS and in the vertical systems. There were fears that this problem would even increase with DHIMS2, because more programmes have their datasets included.

Chapter 6

Implementing DHIS2 in Ghana

In this chapter, the process of implementing DHIS2 in Ghana will be presented. I will start by giving a description of the DHIMS and DHIS2 software, before a brief overview of the implementation process will be given. Some of the challenges of customising DHIMS2 will then be presented, followed by the process of setting up a server, discussions about piloting and the training of users around the country. The process of migrating data from DHIMS to DHIMS2 will then be discussed. Finally, I look at the experiences from the first weeks of usage after the nationwide implementation.

Note that I use DHIS2 when discussing the software, and DHIMS2 when discussing the Ghanian systems *based on* DHIS2.

6.1 The Software

This section will give an introduction to both the DHIS2 and the original DHIMS software, with the main focus on DHIS2. Having some background knowledge on this topic is important in order to understand the issues that will be discussed later in the chapter.

6.1.1 DHIS2

Before going into the technical details of DHIS2, a brief history of DHIS can be useful. Development of the first version of DHIS started in South Africa in the second half of the 1990s. It was developed with heavy involvement from end users, and the goal was to make it as flexible as possible (Braa and Hedberg, 2002). It was based on Microsoft Access, and was thus limited to standalone, offline installations. However, data could be exported and imported between databases. Development of DHIS2 started in 2004, led from the University of Oslo rather than South Africa. The goal was to create a version of DHIS that was built on modern technologies, was database- and platform-independent, and that was web based - even though it would also work in offline installations (Staring and Titlestad, 2006).

DHIS2 Building Blocks

The main building blocks of a DHIS2 database are

- data elements
- date element categories
- datasets
- indicators
- organisation units

Data elements are the basic units for data collection. An example of a data element is "malaria cases". Data elements are grouped into *datasets*, usually corresponding to a paper form. Normally, one field on the paper form corresponds to one data element. However, by using *category combinations* each data element can be disaggregated into categories. For example, one can make categories for "Age" (i.e. "$<$ 5 years," "$\geq$ 5 years" and "Gender" and combine these into a category combinations for "Age and gender". To continue with our "malaria cases" example, by using "Age and gender" as disaggregation, we now have one data element with four possible data values: "malaria cases $<$ 5 years, male", "malaria cases $\geq$ 5 years, male", "malaria cases $<$ 5 years, female", and "malaria cases $\geq$ 5 years, female" (see figure 6.1).

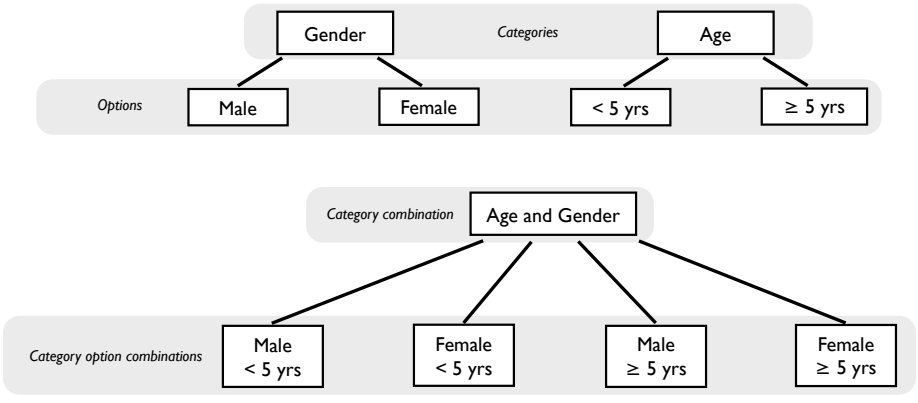


Figure 6.1: Illustration of two categories being combined into one category combination, and how the disaggregation will affect a data element using this category combination.

Indicators are values calculated from one or more data element using a specified formula. For example, given the data elements "antenatal

registrants" and "antenatal visits," we can create an indicator for "average antenatal visits per registrant" by dividing "antenatal visits" by "antenatal registrants". Finally, *organisation units* are the facilities, districts and so on that make up the organisational hierarchy of a given country. They are linked to each other to form a tree, with the country as the root.

Organisation of Data and Metadata

Data is stored in the DHIS2 database independently of the datasets (reporting forms). This means that the same data element can be used in several datasets, and data entered in one of them will appear in all the others. It also means that datasets can be added, changed or deleted without affecting the stored data values, as long as the data elements are not removed.

Data elements, indicators and organisation units are organised in *groups*, to make them easier to find when doing analysis. The groups are grouped in *group sets*. Generally, a data element, indicator or organisation unit can be placed in many groups, however, it can only be in one group per group set.

Aggregation of data in the database is done by a "data mart," which stores the aggregated data element and indicator values in the database for fast retrieval. Initially, it was possible to aggregate data on the fly as reports were being generated. However, this is no longer possible as it is very resource-intensive, and works poorly in environments where the system is used by more than one user at a time. The data mart can be run manually by an administrator, or be scheduled to run every night. The latter approach is used for online installations.

DHIS2 Modules

DHIS2 has many different modules, serving various purposes. I present here those most relevant in order to understand the implementation process in Ghana.

Perhaps the most important is the data entry module for routine data, where regular data entry takes place. The user selects the organisation unit (facility) he or she wants to enter data for, then selects the dataset and finally the period. The dataset is then displayed for the user to enter data, as shown on figure 6.2. The data can be immediately validated by using "validation rules" (explained below) or by auto-generated minimum and maximum values. Upon completing data entry, the user can click a "complete" button to register the dataset as completed. Completeness-reports can then be run based on the number of completed datasets.

For checking the quality of the data, there is a "Data Quality" module. This module lets users run various types of data quality checks, including checks based on auto-generated minimum and maximum values, outlier analysis based on standard deviations, and validation rule analysis. Validation rules are rules configured by the administrators that can be used during data entry and for data quality reports (see figure 6.3). Validation

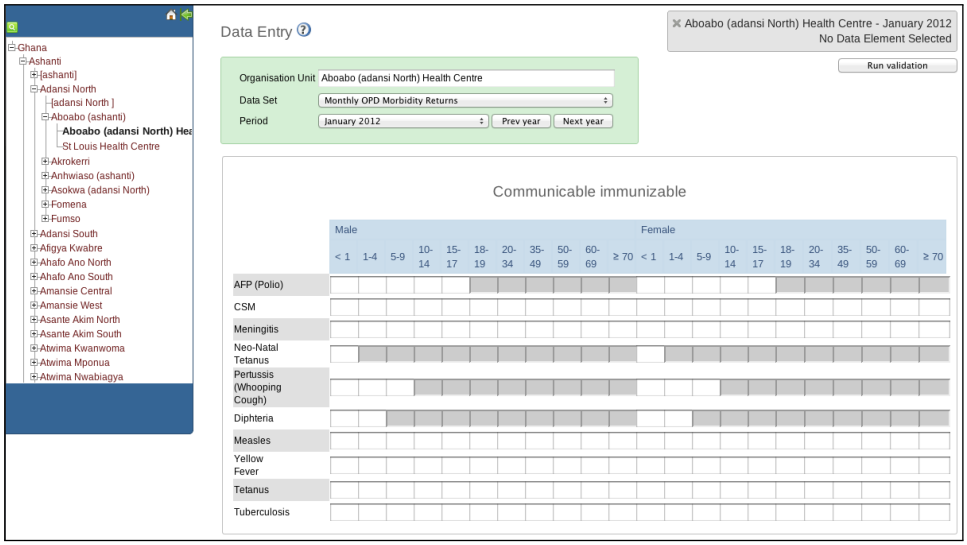
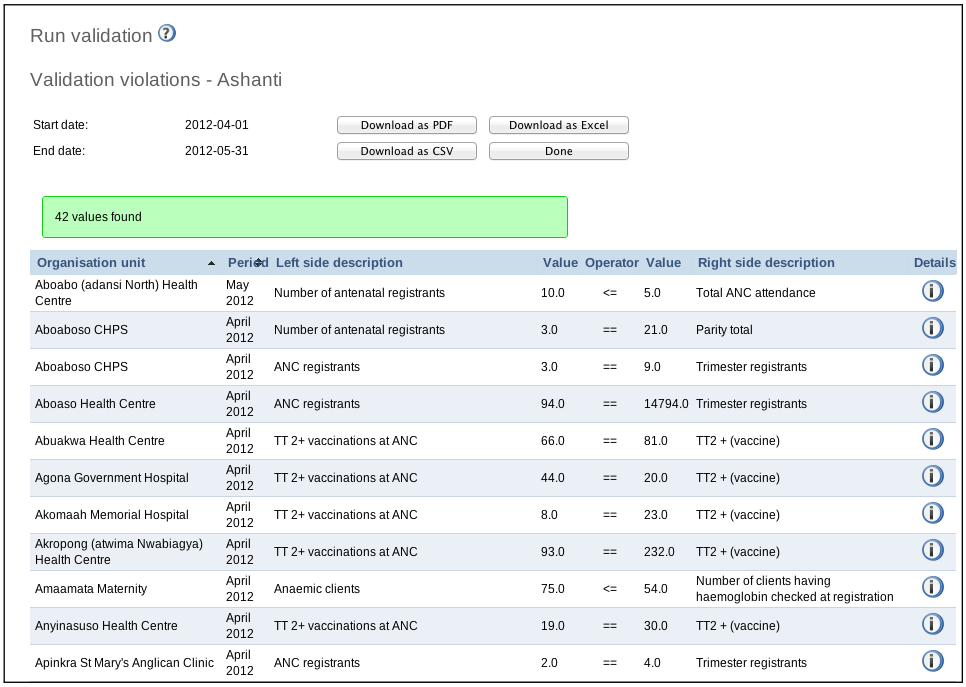


Figure 6.2: The data entry screen of DHIS2.

rules use logic to compare data elements and find inconsistencies. For example, given the data elements "number of deliveries" and "number of babies," a rule can be created to say that the value in "number of babies" should always be equal to or greater than the "number of deliveries".

A module for "Name-Based Data Records," originally called the "Tracker," has functions for entering and reporting on patient level data. The focus is on tracking patients though programmes with several stages, for example for antenatal care. The module was developed in India to be used together with DHIS2 Mobile, but is currently not widely used anywhere. After Ghana requested a way to register anonymous events in DHIS2, this function was added to the Name-Base Data Records module. Data entry for anonymous events work similarly to that of routine data, with the user selecting the organisation unit, dataset and reporting date, and is then shown a form that can be filled in (see figure 6.4).

Next is the reporting module, which includes various types of reports. The simplest report type is the "dataset report," which summarises data over time and up the hierarchy of organisation units in the same layout as is used for data entry. The dataset report thus does not allow comparison of data over time or across organisation units. "Report tables" are a second type or report, which are data tables that can be customised to show any data element, indicators, or completeness value for any organisation unit in any period. Through the use of relative periods and relative organisation units, the same report table can be re-used by users at different levels and over time. Output from report tables are shown in DHIS2, but can also be downloaded to for example Microsoft Excel. Standard reports are reports based on report tables, but with a customised layout which can include graphs. See figure 6.5 for an example. They are presented as PDF-files. The customisation of these standard reports are done in a third party application. Report tables and standard reports are shared by all



Organisation unit	Period	Left side description	Value	Operator	Value	Right side description	Details
Aboabo (adansi North) Health Centre	May 2012	Number of antenatal registrants	10.0	<=	5.0	Total ANC attendance	
Aboaboso CHPS	April 2012	Number of antenatal registrants	3.0	==	21.0	Parity total	
Aboaboso CHPS	April 2012	ANC registrants	3.0	==	9.0	Trimester registrants	
Aboaso Health Centre	April 2012	ANC registrants	94.0	==	14794.0	Trimester registrants	
Abuakwa Health Centre	April 2012	TT 2+ vaccinations at ANC	66.0	==	81.0	TT2 + (vaccine)	
Agona Government Hospital	April 2012	TT 2+ vaccinations at ANC	44.0	==	20.0	TT2 + (vaccine)	
Akomaah Memorial Hospital	April 2012	TT 2+ vaccinations at ANC	8.0	==	23.0	TT2 + (vaccine)	
Akropong (atwima Nwabiagya) Health Centre	April 2012	TT 2+ vaccinations at ANC	93.0	==	232.0	TT2 + (vaccine)	
Amaamata Maternity	April 2012	Anaemic clients	75.0	<=	54.0	Number of clients having haemoglobin checked at registration	
Anyinasuso Health Centre	April 2012	TT 2+ vaccinations at ANC	19.0	==	30.0	TT2 + (vaccine)	
Apinkra St Mary's Anglican Clinic	April 2012	ANC registrants	2.0	==	4.0	Trimester registrants	

Figure 6.3: Validation rule analysis. The screenshot shows the result of a validation rule analysis.

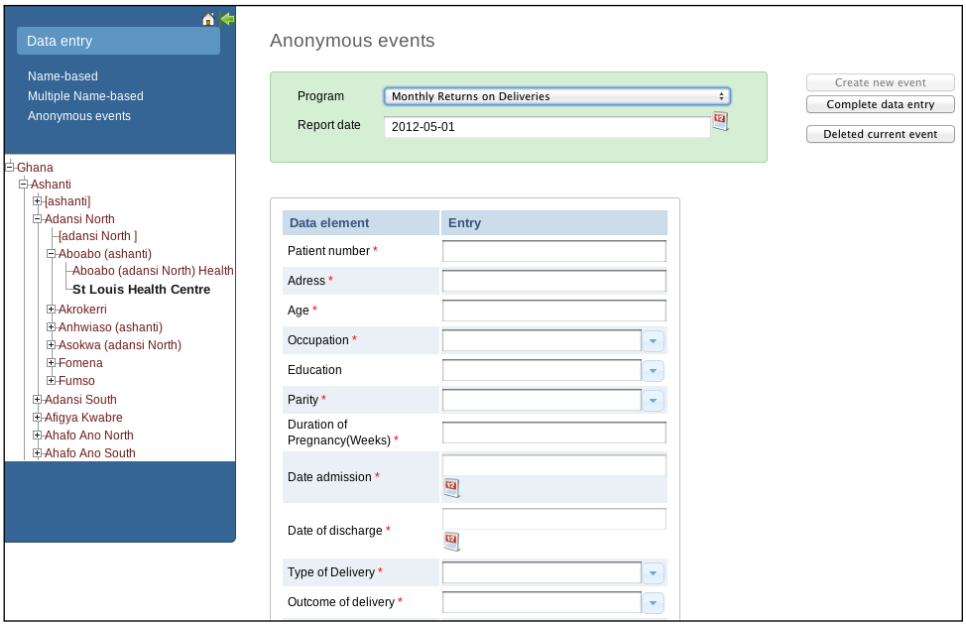


Figure 6.4: Anonymous event registration.

users of the system, and only users with the right user authorities can add, remove or modify them. There are also functions for creating reporting rate (completeness) reports, for sharing web links and files, and creating simple pivot tables.

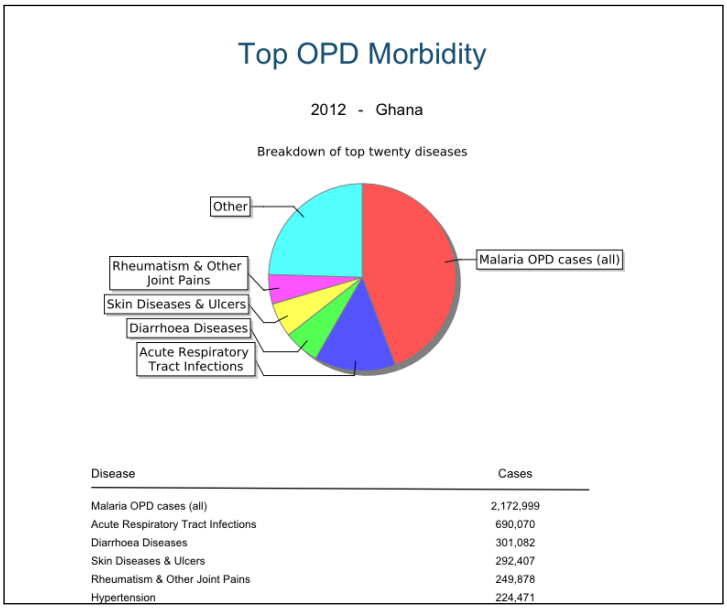


Figure 6.5: Example of a standard report.

A module called "Data Visualizer" was introduced in the autumn of 2011, allowing any user to create charts for any data in the database (see figure 6.6). These charts can be saved as favourites for easy retrieval later. For use outside DHIS2, images of the charts can be downloaded.

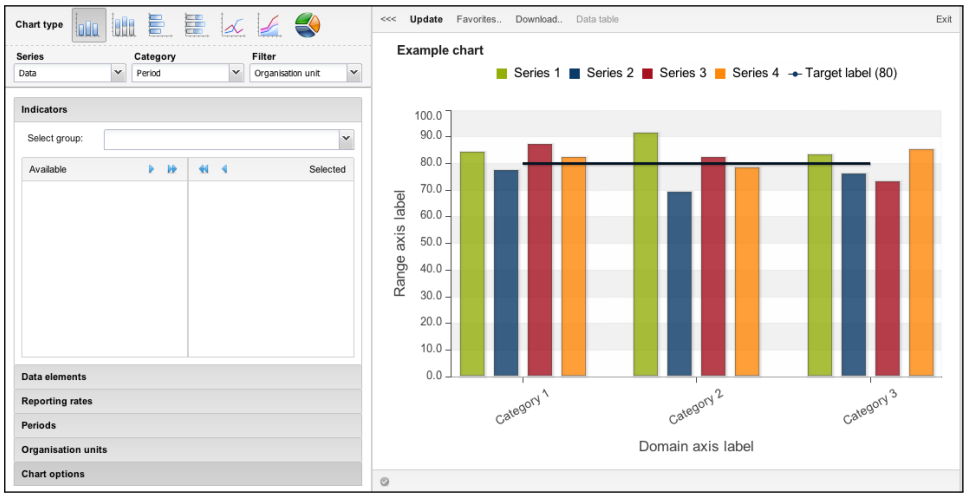


Figure 6.6: The data visualizer interface.

Finally, a geographical information system (GIS) module allows geographical presentation of the data through maps, granted that there are

geographical coordinates associated with the various organisation units (see figure 6.7).

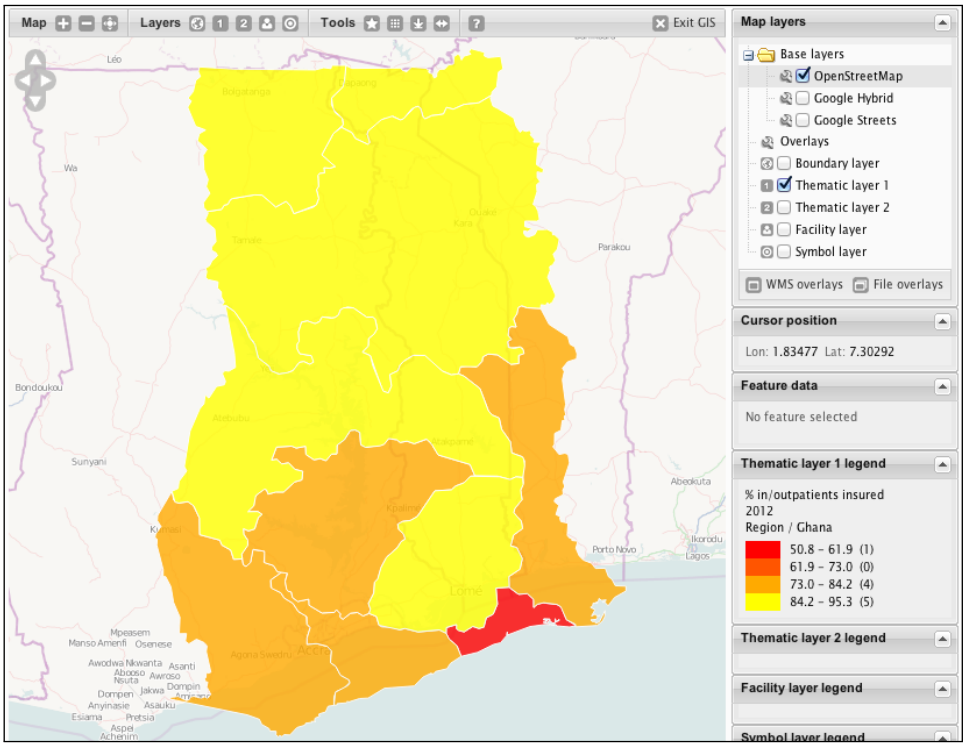


Figure 6.7: The GIS module.

Mydatamart and Excel

In addition to the built-in reporting modules of DHIS2, Microsoft Excel is commonly used for more detailed data analysis. While Excel can connect directly to the DHIS2 database to retrieve data, this does not work well in areas with poor internet connectivity. The reason is that when downloading new data from the database with Excel, all data in the excel file is flushed and everything downloads again, rather than just the updated values. Mydatamart is a small windows application made to solve this problem. It serves two purposes: First, it lets the user select specifically which organisation units and what periods he or she wants data for, and allows *incremental* downloads of this data to a local database. Excel can then connect to this local database instead, where it does not matter that all data is flushed and reloaded. Secondly, Mydatamart provides an easy-to-use user interface for connecting with DHIS2, shown in figure 6.8.

User Roles

User roles define what authorities users have in the system. The user roles are completely customisable, and defined by a set of authorities, such as "See Report Module," "Delete organisation unit" or "Update data value".

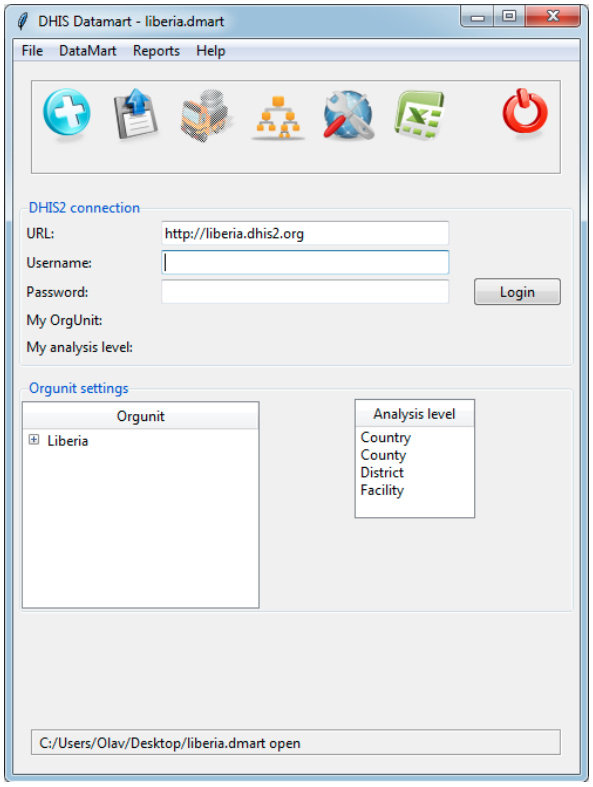


Figure 6.8: The Mydatamart application.

They are also linked to datasets, which allows for the creation of user roles specific to various health programmes. For instance, a user working for the Malaria programme can be limited to enter or edit data on the Malaria datasets only by creating a specific user role for the Malaria programme.

6.1.2 DHIMS and DHIS2 - a Comparison

To better understand the challenges of implementing DHIMS2 in Ghana, it is useful to have an understanding of the main differences between the previous DHIMS software and the DHIS2 software on which DHIMS2 is based. DHIMS is in some ways similar DHIS1. They are both based on Microsoft Access, and are intended to be used as decentralised, standalone database applications. However, while both DHIS1 and DHIS2 are flexible, easily customisable and open source, DHIMS is rigid, difficult to customise, and currently without any source code available. The flexibility and customisability of DHIS2 compared to DHIMS is one of the major differences, and is a very important issue: lack of flexibility was one of the main problems with DHIMS.

DHIS2 is based on web technologies that are very different to those of DHIMS, and far more modern. In Ghana, the system will be internet-based and run on one central server. Moving from an offline to an online system has several important implications:

- Changes made on the central server will automatically be seen by all users.
- Data is available for all users as soon as it is entered into the system - there is no need to manually transfer data by email or on physical media.
- Use of the system requires internet access.

While the first two points are clearly positive developments, the latter can cause problems in areas with limited internet coverage.

Improved support for reporting and analysis is another major difference between the two systems. The reporting functionality of DHIMS is very limited, and attempts to improve it has been hampered by the fact that the source code is not available. DHIS2, on the other hand, has a number of reporting modules, including charts and GIS, and also supports easy loading of data into excel.

6.2 Overview of the Implementation Process

The process of setting up DHIMS2 in Ghana started in earnest in the beginning of 2011. The organisation unit hierarchy was imported from DHIMS, and work on customising the system began. Staff at CHIM, the office in charge of the implementation, were put together in pairs or groups and were assigned data collection forms to add to the system.

I was first involved in the process in June 2011, when I visited Ghana for two weeks. There was talk that a training of trainers might be held around that time, but as the date approached it became clear that the system was not ready for this. Most data collection tools (datasets) had been added, but very little had been done on the reporting side. I was therefore asked to hold training sessions for the CHIM staff in the reporting functionality of DHIS2 during these two weeks. Although reporting was the main focus, when working with the database I also learnt that more work was left on the rest of the system than what was anticipated.

For the next months, work on the system continued, focusing primarily on setting up the data entry functionality properly. The first training of regional staff was held in late September, and three more regions followed in October. Feedback from the trainings were used in the customisation of the system, which continued in parallel. During the DHIS2 Academy in Accra in November, one of the DHIS2 developers helped clean the database of erroneous metadata that had built up during almost a year with lots of trial and error. By this time, the system was getting close to ready for rollout, although still little had been done with the reporting. The main issue that was left was the "line list," anonymous registrations of individual patients. This was not supported by DHIS2 at that stage, but the requirements were discussed with the development team in November.

After the DHIS2 Academy, the metadata in the system was stable enough that work on migrating data from DHIMS to DHIMS2 could begin.

This work was done primarily in Oslo. Although the system most likely could have been rolled out in February 2012, at which time the first data for 2012 was ready for entry into the system, it was decided to wait with the rollout until all regions had been trained. Up till this point, the system had been running on a virtual server in the cloud. Now, a server was configured at a private hosting company in Accra. In February, the line listing functionality for registering anonymous events was ready, and it was customised during my stay in Ghana that month. By mid March 2012 the whole country had been trained, and the nation-wide rollout was scheduled for April 1.

It was decided that a three-day training for regional and district administrators only should be held the first week after the rollout. This was to give the administrators a refresher on the system, especially on their tasks of managing users and organisation units in the system. The training was also used to kick-start the data entry process, as there now was a backlog for the whole of the first quarter that had to be entered. In May and June, staff from CHIM have begun the work of training the regional and district directors, to allow them to make use of the information generated by the system.

6.3 Customisation

In this section, I will go into details of the customisation of DHIS2 in Ghana. I start by outlining some of the problems I discovered when first arriving in Ghana and started getting to know the database. Then, I will go through the implementation of some of the main functions of DHIMS2: data entry, data duplication, the line list, reporting, GIS and user authorities. I will present the main challenges faced, and how we worked to solve these in a participatory process.

6.3.1 Initial Problems

By the time of my first visit to Ghana in June 2011, quite a bit of work had already gone into customising the system. Most datasets had been added, and were regarded as more or less ready. However, I soon noticed that there were some problems with what had been done. The biggest problem was the wrong use of *category combinations* and poor naming of *data elements* and *indicators*.

When adding a reporting form - a dataset - to DHIS2, one has to consider how to represent the various fields in the system. One of the most important aspects of this is to decide if category combinations should be used, and if so, in what way. It was clear that the understanding of how to use category combinations was poor among many of the implementers at CHIM. One problem was that the category combinations were not used in the right cases, or were used in a wrong way. Another problem was lack of coordination among the implementers, meaning that many of the same categories and category combinations were duplicated. This does not have

any impact on data collection, but makes it difficult to compare the data when doing analysis. Consequently, we had to put quite a lot of time into resolve these problems.

The naming of data elements and indicators was the other major problem I found. First of all, there was no agreed-upon standard for creating names. Thus some data elements had names with symbols like $< > =$, others used different words like "less than," "below" and so on. Furthermore, many data elements had been given long prefixes to the names of the dataset they belonged to. This was done to make it easier to keep track of the data elements in the system, but a side effect was to make the names very long and difficult to use for analysis purposes.

Indicators and data elements in DHIS2 have a *short name* property, which is used instead of the full name in many report modules. As the name indicates, it should reflect the name of the data element or indicator, but in a shortened form - 25 characters or less. Short names are mandatory when creating data elements and indicators, but the short names used in Ghana were in many cases impossible to decipher, even by the person who created them. Making reports with these was therefore impossible, and time had to go into rectifying this as well. The staff at CHIM explained that they did not know what the short names where used for, and therefore payed little attention to them.

To improve the issue of naming, I sat down and made some suggestions for naming conventions and how various names could be shortened for use as the short name property. I then sat down with the staff at CHIM, and we discussed these suggestions and made improvements. Once we had an agreed-upon list, it was distributed to everybody at CHIM. This could then be used as a guideline when making new names, and when changing the ones that had been added but could not be used.

6.3.2 Preparing Data Entry

Communication Problems

No integrated datasets have been developed in Ghana. Instead, each division and programme define their own reporting formats that are used throughout the country. These reporting forms are given to the staff at CHIM in electronic format, usually as a Microsoft Word or Excel file. CHIM then adds the reporting form as a dataset in DHIMS2.

While this process may sound straightforward, there have been quite a few issues. Communication between CHIM and the various health programmes and divisions has been poor. On occasions, we have received a reporting format and added it to the system only to realise later that the form sent from the programme was not the latest version. Other times, the staff at CHIM knew that a dataset in DHIMS2 had been changed, but still had problems getting hold of the newest version.

When working on a particular dataset, we often had concerns or questions about what was meant with some of the fields or how it should be filled. For example if a particular field could be auto-calculated from

other values or not. Sometimes the chief biostatistical officer at CHIM could answer these questions, but in some cases he was not sure or was not available. I then suggested on several occasions that we should make a call to someone in the division or health programme responsible for the form and ask them. However, in almost all the cases I was told that there either was no one to call, or that the person that could be contacted was never available so there was no point trying.

The perhaps best example of the lack of communication occurred as late as in February 2012. At the end of the last day of training of users in the Upper West region, all disease control officers were asked to stay in the conference room for a short briefing. Here, a representative from the Immunisation programme presented the new immunisation reporting format to be used in 2012, replacing the two previous forms that had been added to DHIMS2. This was the first time we saw this new form, despite the CHIM and Immunisation programme offices being only a two minute walk apart.

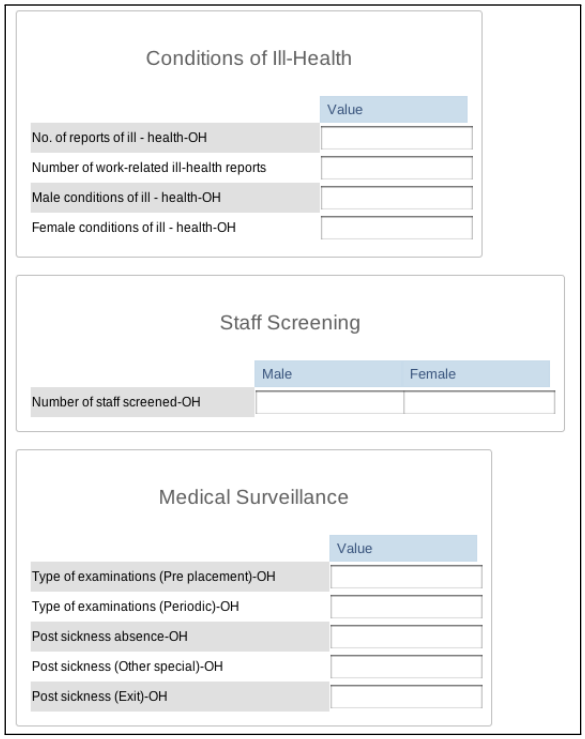
Customising the Datasets

The data entry interface in DHIS2 can be laid out in two different ways, in a "Section" or "Custom" layout (see figure 6.9 and 6.10). With the section layout, the user specifies one or more sections and adds data elements to those sections. The system then generates a table layout automatically. With a custom layout, the user specifies the whole layout manually. This can be done either by writing HTML code directly, by using a built-in HTML editor, or by copy and paste from Microsoft Office, OpenOffice or similar.

The pros of the custom forms are that they allow the data entry interface to mimic the paper forms more exactly, and that they allow use of indicators to have, for example, totals appear during data entry. The cons are that they are more time consuming to create and edit, and, when copied from third party applications such as Excel, produce less efficient HTML code that takes longer to load. In addition, tables copied from external applications are often of fixed width that extends beyond typical screen sizes, and thus require horizontal scrolling during data entry. Section forms are easy to make and edit, and provide a clean and uniform interface. However, they cannot easily be made to mimic paper forms and do not support showing indicators during data entry.

In Ghana, many of the most widely used datasets had totals or other calculations together with the actual data entry fields. To make a dataset with totals, it was at this time necessary to create indicators that are equal to a data element.[1] Take for example a data element "Polio cases" disaggregated into "Male" and "Female" by using a category combination. To get the figure for the total of "Polio cases" to appear during data entry, an indicator equal to "Polio cases, male" plus "Polio cases, female" must be created. However, this indicator is the same as the data element "Polio

[1] With the current version of DHIS2, this is no longer necessary.



Conditions of Ill-Health

	Value
No. of reports of ill - health-OH	
Number of work-related ill-health reports	
Male conditions of ill - health-OH	
Female conditions of ill - health-OH	

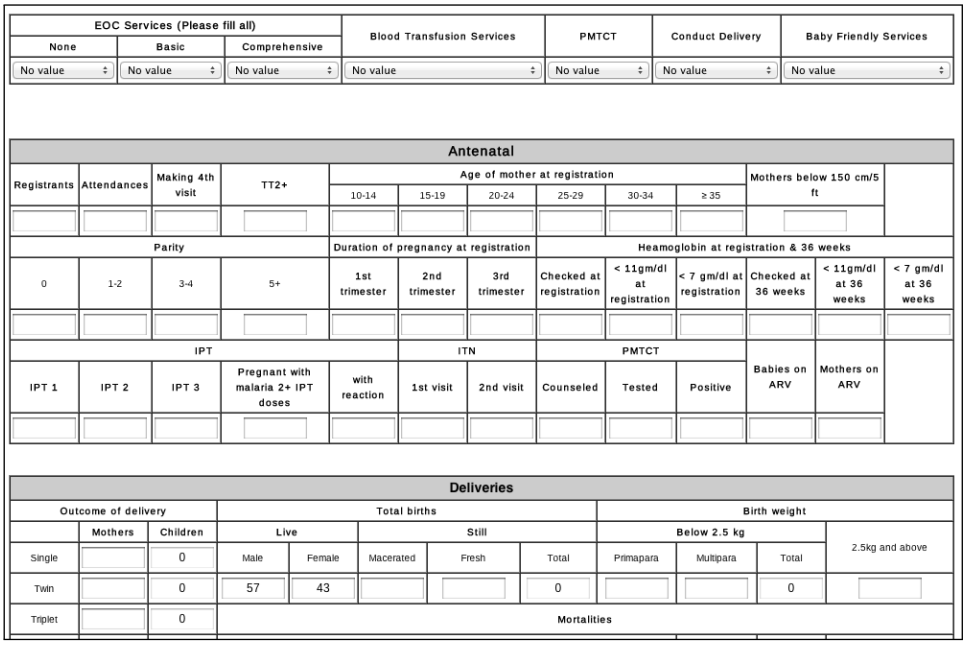
Staff Screening

	Male	Female
Number of staff screened-OH		

Medical Surveillance

	Value
Type of examinations (Pre placement)-OH	
Type of examinations (Periodic)-OH	
Post sickness absence-OH	
Post sickness (Other special)-OH	
Post sickness (Exit)-OH	

Figure 6.9: Example of data entry interface of a section form.



EOC Services (Please fill all)			Blood Transfusion Services	PMTCT	Conduct Delivery	Baby Friendly Services
None	Basic	Comprehensive				
No value	No value	No value	No value	No value	No value	No value

Antenatal

Registrants	Attendances	Making 4th visit	TT2+	Age of mother at registration						Mothers below 150 cm/5 ft
				10-14	15-19	20-24	25-29	30-34	≥ 35	

Parity				Duration of pregnancy at registration			Heamoglobin at registration & 36 weeks					
0	1-2	3-4	5+	1st trimester	2nd trimester	3rd trimester	Checked at registration	< 11gm/dl at registration	< 7 gm/dl at registration	Checked at 36 weeks	< 11gm/dl at 36 weeks	< 7 gm/dl at 36 weeks

IPT				ITN		PMTCT				
IPT 1	IPT 2	IPT 3	Pregnant with malaria 2+ IPT doses	with reaction	1st visit	2nd visit	Counseled	Tested	Positive	Babies on ARV	Mothers on ARV

Deliveries

Outcome of delivery			Total births					Birth weight			
	Mothers	Children	Live		Still			Below 2.5 kg			2.5kg and above
			Male	Female	Macerated	Fresh	Total	Primapara	Multipara	Total	
Single		0									
Twin		0	57	43			0			0	
Triplet		0	Mortalities								

Figure 6.10: Example of data entry interface of a custom form. Note that the custom form also has "sections", but these have been created manually using HTML

cases" without the disaggregation, and it therefore serves no purpose for analysis: the data element without the disaggregation can be used instead. Having many of these total indicators only makes it more difficult to identify the indicators that *are* useful.

There was also initially a misunderstanding among CHIM staff about how to create these total indicators: when making the indicator formulas, you can choose to use only one category of the data element, or to use the total of all categories (see figure 6.11). To make a total indicator, it is thus often only necessary to select one object. However, most of the totals in the Ghana database was initially made by manually summing up all the categories, in some cases up to 22 of them. Not only was this unnecessary, it also had an impact on the time it took to load the data entry module, because the indicator formulas became very big.

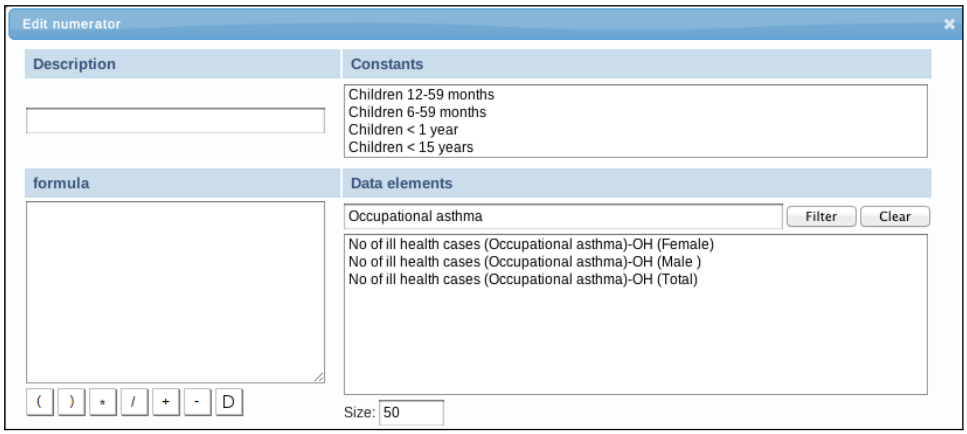


Figure 6.11: Screenshot illustrating how the user can choose between using only one category option of a data element, or the total.

After many discussions between myself and the team at CHIM on how best to address the issue of totals, we decided to suggest to the developers to develop built-in support for totals of category combinations. This feature was added to the next release of DHIS2. Dozens of unnecessary indicators could be deleted from DHIMS2 as a result.

In Ghana, all forms were initially created as custom forms by copying tables from external applications. Thus they closely resembled the paper forms, and supported the use of indicators. However, I found that many of the layouts did not function very well on a computer screen, and made data entry quite slow to load due to the large number of indicators and bloated HTML code. We had many discussions about this at CHIM. For the reasons given above, myself and some of the staff argued for changing at least some of the custom forms to use sections, primarily those where the section layout would still be similar to the paper form or where the custom forms were not working well. Others argued that we could not move away from the custom layout both because managers had promised all the stakeholders that the data entry would mimic the paper forms, and because of concerns that the end users would have problems using it. This

discussion went on during several meetings. As a part of this process, I created alternative layouts to several of the forms, which we went through and discussed back and forth, in order to try to identify which could be improved.

The whole process took a new turn in late August when DHIS 2.4 was released. This version added support for doing data entry offline, using new HTML5 standards. The HTML layout for all datasets is stored offline in the browser so that they are available should the internet connection drop. Data can still be entered, and stored locally in the browser. Once the connection is restored, the user is prompted to upload the newly entered data to the server (see figures 6.12 and 6.13).

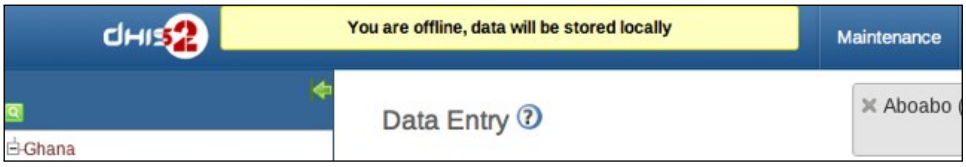


Figure 6.12: Message telling the user he or she is offline.

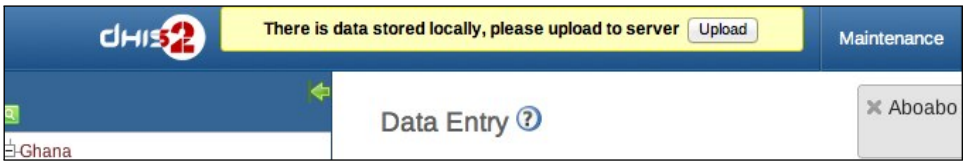


Figure 6.13: Message telling the user data has been stored in the browser and needs to be uploaded.

Due to the extensive use of custom forms in Ghana, often with bloated HTML, one of the developers noticed that there simply was not enough storage space in the browser cache to store all the forms used in Ghana. Offline data entry would thus not work. Furthermore, downloading all the forms the first time was time consuming, even on a relatively fast internet connection. For users around the country on slow connections, it would be very slow. It was later discovered that some of the slowness was a result of a software bug. However, because we believed the slowness was caused only by the custom forms and because offline data entry would not work, it was decided that at least some of them should be changed to use the section layout.

In hindsight, it seems there were three ways we could have changed the datasets to solve these problems:

- Recreate the datasets with section layout.
- Clean up the custom HTML code.
- Create the datasets from scratch as custom forms with clean HTML.

Since neither the staff at CHIM nor myself had more than a very basic HTML knowledge, the second option was quickly ruled out. The

third option was not really considered: partly because the developers encouraged the use of section layout when possible, and partly because we simply didn't consider it an option at the time. A couple of months later, that option was used for several datasets. Consequently, we decided to identify at least some datasets that could be changed to use a section layout.

The initial criteria when selecting datasets to change was:

- The size of the HTML layout code would be reduced.
- The custom layout did not work well.
- A section layout would still resemble the paper form.

Together, we sat down to identify datasets that met these criteria. Some had already been made available as section forms during the previous discussions, others I quickly redesigned. Thus initially, we changed a handful of datasets to make offline data entry work. During the next couple of months, more forms were changed, this time with an improved data entry interface as the goal.

At the DHIS2 Academy in November 2011, the idea of creating custom forms from scratch came up. I sat down to find a free WYSWYG[2] editor, and redesigned some of the less user-friendly custom forms. The staff at CHIM liked the result, and I gave them an introduction on how to use this editor to create custom layouts. As can be seen in the figure 6.14 and table 6.1, the end result has been that both the total and average size of the datasets in DHIMS2 has gradually decreased.

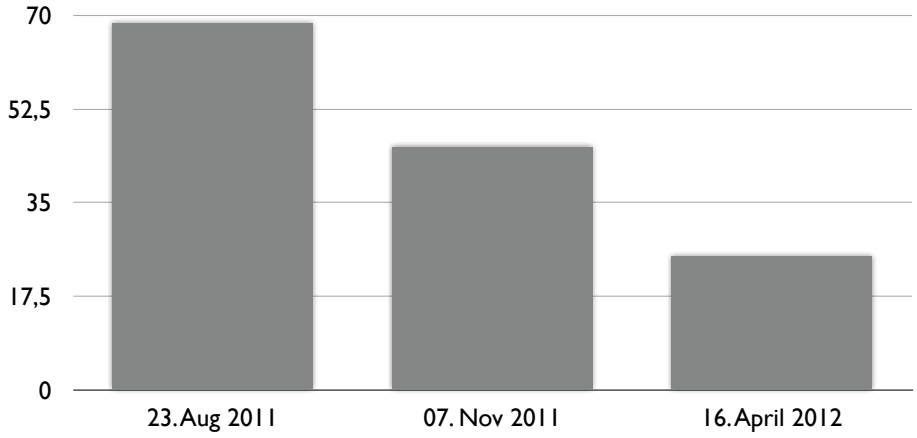


Figure 6.14: Graph showing the size of datasets (in KB) in DHIMS2 over time

In all, then, getting the datasets into the system has been one of the main challenges with the DHIMS2 implementation. Even though the datasets were regarded as more or less finished already in June, they

[2]WYSWYG - What You See is What You Get

	23/08/2011	07/11/2011	16/4/2012
Total number of forms	27	33	41
Number of custom forms	23	23	26
Total size in KB (approximate)	1850	1500	1030
Average size	68,5	45,5	25,1

Table 6.1: Table showing the size (in KB) of datasets in DHIMS2 over time.

were, in fact, not ready until the end of the year. This has been due to technical challenges, poor initial training of the implementers, and lack of communication between agencies of the GHS.

6.3.3 Data Duplication

Because the data collection in Ghana has not been integrated, there are many data elements which are present on more than one form. DHIS2 supports using the same data element in several datasets, so that data entered in one dataset appears in all the others. Thus the data is stored only once in the database, and an *integrated* data repository or warehouse is created "behind the scenes".

As soon as I introduced this linking feature to the staff at CHIM, this became a major focus for them. They wanted to reduce the burden of data entry personnel by linking data elements across datasets, as they knew how frustrating the duplicate data collection could be. Together, we sat down and went through some of the datasets where there was data that could potentially be linked. In some cases, linking data elements was very straight forward - the data represented the exact same thing on two or more datasets, the same categories were used, and the data was collected at the same interval. However, we found many cases where the definition of the data element was poorly defined or ambiguous, making it hard to decide wether the data could be linked or not.

Data elements with the same definition but different age groups were also a common problem. One solution to this is to use indicators. For example, let us say we have a situation where one form has the fields "Malaria cases <1" and "Malaraia cases 1–4" and another form has the field "Malaria cases < 5". In this case, it is possible to use an indicator to populate the second form from the first one. However, it is not possible to do it the other way around. That is the main problem with linking of data elements that have different categories: they only allow data entry from one of the forms. One of the concerns at CHIM was that this could lead to protests from programmes who had their forms essentially "blocked" for data entry. As soon as the end-users accessed the system at trainings, however, they continuously asked for further linking of data even where it meant blocking one dataset for data entry. End users also identified several instances where additional linking could be done.

6.3.4 Line Listing

The original DHIMS was installed at the regional and district hospitals, allowing these facilities to enter anonymous patient data into the system. This was called a *line listing*, as each patient was registered on one line (see figure 6.15). Two line listings were used in DHIMS: "In-patient morbidity and mortality" and "Monthly returns on deliveries". We agreed that it was important to include these into DHIMS2 to avoid a situation where users in the hospitals had to use both systems in parallel.

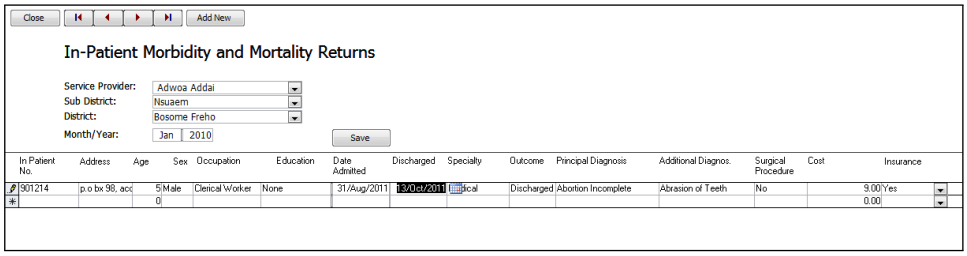


Figure 6.15: Line listing interface of DHIMS.

In the spring of 2011, GHS engaged a lecturer at the University of Ghana to work on adding line listing functionality to DHIS2. After a few emails back and forth with HISP at the University of Oslo concerning documentation for DHIS2, I was asked to work with this lecturer to help coordinate with the main DHIS2 developers. However, I never got any reply to the mails I sent to him.

At CHIM, the line listing was not initially a topic, since that work had been delegated elsewhere. By October, nothing had been done on the line listing, however, and thus the staff at CHIM and I realised we would have to implement the line listing as well. At the DHIS2 Academy in November, two of the CHIM staff and myself sat down with one of the DHIS2 developers to discuss the requirements for the line listing. The developer would try to have it implemented in time for the rollout of DHIMS2.

By late January 2012, the new "Anonymous Events" module was ready. During my stay in Ghana in January-Febrary, I sat down with four of the CHIM staff and discussed how we could best implement the two line listing datasets in DHIMS2. Both datasets presented us with some challenges. We realised that the paper version of the first line list, "Monthly returns on deliveries", had a quite complex way of registering the outcome of births. Consequently, we sat down with the head of CHIM and revised the paper version of the form, and implemented this new version in DHIMS2.

The other dataset, "In-Patient Morbidity and Mortality returns", was challenging in another way. It required a drop-down list of about 1000 International Classification of Diseases (ICD) version 10 based diseases, the same as was used in DHIMS. I was eventually able to import this list from DHIMS directly in the DHIMS2 database, bypassing the regular user interface.

While there are some minor issues still outstanding with the anonym-

ous events module, for example there is no way to easily edit entries, the line listing was ready for the rollout.

6.3.5 Reporting

I have now looked at the process of configuring data entry in DHIMS2, and in this section the customisation of the reporting functions will be discussed. An introduction to the reporting in features DHIS2 was given above. During the implementation process, new versions of DHIS2 were released with new and improved reporting functions. For example, the Mydatamart tool was first released in the summer of 2011, and the Data Visualizer in version 2.5 in mid October.

At my first two-week visit to Ghana in June 2011, reporting was the main focus, primarily training of the staff at CHIM on making "standard reports". Some reports were added to the system during these two weeks, but they had little use beyond being "training material" and were later removed. As part of the training, I was asked to make a quite detailed manual on the process of creating standard reports. This was later merged with the partly outdated section on standard reports in the official DHIS2 manual.

In the two months from June till I returned to Ghana in August, essentially no new reports had been made. It also became clear to me that few at CHIM actually mastered creating standard reports at this point. When I talked to the staff at CHIM about reporting, they explained that they thought the *dataset report*, which requires no customisation, would cover the reporting requirements in Ghana. Although I argued that the other types of reports offered far better options in terms of presenting the information in a meaningful way, the answer was that in Ghana the users would be happy as long as they could get the basic dataset reports they needed to submit. I suggested to contact the various health programmes for feedback on what kind of reports and indicators they were interested in, but this was never done.

It was not until one of the first end-user trainings that there was renewed interest in the standard reports. The reason was talk of whether the "RCH Bible" could be added to the system. The "RCH Bible" is a reporting format used by the Reproductive and Child Health (RCH) department all the way from the facility level to the regions. It consists of 21 tables, some of which have monthly data and some quarterly. In addition, it is calculated for half years and years. While not all the data required to generate "the bible" is available in DHIMS2, the majority can be generated as standard reports. This table has normally been calculated in Excel or by hand, thus having it available as a one-click report was something we though of as a good way to get buy in from staff working with RCH.

Work on setting up the RCH bible as standard reports was started by the CHIM staff and myself in free time during the end-user training. We customised the standard reports in plenary sessions, with everyone working on one table of the report in parallel, with my computer connected to a projector so that everybody could follow the process. This allowed us

to have both hands-on practice, and get the reports into the system.

A situation in which reports from only *one* department was included was not ideal for a system meant to integrate the whole health system. Participants at some of the training sessions also commented on this. We therefore asked them if they could provide us with some report templates from other programmes and divisions, which we could add to the system. However, people were reluctant to give away the templates, and said they would have to consult their bosses first. Thus in the end, we did not get any new templates to add. Again, I suggested to the staff at CHIM to add some generic reports that they though could be useful, but this was never done. In the end, I have added quite a few reports myself in order to have something to show the users both at the training sessions and after the rollout.

While the Data Visualizer and GIS module do not *require* any configuration, system-wide favourites can be added to give users quick access to commonly used charts or maps. Again, the staff at CHIM showed little interest in adding any favourites, and I ended up creating some to demonstrate for the users.

While not technically a part of the DHIMS2, some work has also gone into creating Excel templates for use with the Mydatamart application. Initially, Mydatamart did not work with the Ghana database due to problems with the metadata. This was sorted out in late august, and I created a template to use for demonstrations at the training sessions. Further work on adding more Excel templates was postponed, as there was more urgent work left on the rest of the DHIMS2 database.

While in Ghana in Febrary 2012, we had a short training session at CHIM on how to create new Excel templates for use with Mydatamart. Here, we discovered that several indicators did not work as expected when exported to Excel. The problem was primarily caused by indicator formulas being poorly designed, but also to some degree that they had not been grouped in a meaningful way.

During my visit in March, I held a more practical session with the staff at CHIM where we were able to develop several Excel templates. These were kept quite simple, both to simplify the process of making them, but also to make them easy to understand for end users. We decided that it was best to have simple templates that people could make use of easily, and rather add more advanced templates upon request later, or alternatively to teach the end users how to make the templates they require themselves.

One general issue that has made the process of setting up reporting functionality more difficult has been the lack of data in the database during most of the customisation process. While data can be entered manually to test reports, this is both time consuming and uninspiring, especially since data is often required for several data elements, in several organisation units, over many periods.

6.3.6 Geographical Information System

While normally seen as a reporting function, configuration of the geographical information system (GIS) module in DHIMS2 is discussed separately because it has some unique properties. First of all, GIS requires that geographical coordinates are available for the organisation units. By the time I started working with the Ghana database, there were coordinates in the system for all the ten regions, the majority of the districts, but no sub-districts or facilities. However, some of the available coordinates were wrong, with districts being placed far out in the Bight of Guinea. At the DHIS2 Academy in November, the DHIS2 developer working on GIS helped rectify these problems, and was also able to import coordinates for about 1250 of 3500 facilities in the Ghana database. I travelled with the same DHIS2 developer to Ghana in March, and during that visit he was able to store the coordinates for all the remaining districts except one. Thus currently, there are coordinates for all regions, all districts except one and for about one-third of the facilities.

Unfortunately, there are some challenges ahead when it comes to GIS and coordinates. First of all, sub-districts are in many ways the primary level of analysis for the districts. However, getting coordinates for the sub-districts is difficult. They are an administrative unit exclusive to the GHS, thus unlike coordinates for districts or regions, GHS are on their own in needing sub-district coordinates. Secondly, I have understood from conversations with district users that the sub-districts change quite frequently, so having up-to-date coordinates would be a continuous process. Districts are more stable, but changes do occur there as well. It has recently been decided to increase the number of districts from 170 to over 200, which is likely to require huge changes in DHIMS2 in general and for the GIS module in particular.

Although there are far more facilities than districts and sub-districts combined, I believe facility coordinates will be the easiest to obtain. While old facilities close and new ones are built regularly, the large majority remain unchanged over time. A few missing facility coordinates also have less impact on the usefulness of the GIS than if for example districts are missing. Furthermore, obtaining facility coordinates can be done by staff at the district using a simple GPS device, for example during monitoring visits, and the district administrator can personally add the coordinates into DHIMS2. According to one officer at CHIM, at least two regions have or have had the coordinates for all facilities in their area. However, in one region, the person sitting on the coordinates have been reluctant to share them, and in the other region, the coordinates had simply been lost.

6.3.7 User Authorities

User access to DHIMS2 has been an important issue for GHS. How user roles are set up was discussed in the section on the DHIS2 software. In this section the focus will be on how the specific user roles in DHIMS2 were developed.

Access to DHIS2 is controlled through

- the organisation unit a user is assigned to
- the user role given to a user

What organisation unit or units a user is assigned to is more or less a given based on where that user is employed. Configuring user roles, however, is less straightforward. A draft of user administration and user roles were made early in the implementation process by two implementers outside CHIM involved in the initial phases of setting up DHIMS2. This was based on a system with shared user logins, at least initially, and seven different administrative user roles: for each of the national, regional and districts level there would be a basic and advanced system administrator, and for "emergency" use there would be a superuser role at the national level. In addition, there would be a supervisor user role in each district, as well as a "health information officer" role and a data entry role. These proposed user roles were never implemented in the system.

There were several reasons why a different setup was used in the end. First of all, one of the basic premises for DHIMS2 was that there should be no way to edit data from the regional or national level. The initial proposal allowed the regional administrator to add data entry users, thus making it easy to bypass this restriction. Secondly, we saw it as more complex than what was necessary, for example having two levels of administrators in the districts and regions. Thus a new system was developed, shown in table 6.2 below. This setup relies on one separate administrator role at the district, region and national level; a data entry user role; and a user role with access to reports. In addition, there is a role for system administrators and superusers. All users in the system should be personal, not shared as had been proposed at first.

I had several talks with the directors of PPME, IME and that staff at CHIM on whether or not it would beneficial to have separate data entry user roles for different programmes and divisions, so that for example only the NACP focal person would have access to enter and change the NACP datasets. In the end, we decided to have only one common user role, for several reasons. Letting all users have access to all the data could promote having data validation meetings and teamwork in the districts, and help avoid a situation where one person in the district *owned* parts of the data. It would also make administration of users easier, especially in cases where one or more user was absent. Furthermore, some data is linked across datasets and even across health programme areas, so there would still be many situations where users could enter data in datasets they did not have access to. And finally, it would cause questions about who should do data entry for datasets where there is no focal person, for example nutrition.

6.4 Installation

In parallel with the customisation of DHIMS2, preparations where made for the rollout. This included discussions on whether or not a fully online

User role	Authorities	Can create	Intended for
User	See reports	None	Any user who should see reports
Data entry user	Enter data, see reports	None	User working with data entry in district or at facilities
District administrator	Enter data, see reports, edit users, edit organisation units	User, Data entry user	District administrator, one per district (typically a Health Information Officer)
Regional administrator	See reports, edit users, edit organisation units	User	Regional administrator, one per region (typically a Health Information Officer)
National administrator	See reports, edit users	User	Administrator in divisions or programmes, oner per unit
System administrator	See and edit reports, edit users, edit organisation units	All of the above	Staff at CHIM working on DHIMS2
Super-user	All - notably adding/editing datasets	All of the above	Core implementers at CHIM

Table 6.2: User roles in DHIMS2.

installation would be feasible, and how the system should be hosted.

6.4.1 Central Server or Offline Installations?

As has been explained earlier, DHIS2 can be deployed either online, using standalone offline installations, or as a hybrid. The goal in Ghana from the beginning was to have an online installation with one central database. Internet access in the country was seen by the GHS as sufficient, and rapidly improving. In an internet access survey of 117 districts made by GHS in July 2010, 18 district reported that they did not have internet access. Not all districts participated, thus the actual number of districts without access is likely to have been higher. Unfortunately, the report did not indicate whether districts did not have internet access because it was not possible, or if it was because the district administration had chosen not to pay for it.

Because of the uncertainty about internet access in a number of districts, I suggested developing options for using offline installations for districts unable to connect to DHIMS2 online. However, the director of the IME department made it clear that no districts should be offline. He explained that he had big faith in development of mobile internet access in Ghana, especially with a new operator, *Glo*, that is expected to launch its operation in Ghana soon. In February 2012, he told me that the GHS was in talks with several internet service providers on how internet access could be improved in districts with poor coverage. The options discussed were improving mobile coverage, using fixed lines or by reviving an old government Wide Area Network (WAN).

A couple of months into the rollout of DHIMS2, it is still too early to tell whether internet access has become a major problem or not. There have been few complaints in the internal DHIS2 feedback system, however, that may not say much as a district without internet access will not have access to that function. Staff at CHIM have reported that they have received some phone calls about the issue, but not many. Complaints made through the local GHS hierarchy might take longer to arrive at the central level.

6.4.2 Server Hosting

Server hosting was another important part of the DHIMS2 implementation. During most of the customisation period, DHIMS2 was running on a virtual server hosted with a commercial company in London, rented by the HISP group at the University of Oslo. For the rollout, a more powerful solution was needed. GHS had already been given a physical server for DHIMS2 as part of an agreement with the U.S.-based Centre for Disease Control (CDC), and planned to host this in Ghana. The question was where.

The two main hosting options discussed was a government centre which was under development and a private hosting company in Accra. One person at the IME department was given the task of finding the best option. It became clear that the government centre could not be used, and instead "Rack Africa," a private company, was chosen.

The physical server was moved to the hosting company in November 2011. A linux-based operating system was installed so that further configuration could be done remotely over the internet. There was no capacity in GHS to configure the server further, thus a HISP member with experience in server hosting was asked to help with the administration until someone could be found locally.

No further work was done on the server until early January 2012. In the meantime, the server had been hacked. In a Skype meeting with the person responsible in IME, the HISP member and myself, it was decided to reinstall and configure the server properly, and start the process of obtaining a domain and an SSL certificate.

ghsdhims.org was soon purchased as the domain, and the address was soon ready for use. However, the SSL certificate turned out to be a problem, as the company issuing the certificate spent a long time on the verification process, including sending a third party company to verify that the GHS was what it claimed to be. Thus this normally quick process ended up taking about six weeks. As the HISP member configuring the server commented: "don't ever let anyone tell you the internet is a neutral space in which we all participate as equal netizens", implying that this would not have happened in a developed country. Despite these problems, the server was ready for the rollout April 1.

The server is still administered by the above mentioned HISP member, one of the DHIS2 developers, the person from IME and myself. Most maintenance, for example upgrading DHIS2, is done by the former and myself. There is still no local capacity for this in Ghana, although this was something I discussed with the directors of CHIM and PPME during my last visit to Ghana.

6.5 Piloting

Health information systems are complex, and introducing a large component like DHIMS2 can have unintended side-effects. There can be issues the implementers have not thought about, and that will only be discovered through actual use of the system. Because of this, GHS was encouraged by myself and others in HISP to pilot DHIMS2. Especially the offline data entry functionality was an untested feature at that time, and had not yet been widely used elsewhere.

GHS was negative to piloting the system, however. Several reasons were given. One was that there was no funds for running a pilot. Another was that DHIMS2 was "just a software upgrade" compared to the DHIMS that was already used. I am under the impression that piloting would send a wrong signal to the various stakeholders, since DHIMS2 had been sold to stakeholders as an upgrade, not a major change.

One of the CHIM staff also told me that his experience with piloting in Ghana was not good. The primary concern was compensation: without compensation, it would be difficult to persuade users to try a new system in parallel with an old one, but *with* compensation, colleagues would become

jealous.

In the end, one of the DHIS2 developers and myself managed to get a very small "pilot" started during our visit to Ghana in March, with the blessing of CHIM and GHS. This was only two weeks before the rollout. A handful of users spread out across the country were contacted and given access to DHIMS2, and asked to start using the system. We told them to report back on any issues they encountered straight away, so that these could be resolved in time for the rollout. The pilot proceeded without any major problems, but several smaller issues were identified and resolved.

6.6 Training and Knowledge Transfer

In this section I will discuss issues regarding training and knowledge transfer. Training of end users is an important part of the implementation. Building local capacity to maintaing and develop the system further is also critical, and requires the transfer of knowledge from the implementers based abroad to the local implementers in Ghana.

6.6.1 Training of the Local Implementers

Transfer of knowledge has primarily taken place at CHIM, where the implementers in Ghana work. The main vehicles of this has been plenary session held at CHIM, and one-on-one training on particular issues and topics. I have presented several examples of this in the above sections. Some of the staff has also participated in DHIS2 workshops both in Ghana and abroad.

Initially, the whole staff at CHIM was part of the development of the system, and thus in all trainings related to DHIS2. Over time, however, a core team of five persons developed. These were among the most experienced staff at the office, and had been part of the process from the beginning. They also knew the Ghana health information system well. While the intention of training as many people as possible as implementers and system administration was good, it became obvious that it also had it downsides. It meant the pace of training at CHIM had to be reduced, and because the work was divided between such a large number of people, there was often not enough work for each person to get a thorough understanding of the issues at hand.

As the end-user training begun, it became clear to me that many of the implementers had limited knowledge of many parts of the system. The reason was that almost all work before the trainings had been on setting up the data entry module and adding a handful of reports. As people started asking questions about how things worked and why the system behaved as it did, new aspects of the system was revealed that the implementers did not know. Consequently, the end-user trainings helped improve the skills of the trainers in many important areas.

During the time I spent at CHIM, I held many training sessions with the staff there, from the first visit in June 2011 to the last one in March

2012. These included several sessions on how to make "standard reports," creating datasets for data entry, excel pivot tables, and also basic server and network administration for use at end user trainings around the country. I developed small written guides for some of these topics, parts of which was later added to the official DHIS2 manual. As far as I could tell, however, these guides were never really used, despite many requests to make additional ones.

As the composition of the implementer group at CHIM changed from being a large, inexperienced group to a smaller and more experienced one, the trainings could progress faster, and it allowed for more practical exercises. I also tried to increase the amount of practical work during the trainings because it seemed to be a lot more efficient learning method than the combination of demonstrations, lectures and exercises I tried initially.

The DHIS2 Academy, held in Accra November 2011, and the DHIS2 Database training, held in Lomé, Togo, April 2012, was important learning opportunities for the local implementers. The Academy and the database training will be discussed in more detail in the next chapter.

6.6.2 Organisation of End User Training

Training of end users was initially planned to start with a trainer of trainers in June. This was delayed when it became clear that the system would not be ready in time for this. At the same time, it seems there was a change of plans to use the staff at CHIM as end-user trainers across the country, rather than training a separate set of trainers. The first round of training would focus on users in the districts and facilities responsible for data entry, whilst the district and regional directors as well as users at the national level would be trained later. The trainings were done region by region.

While CHIM became the training institution, neither it nor the GHS in general had funds to hold trainings. Partners were therefore needed to help fund and organise the trainings. Funding for the first trainings were provided by FOCUS, a programme sponsored by USAID. FOCUS has a presence in three regions of Ghana, Greater Accra, Central and Western, and agreed to organise DHIMS2 trainings in those regions. The funding expired by the end of September, setting a deadline for when the training had to begin. This had both positive and negative consequences. Having a deadline for when the system had to be ready increased the speed of the work on the system. However, the first users being trained suffered because the system was not completely finished in time.

The fact that CHIM was not involved in organising or planning the training caused some problems. Again, this was a problem in the first region in particular. For example, it was not clear if CHIM should make the programme for the training or not. The only information given to CHIM was that there would be two groups being trained, for two and a half day each. Furthermore, we assumed there would be internet access at the hotel where the training was held, since DHIMS2 was on online system. However, there was no internet in the conference facility, and coverage with modems was poor. Much of the first day of training was consequently

wasted. Although we got hold of a desktop to use as a local server for the second day, this was not configured properly and failed several times during the week. Only gradually over the trainings of the first three regions were the organisational issues resolved.

At the three first trainings, a total of 7 trainers were involved including myself. These were the most experienced of the CHIM staff. Seemingly because of complaints from the rest of the staff, it was decided that for subsequent trainings, everybody at CHIM should be involved. A pair of one experienced and one less experienced of the staff should be sent to each of the regional trainings. This concerned the more experienced staff at CHIM and myself, as we were concerned this would come at the cost of inadequate end-user training - both the fact that only two persons would facilitating in each region, and that one of these would be among the least experienced. The first end-user training had revealed that even the most experienced persons at CHIM struggled with many of functions in DHIMS2 when asked by the users. In the end, the decision was reversed, and only the core team at CHIM was used for the end-user trainings.

As mentioned, the trainings were held in batches, with each batch or group being given two and a half days of training. Each group normally consisted of 40–50 participants from of 8–10 different districts. In most regions, there were two such batches, although some had one or three depending on the number of districts. From each district, one or two persons from hospitals using DHIMS were present. The participants from the district headquarters were usually the health information officer, a disease control officer (representing the disease control division) and a public health nurse (representing the RCH department).

The original schedule was to have all the ten regions trained by the end of 2011, so that the users would be ready for a January rollout. However, for several reasons, this was not possible:

- "Immunsation week" was held in the end of September/beginning of October, and for a two week period staff at the district health directorates could not leave to participate in the training. The trainings in Central and Western regions were therefore pushed back two weeks from when they were first scheduled.

- The DHIS2 Academy in November, where the staff from CHIM participated, meant that no trainings could be held for the second week of November.

- Christmas made trainings during the second half of December difficult.

- District and regional staff were busy with yearly reviews in parts of January and February, preventing trainings in this period.

- Because the GHS did not have a training budget, trainings could not be scheduled before funding had been secured.

The consequence of this was that only five of the ten regions were trained by the end of 2011, with the rest being trained by mid March. In addition to this initial training, it was decided to have a three-day administrator training in each region to coincide with the rollout the first week of April. This was a training only for one designated administrator from each district and region. The primary goal was to have a refresher in user and organisation unit management, and make sure all the districts got started with the system. Since the rollout, staff from CHIM have held regional trainings, this time of managers and directors. In addition to these trainings organised by GHS centrally, the Western region funded and organised a refresher training, with two officers from CHIM present to support it.

6.6.3 Content of the End-User Trainings

The content of the training was dynamic, especially to begin with. There were several reasons for this. First of all, as we gained experience in what the users struggled with, we tried to adapt the content of the training to focus more on those parts of the system. Secondly, the system was not finished when the training begun, and new features became available during the trainings. Third, the user roles were not clear as the training started, thus it was not decided what functions users would have access to. Finally, the users gave feedback on what parts of the training they found most useful, and we tried to adapt to that. In all, this led to continuous adjustments in the trainings.

Although the content of the training changed over time, approximately the same time was spent on the main components of the system. Data entry and reporting each took about two-thirds of the first and second day, while around one-third of a day was spent on Mydatamart, data quality, user and organisation unit management, and introductions and feedback.

6.6.4 Training Material

Extensive documentation is available for DHIS2, compiled in an "Implementers manual", a "User manual" and an "End User Manual". For the training and as a general reference, however, GHS wanted a local user and training manual. The director of the IME department started this work by writing a few pages, before sending it to me and the staff at CHIM asking us to finish it.

As the end result of this manual was meant to be more or less the same as the official DHIS2 "End User Manual," I suggested adapting that rather than starting from scratch. The DHIS2 documentation is available in the XML-based *DocBook* format. One can therefore easily pick exactly the chapters and sections one wants through a configuration file, adding any custom chapters that are required, and compile it to various formats. While the staff at CHIM agreed that adapting the official manual would be a better approach, the IME director insisted on a DHIMS2 manual written from scratch for Ghana. Two officers at CHIM started working on the manual,

but as the first regional training approached, it was far from finished. Furthermore, there were many inaccuracies and poor illustrations. Before the first training, I therefore sat down to improve the manual, taking better screenshots and adding parts that were missing. The manual was still not complete for the first training, but the most basic aspects of DHIMS2 were covered.

As the curriculum of the trainings changed and new features added to DHIS2, the training manual had to be continuously updated. I encouraged the staff at CHIM to work on this, but nothing was done. This could be because they did not feel confident enough with the software, or it may simply be that no one wanted to take the extra work. Nonetheless, this does not bode well for the maintenance of the manual going forward. While I have made some further updates to the manual, several topics are still covered only in the very basics.

6.6.5 Problems Encountered at the Trainings

Several problems were encountered at the trainings, especially in the first three regions. Below are the problems I identified, and issues raised to me by users directly or on a feedback form all participants were asked by CHIM to fill in at the end of the training (see appendix A).

As was mentioned above, the system was not finished when the training started - neither the data sets for data entry, nor the reporting. For the first three regions, only the eight most widely used datasets where available to the users. The issue of user roles was also a problem, as we had not yet reached an agreement on what authorities the district-level administrators should have in terms of administering reports. A decision on this was not made until during the third regional training.

Another major problem for the first half of the regional trainings was the lack of data in the system. Because there was not data, it became difficult to understand and appreciate the report functionality of DHIMS2. Data had not yet been migrated from DHIMS, and users had not yet started entering data. We tried to mitigate this by letting users practice on data entry on the first day of the training, so that this data could be used for reporting the next day. This worked to a certain degree, but the amount of data was not sufficient to give a realistic representation of how the reporting would work.

Facilitation was also a problem at times. Lack of knowledge on many DHIS2 functions was one part of this. While the CHIM staff knew how the functions worked in general, both them and at times myself struggled to give explanations on some of the detailed questions from the users. As a consequence, several facilitators often ended up responding to the same questions, but giving different answers. As one participant noted "It was quite helpful but also confusing as you cannot know who to listen to as all have different opinion about the issue that was being discussed." However, as the training progressed, this improved considerably. At the fourth training, there were fewer complaints about confusion, and one participant instead stated "Bravo trainers, you really know your stuff".

The fact that the number of trainers were reduced contributed to this. At the first training in Greater Accra region, there was at times seven trainers involved, eight including myself. At the next three trainings, we were seven persons in total, but after that the, only a core team of four to five persons were involved.

Anther common complaint from users was that there should be more time for practical exercises. Although the goal was to have as short presentations as possible to enable exactly that, this was at times difficult to achieve. There were many functions to demonstrate, and users posed many questions. The fact that not all users had computers to bring to the training also reduced the hands-on time of each participants, something several users complained about.

One final issues that was brought up in the first regions was the long period from the training to the planned rollout. Thus refresher trainings was a common request among users. However, this was not something that could be promised. In addition to lack of funding, no team of trainers had been established apart from the staff at CHIM, and they had more than enough to do covering the country once before the rollout. The only refresher training given in the end was therefore the three day administrator training coinciding with the roll-out in April.

6.6.6 Feedback on the System

The regional trainings were an important arena for getting feedback from users on the system itself, both requests for additional features, and comments on problems or errors. This feedback was especially important because there was no pilot. The trainers from CHIM were eager to write down comments from users, especially in the first regions.

One of the most common requests was stricter controls on what could be entered into the system. First, there was the issue of preventing wrong types of numbers to be entered, for example decimal numbers in fields that captured numbers of cases. We easily rectified this by changing the number type of the data elements to *integer*, which causes DHIS2 to only store integer values. Secondly, some users argued that the system should require all fields in a form to be filled with zeros before it could be registered as "completed," even if it meant filling in hundreds of zeros. This was not done, as it would lead to much wasted time for no real benefit. For example, one dataset for registering outpatient cases has 76 diseases with 11 age groups for both male and female. For most facilities, there are only cases of a fraction of the diseases for a few age groups, meaning that most of the 1672 field would have to be filled with zeros every month. If these zeros made a difference in the analysis of the data, entering zeros could perhaps be defended in some cases. However, except for two specific datasets, the zeros are not even stored in the database.

Access to see and change the data was also a major issue. People at the district level, where data is entered, were concerned that other users could change the data they entered. They wanted limitations so that only the person entering data could change it, and they wanted separate data

entry user roles for the different programmes. In this case, all we could do was to comfort the users by the fact that no one at the regional or national level could change their data, but that a decision had been made centrally that there should only be one data entry user role in the districts. One interesting comment was given on this issue. A user in the Central Region stated that with DHIMS2 he "[...] will ensure proper data entry and validation since everyone will have access to my data", indicating that the reasoning behind giving wide access to the data is correct.

Besides the issue of data access and data quality checks, datasets used for routine data entry caused the most concerns and questions. Some of these were the results of errors and mistakes in the customisation, and these were quickly rectified. Other questions were caused by the datasets in DHIMS2 being updated versions of the forms used on the ground.

In general, people expressed that they were happy with the new software. Compared to the first DHIMS, the reporting functionality was seen as a large step forward in particular. In the five regional trainings I took part in, only one user said he though DHIS2 was "not user friendly at all" compared to the old system. This comment was met with protests from other participants.

A final concern raised was that of internet access. Some users were afraid they would not have good enough coverage in their districts to work online, others were concerned about who would cover the costs. Private hospitals in particular were concerned about who would pay for their internet access. At the trainings where the director of IME was present, these concerns where rebutted: there would be access, and the districts would find a way to finance the systems. At the other end of the spectrum were users who stated that they looked forward to having a web based system, where they did not have to worry about manually sending data every month.

6.7 Migration of Data

Stakeholders had been promised early in the process that data from DHIMS would be migrated to DHIMS2. This was also a great relief for users in the districts, who were concerned that they would have to manually key in historical data. This section will describe the data migration process.

6.7.1 The Migration Process

At the DHIS2 Academy in Accra November 2011, the Ghana database was cleaned up and the datasets were mostly finalised. The process of moving data could thus begin. A member of the HISP team from Oslo started the preparations during the Academy, working with one of the staff at CHIM to identify which datasets that could be moved. There is currently no documentation on how to migrate data into DHIS2 from system such as DHIMS. Back in Oslo, I was given a brief introduction to Microsoft Access and some guidance on the general migration process by the HISP member.

I then continued the work from there, spending several weeks working on the data migration. Overall, the process I followed has five main steps:

1. Identifying the data to move from the source system, and matching it with the data in the target system.
2. Transpose the data according to the format of the target system.
3. Update the metadata to match the target system format.
4. Clean up the data.
5. Move the data into the new database.

Each step will be described in more detail below. The process described is a general one, and there were exceptions in the DHIMS database with data being stored differently in some datasets.

The primary tool I used during the migration process was Microsoft Access. First of all because DHIMS is Access-based. DHIMS2 is running on a PostgreSQL database, but using an Open Database Connectivity (ODBC) driver, tables from DHIMS2 can be linked into Access and used almost as if they were regular Access tables.

6.7.2 Identifying Data To Move

The first part of the job was identifying what data in the old system should be migrated. While the datasets in the old database were all meant to be included, the format in which the data was stored in the DHIMS database was not straightforward. For most datasets there was one main table where the data was stored, sometimes two. However, the names of the tables and also the data elements in the tables were often hard to identify. Furthermore, there were dozens of tables cluttering the database which it was difficult to understand the purpose of without the source code, as shown in figure 6.16.

Once the tables containing the data for a dataset had been identified, the metadata of the old and new system had to be matched. With few exceptions, the format of the DHIMS tables was such that each row represented one complete dataset for one facility in one period. Thus each data field was represented by one column. By extracting the column headings, the equivalent of data element names in the old system had been found. These would then have to be matched with data elements in DHIMS2, along with the period and organisation unit.

For several reasons, matching the data in the old and new database was not as straightforward as it initially appeared. First of all, while the names of data elements in DHIS2 are seen by the users and therefore generally make sense in their own right, that was not the case with those in DHIMS. The names found in the database tables are only used internally in the source code, and the names were therefore often hard to understand. Another complicating factor was the fact that there had been changes in several of the datasets between DHIMS and DHIMS2. It was therefore

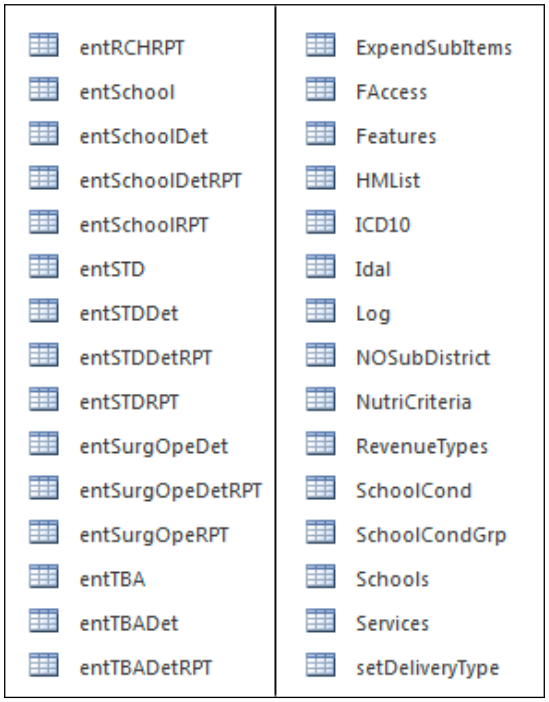


Figure 6.16: Screenshots showing some of the tables in the DHIMS database

not always clear whether the new and old data elements actually matched directly, if some the DHIMS data element had to be merged into the new data elements, or if they should not be imported at all.

The matching of data elements was done by the staff at CHIM and myself. With some exceptions, the matching was done by creating a spreadsheet for each dataset, with columns containing the data elements and categories from both DHIMS and DHIMS2. Using copy and paste, matching data elements were then placed on the same rows. Each row thus became a "map" of the data from DHIMS to DHIMS2. See figure 6.17 for an example.

In addition to the data, two other identifiers are needed to migrate the data: the reporting facility (organisation unit) and the period. DHIMS stored both of these identifiers in one variable "entCode" with 16 digits, where the first ten digits are the organisation unit code, the next four the year and the last two the month. The organisation units were migrated from DHIMS to DHIMS2 in the first place, so these could quite easily be matched by using the facility code property in the DHIS2 database. The periods were also straightforward to match, using the period-table in the DHIS2 database.

6.7.3 Transforming the Data

Once the required metadata matching had been done, the next step was to transform the DHIMS data into a format similar to that used in DHIS2. Unlike DHIMS, DHIS2 stores all data in one table, with one row for each

DHIMS Data element	DHIMS Age Group	DHIMS2 Data element	DHIMS2 Category
AdmissionsM	Below 1	Admissions - insured patients	(Male, under 1 yr)
AdmissionsM	1 to 4	Admissions - insured patients	(Male, 1 to 4 yrs)
AdmissionsM	5 to 9	Admissions - insured patients	(Male, 5 to 9 yrs)
AdmissionsM	10 to 14	Admissions - insured patients	(Male, 10 to 14 yrs)
AdmissionsM	15 to 17	Admissions - insured patients	(Male, 15 to 17 yrs)
AdmissionsM	18 to 19	Admissions - insured patients	(Male, 18 to 19 yrs)
AdmissionsM	20 to 34	Admissions - insured patients	(Male, 20 to 34 yrs)
AdmissionsM	35 to 49	Admissions - insured patients	(Male, 35 to 49 yrs)
AdmissionsM	50 to 59	Admissions - insured patients	(Male, 50 to 59 yrs)
AdmissionsM	60 to 69	Admissions - insured patients	(Male, 60 to 69 yrs)
AdmissionsM	70 & Above	Admissions - insured patients	(Male, >= 70 yrs)
AdmissionsF	Below 1	Admissions - insured patients	(Female, under 1 yr)
AdmissionsF	1 to 4	Admissions - insured patients	(Female, 1 to 4 yrs)
AdmissionsF	5 to 9	Admissions - insured patients	(Female, 5 to 9 yrs)
AdmissionsF	10 to 14	Admissions - insured patients	(Female, 10 to 14 yrs)
AdmissionsF	15 to 17	Admissions - insured patients	(Female, 15 to 17 yrs)
AdmissionsF	18 to 19	Admissions - insured patients	(Female, 18 to 19 yrs)
AdmissionsF	20 to 34	Admissions - insured patients	(Female, 20 to 34 yrs)
AdmissionsF	35 to 49	Admissions - insured patients	(Female, 35 to 49 yrs)
AdmissionsF	50 to 59	Admissions - insured patients	(Female, 50 to 59 yrs)

Figure 6.17: Part of an excel sheet used for matching metadata between DHIMS and DHIMS2.

data value. To transform the tables in DHIMS into a similar format, I was given a small "Anti-Pivot" application developed in South Africa for use with DHIS1. As the name implies, the tool only does one thing, which is anti-pivoting database tables. This was exactly what was required to get the DHIMS tables into the right format, pivoting the columns containing data values. The below tables (6.3 and 6.4) show the format of the tables before and after they are anti-pivoted.

EntCode	**Malaria cases**	**Malaria deaths**
0132342456200701	10	2

Table 6.3: Format of DHIMS database table before anti-pivoting.

EntCode	**Field Name**	**Value**
0132342456200701	Malaria cases	10
0132342456200701	Malaria deaths	2

Table 6.4: Format of DHIMS database table after anti-pivoting.

While this Anti-Pivot tool is quite old - it only works with Windows XP and Access databases in 2003 or earlier formats - it could still be used with the DHIMS database. Using this tool, I was able to transform each data table from DHIMS into tables in a format similar to that of DHIS2.

6.7.4 Updating the Metadata

Once the DHIMS tables were in the right format, the metadata in these tables could be updated with the metadata required by DHIS2. In total, the

data value table in DHIS2 has nine columns, based on unique IDs rather than names or organisation unit codes. These columns can simply be added to the data tables from DHIMS, and the right IDs written based on the metadata that has been matched.

6.7.5 Cleaning the Data

Once the data is in a table of the right format, and with the right metadata, a rough cleaning of the data can be done. First of all, I removed empty fields and fields with zeros. Next, by sorting the data values from high to low, I could delete obvious outliers in the data resulting from errors. In the case of Ghana, my experience was that there were usually around 10–15 such values in each dataset. This may seem insignificant, but a few values orders of magnitude larger than the rest can skew the whole datasets quite significantly.

More detailed analysis can of course also be done to determine more exactly which data values are unrealistic, for example sorting data values for each data element in a dataset separately. A realistic maximum number of "Malaria cases" will be much higher than one for "Polio cases". Similarly, a figure that can be valid for a large health centre or hospital can be totally unrealistic for a small community clinic. Due to time constraints, I did not go through the data with such detail. It would most likely have required assistance from health statisticians with knowledge to the situation in Ghana, and this was difficult as I worked on the migration from Norway. Getting replies on even basic questions relating to the data migration often took a long time, and if this should also involve a detailed analysis of the data the process would have been further delayed.

I did a second type of cleaning, or rather filtering, along the time dimension. DHIMS was piloted in a number of districts in 2007. However, this data was not complete. We therefore decided to only import values from 2008, when it had been rolled out nation-wide, up till the end of 2011. Not only did that leave out the incomplete data from the pilot, but it also excluded quite a few values entered mistakenly, with dates ranging from the 1990s to the 2020s.

6.7.6 Moving the Data to DHIMS2

The final step of the migration process is to move the formatted, matched and cleaned tables from Access into the DHIS2 database. While the data *can* be moved directly to PostgreSQL over an ODBC-connection, the number of rows that can be moved is limited - on the computer I used for the migration it failed at around 200 000 rows. The biggest dataset contained over 6 million rows alone, thus I opted instead export the data values from Access to a Comma Separated Value (CSV) text file that could be imported directly into the PostgreSQL database. In those cases where several data values in the old database are being merged into one value, this is done as the data is exported from Access. Where there are more than one row with

the same data element, category, facility and period, the rows are summed up and merged into one value.

I was able to migrate most of the data before the system was rolled out. Before the rollout, I could copy the online database from the server, import the data locally, and upload the updated database to the server. After rollout, this was no longer possible. Instead, the CSV-files with data had to be uploaded to the server and imported directly there.

6.7.7 Status of the Migration

Currently, 21,6 million data values have been migrated from DHIMS into DHIMS2, making it the largest online DHIS2 database anywhere. There are currently only two datasets left to migrate into the DHIM2 database. In addition, I have agreed to try to migrate the anonymous event data if possible, but work on that has not yet been started.

6.8 Rolling out DHIMS2

> DHIMS2 is moving on a higher plane, let us all fuel its engine by using it, and I bet you, DHIMS2 will take us to heavenly places in the GHS. Enjoy the use of DHIMS2. (Regional health information officer in a message to DHIMS2 users).

6.8.1 First Impressions from the Rollout

As I have already mentioned, the system was rolled out nationwide in April. As of this writing, on July 26h, 7,982,119 data values have been saved, 177,913 datasets have been registered as completed and 132,657 anonymous events have been recorded. The data entered is from the first half of 2012. By comparison, the migrated DHIMS data consists of about 22 million values, thus on average less than 2,8 million values per half year. While it is difficult to make exact comparisons between DHIMS and DHIMS2 - the number of datasets is greater in DHIMS2 for example - it seems safe to conclude that the system has already been put in wide use.

DHIS2 has a built in messaging and feedback system. The 2533 registered users (again per July 26th) have so far sent 1218 messages. These can help give some first impressions of the system, although the main topic is generally requests for assistance on specific issues. Most of the feedback so far has been related to the data entry part of the system, with questions and comments on the datasets. The most common issues that have been raised have been requests for the linking of data across datasets, one dataset in particular, and blocking linked datasets from data entry except from the primary source. Both these issues were addressed during the "DHIS2 Database Training" in Lomé, Togo, in late April, which will be discussed in the next chapter. In the first weeks after the rollout in particular, there were a number of questions and issues regarding organisation unit and user management. Lately, there have been fewer messages about this. At the

moment, it is the anonymous events that are causing the biggest concerns. Many users have reported that it is very slow, and works poorly in areas with slow internet connections. There are also complaints on the fact that event cannot be deleted or edit after they have been entered. Finally, staff at the regional level has used the messaging functions to encourage districts to work on data entry, and to contact districts with low reporting rates, and staff at CHIM and in IME have also contacted regions about the same.

CHIM has been active in replying to these messages, at least in periods, but also report that they contact many of the users by phone when they send feedback. I have also used the messaging function extensively to communicate with and assist users, and of the 1218 messages that have been sent I am responsible for 176 of them. Figures 6.18 and 6.19 are an examples of message conversations, more examples are found in appendix C.

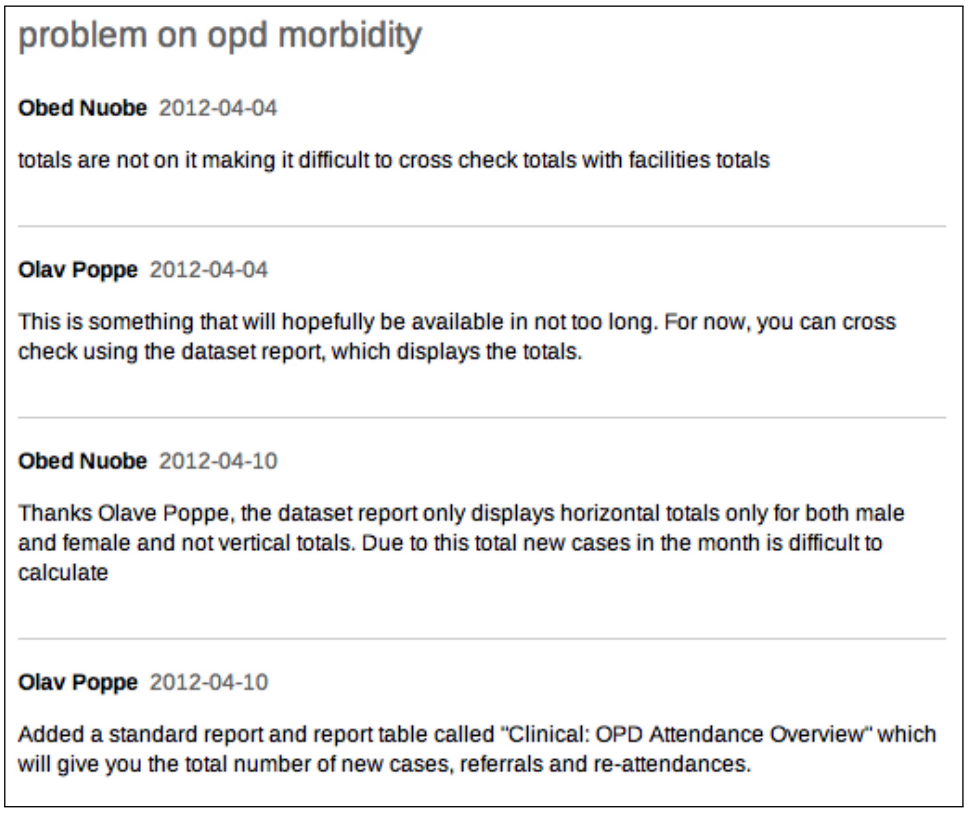


Figure 6.18: Conversation with an end users in Ghana, using the DHIS2 messaging functionality. The result of this conversation was to add a report to the system that could be used temporarily, while the request for "vertical totals" were forwarded to the developers.

I have asked the staff at CHIM if they have discovered any particular problems which I have not been able to pick up through the built in messaging functions. While they have been receiving various phone calls with questions and suggestions, it has mainly been the same issues as those discussed above. There had also been some complaints about poor internet

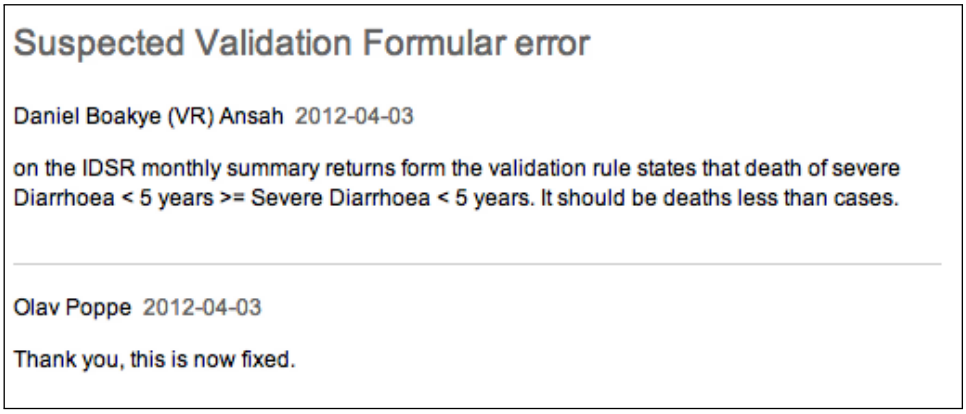


Figure 6.19: Conversation with an end user in Ghana. The user has discovered a error in a "validation rule", which I was able to correct on the server.

access, but not many. However, the overall the response from users as well as the use statistics are positive so far.

In June, DHIMS2 was awarded third prize for innovations in Public Service at a Public Service Award ceremony.

Chapter 7

Implementing DHIS2 in Liberia

In May 2012, I was given the opportunity to visit Liberia for one week with a DHIS2 developer to help with the DHIS2 implementation there. This, as well as meetings at workshops and electronic correspondence with the main DHIS2 focal person in Liberia, has given me valuable insights into the situation of DHIS2 in particular and the health information system in general.

7.1 Introducing DHIS2

7.1.1 Moving from DHIS1 to DHIS2

Liberia has been using DHIS1 for several years. In 2010, a decision was made to upgrade to DHIS2, with the support of several donors, as well as WAHO and the University of Oslo[1]. Work on implementing DHIS2 started early 2011. I first met the main implementer from Liberia at a workshop in Oslo February 2011.

The infrastructure in Liberia is poor, after years of civil war. Neither fixed nor mobile internet is widely available. It was therefore decided that DHIS2 could not be rolled out on a central server, with districts accessing the system over the internet. Instead, DHIS2 would be used in the same way as DHIS1, with standalone installations in the 15 counties and on individual users's computers in the ministry of health.

Coinciding with the introduction of DHIS2, Liberia was introducing a new, integrated reporting format. All the various programmes and divisions had agreed on a common dataset, and duplication of data collection could thus be avoided since all data is available on the same dataset. The integrated form has separate sections on the various areas such as immunisation, maternal health and malaria.

To speed up the process of configuring DHIS2, metadata was imported from DHIS1. This meant that for example the organisation unit hierarchy

[1]Donors included GAVI (Global Alliance for Vaccines and Immunisation), Global Fund and USAID through the Rebuilding Basic Health Services (RBHS) project.

would not have to be recreated. However, because revised datasets were being introduced along with DHIS2, most data elements and indicators had to be recreated.

In September 2011, DHIS2 was ready for rollout nationally, after being piloted in two counties for two months. The new integrated reporting forms were introduced at the same time (Braa et al., 2012). Standalone installations were thus set up in all the 15 counties, just as DHIS1 had been used.

7.1.2 New Challenges

The DHIS2 implementation in Liberia faced many challenges, to which we were introduced upon our arrival in the country in May 2012 [2]. The move from DHIS1 to DHIS2 had not been trouble free, even though the systems were used in the same standalone configuration. The first day of our visit, we met with the IME coordinator in the Ministry, and discussed some of the issues they had. The main DHIS2 implementer in Liberia, who is now the acting HMIS director, was also present. The IME coordinator complained that "currently, we are only using 5% of feature of the software". What we identified as the main problems with DHIS2 in Liberia, which we would work on during our visit, were:

- migration of DHIS1 data
- removal of unused metadata
- under utilisation of the software
- lack of a central server, even in the ministry of health
- limited capacity to install and maintain DHIS2

The consequence of these problems was that both users in the counties and data managers and directors in the ministry had become dissatisfied with DHIS2, and were questioning whether the software was appropriate for the Liberian context. This was also something the HMIS director, who almost solely runs the DHIS2 implementation in Liberia, had told me he was worried about in a Skype chat a few weeks earlier. Towards the end of our visit, after some of the problems had hopefully been solved, we agreed to hold a demonstration for data managers and directors who were interested, showing some of the things DHIS2 could do.

7.2 Improving the DHIS2 Implementation

7.2.1 Migration of Data

The first issue we tackled was that of data migration from DHIS1. Because the reporting tools were changed at the same time as DHIS2 was

[2] A Terms of Reference had been prepared for out visit, giving some background information, outlining some of the current challenges and listing the priorities issues. This is attached as appendix D.

introduced, the migration of data required a manual process of matching data elements between the new and old system, similar to what I had done in Ghana and was presented in the previous chapter. There were two differences from the process in Ghana, however. First, the datasets in the old and new system were completely different, not just slightly updated as in Ghana. Thus the task of matching data elements was a lot more difficult. Second, the metadata and the data in DHIS1 are stored in two separate database tables in the same way as in DHIS2, thus the actual migration of data becomes somewhat easier.

As in Ghana, I made two lists of data elements - one from the old system and one from the new. The HMIS director then sat down and matched data elements from DHIS1 with data elements and category options in DHIS2. Some data were easily matched, with the data elements being similar. In other cases, two or more data elements from DHIS1 could be merged into DHIS2 data elements. Finally, some data elements were more disaggregated in DHIS2 than in DHIS1, and could therefore not be migrated.

In the end, we managed to import most of the data from DHIS1, with two main exceptions. First, data elements with few values were simply skipped. This was done because the matching of data was difficult and time consuming, and we had to finish the migration before we could start the process of removing unused metadata. Secondly, there was some important data in DHIS1 which could not be imported into the new datasets, because the data elements was not collected in DHIS2 or because of different disaggregation. After some discussions, we decided to keep this data in DHIS2, in a dataset called "Legacy data". In all, I imported about 1 million data values.

After we left Liberia, the HMIS director sat down with representatives from different programmes and reviewed the data we had migrated. They discovered some errors in the matching we had done, and made a revised list with matching data elements. Consequently, I have to delete some of the migrated data and re-import it.

7.2.2 Cleaning the Database

When work started on migrating from DHIS1 to DHIS2 in 2011, most of the metadata, such as data elements and indicators, was directly imported. However, due to the reform of the datasets none of the data elements and indicators were actually used in DHIS2. In total, we found more than 2000 unused data elements and indicators from DHIS1 cluttering the Liberian database. This was problematic when using the data, as it meant there were many data elements and indicators where there was no data, and finding out which had data was difficult.

Once we had migrated the historical data into DHIS2, we therefore set about deleting all data elements which were not used anymore. We then grouped the rest of the data elements according to datasets. As for the existing indicators, none of these could be used anymore as the source data elements were no longer in use. Consequently, we deleted *all* indicators as

well.

7.2.3 Improving Reporting

Under-utilisation of the DHIS2 software was the third issue we looked at. We first tried to find out how users in Liberia used the data in DHIS2, and what we found was that the reporting functionality in the system was not really used. Instead, users downloaded the raw data into Excel and did all the analysis and reporting there. Users did not really have any other options, as the systems had no customised reports of any kind. Not even users who had been to DHIS2 workshops, for example the DHIS2 Academy in Accra, appeared to use any built-in reporting functions.

As mentioned, there had been no usable indicators in the system. Furthermore, no population data had been entered into the system, thus many of the most common indicators could not be calculated. We therefore decided that we should make sure the population data was put in the system, and then identify and add some core indicators. The goal was to have something to show people so that they could start appreciating the built in reporting features, including automatically calculated indicators.

The HMIS director was able to produce an Excel file with catchment population data for all public facilities in Liberia from a 2008 census, with estimates until 2021. There is currently no master facility list in Liberia, making it a manual job to match the facilities in the Excel sheet with the facilities in the system. This seems to be a general problem, as there were other changes in the organisation unit metadata that the HMIS director also wanted to make, but which required manual identification of facilities based on names and districts. Nonetheless, I was able to import the population data into the system in the end.

In the meantime, we also got hold of a list with definitions of core indicators for the ministry as a whole, and specific indicators for the malaria programme. The DHIS2 developer and myself added these to the system. At this point, we thus had a clean database, with historical DHIS1 data and population figures, and some core indicators. The next step was to start making reports.

At the database training in Lomé, I helped the two participants from Liberia to get started making reports. This was more for the sake of practicing than because they had any specific reports they wanted to make, and the reports themselves were not very useful. Consequently, we removed the handful of reports that already existed and started adding new reports from scratch. As we had limited time available, we agreed that is was best to focus on making many different *types* of reports, in order to showcase the system and to give users a reference in terms of what the system could produce. With these reports as a reference, they could then request for other reports to be added according to their needs. In the end, we were able to produce a handful of standard reports, as well as some Data Visualizer and GIS favourites.

7.2.4 Moving DHIS2 to a Central Server

The last two problems Liberia struggled with were in many ways related: because they did not have a central server, DHIS2 had to be installed on the computer of everyone who wanted to access it - both in the counties, and centrally in the Ministry of Health. There was no sufficient human capacity for this. Installing and configuring DHIS2 can be a challenge for users only familiar with typical step by step software installers, as it requires installation of a database system, a Java runtime and a web server. There is a simplified installer package called DHIS2 Live which facilitates the installation, but this was not used in Liberia - and even DHIS2 Live requires a database system to be installed separately.

The HMIS director explained that a lot of his job revolved around support and installation, rather than managing and improving the overall system. For example, he told us that if the computer running DHIS2 out in the counties crashed, the county user would often have to travel all the way to the capital to have the system reinstalled, or he would have to travel to the county. Thus setting up a central server in the ministry of health, and make in available on the local network, was perhaps our most important task. While users in the counties would still need to deal with their offline installations, it meant that users in the ministry could access the data from any computer without installations as long as it was on the ministry network.

Setting up the server turned out to be a time-consuming tasks. We started working on this on Monday, our first day in the Ministry. We decided to use Windows Server as the operating system, as no one in the ministry had any experience with the preferred Linux operating system. While the installation of the operating system did not pose any problems, the internet was very slow, thus downloading security updates and the software required to configure DHIS2 was problematic. Furthermore, a firewall preventing certain types of downloads also caused problems. By using the internet at our hotel for downloading in the evenings, we were able to get the server up and running by Tuesday afternoon.

Figure 7.1: Server configuration in the Ministry of Health, Liberia.

We used the server without any problems on Wednesday. When we arrived in the ministry Thursday morning, however, it had crashed and did not boot. Luckily, we had made a backup of the database before leaving on Wednesday, so no work was lost. Something was clearly wrong with the server, and we did not have much time for troubleshooting. Thus rather than trying to find out what the problem was, we started configuring an identical server that was available - this time using the linux-based Ubuntu operating system in case the first server crash was software related.

7.2.5 Liberia Moves Online

To ease the process of configuring the second server, the director of IT in the ministry provided us with a public IP address, bypassing the firewall and other restrictions on the local network. Not only did this allow us to download updates more easily. It also meant the server was accessible over the internet. Although the internet is slow, this event was very important.

First of all, it allowed us to configure the server for remote access. Thus we would be able to access the server from outside Liberia to provide technical assistance, help with upgrades and so on. This was especially important since we did not have much time to teach anyone in the ministry how to administer a Linux server. After leaving Liberia, I have used the remote access several times to help take extra backups, import data and so on, and other members of the HISP team have done the same.

Secondly, there was an opportunity for counties to do data entry online. We discussed with the HMIS director whether counties with internet access should be asked to start using the online server immediately. Because the server was hosted in the ministry, with periodic power cuts and slow internet access, we were a bit reluctant to trust the server for all data entry. However, we all agreed that it would solve many problems to let counties work online. The HMIS director therefore got two counties to use the server the week we were in Liberia.

Since we left, the HMIS director has been working hard to get as many counties as possible to work online. As of late June, he hopes that all or close to all counties will enter the data for the next month online. Those counties who are unable to do so will be given the cleaned-up database with population data and sample reports to work on. They will also get the latest DHIS2 version 2.8, which makes importing and exporting of data easier.

7.2.6 Promoting DHIS2 in the Ministry

The demonstration of DHIS2 to users in the ministry was a success, as all those present expressed that they were very happy with what the system could provide. We focused on showing the reporting functionality, since the data entry aspect of the system is less relevant for those in the ministry. In addition to the data managers and directors in the ministry, two representatives from the Malaria Control Programme were present. They expressed their satisfaction with the system, and thought it could be

an important tool for the Liberian health system - although data quality had to be improved at the lowest levels. The IME coordinator, who initially complained that only 5 % of the DHIS2 functions were used, was also happy. He thought that they now would be able to use much more of the possibilities of DHIS2, and even if they only used 65% it would be a big step in the right direction.

Two officers from the Clinton Initiative were also present at the presentation. They had coincidentally seen a "Mobile" menu in DHIS2, and contacted us later for information about the mobile component of DHIS2. They were planning a mobile tracking system for maternal and child health, and wanted to know how DHIS2 could support this. Because neither the developer I travelled with nor myself were up to date on DHIS2 Mobile, we put them in contact with the DHIS2 Mobile group at the University of Oslo.

7.3 Current Status

Since our visits, most counties have started doing data entry online, and I have been told that the system is being accessed over the local network in the ministry. Furthermore, after the HMIS director made a presentation of the updated system to the logistics department, work has begun on integrating the Logistics Management Information System (LMIS) into DHIS2.

While we were able to make many improvements to the DHIS2 implementation in Liberia during the week we spent there, and have continued to work with Liberia from Oslo, there are still many issues remaining. First of all, the IME coordinator explained that they wanted to integrate even more systems into DHIS2, similar to what is now being done with the LMIS. Secondly, local human capacity must be increased. Although several data mangers in the ministry have participated in DHIS2 workshops and trainings abroad, including the DHIS2 Academy and the training in Lomé, our impression was that only the HMIS director had more than superficial knowledge of DHIS2.

Liberia now has an online database, but there is need for improvement on many aspects of the server configuration. There is currently no automated offsite backup, the capacity of the internet connection is low, the server might not be powerful enough to support the whole country over time, and there is no proper domain.[3] Many of these issues could be solved by using a commercial cloud service provider. However, hosting the server outside the country poses other problems. It might not be politically or juridically acceptable to store health data abroad, and it still would require the Ministry of Health to improve its internet connection because data would no longer be accessible over the local network. Furthermore, it would create an additional cost in running the system.

[3] At first, an IP address was used to access the server. Now, a subdomain of the official dhis2.org address is used instead (liberia.dhis2.org).

Chapter 8

Regional Developments

In this chapter, I will take a wider look at developments around health information systems in general, and DHIS2 in particular. The last couple of years, the interest in DHIS2 has grown across the African continent, and countries like Kenya, Uganda, Rwanda and Tanzania are currently using or implementing DHIS2. Interest has also grown in West Africa, and that is the region I will focus on.

In West Africa, a number of countries are either already using DHIS2, are in the process of implementing it, or are considering whether or not to start using it. Table 8.1 below shows which West African countries are currently using or actively working on implementing DHIS2.

Country	**Roll-Out**
Burkina Faso	-
The Gambia	2010
Ghana	2012
Guinea Bissau	-
Liberia	2011
Nigeria	-
Sierra Leone	2008
Togo	-

Table 8.1: Countries currently implementing DHIS2 in West Africa.

In this chapter, I will first look at how HISP is trying to support the West African countries through regional training sessions and workshops. Then, I will give an overview of the status of HIS across the region. Finally, I briefly present the countries considering or using DHIS2 in the region, as well as describe the role of WAHO.

8.1 Building DHIS2 Capacity

Efforts are being made by the HISP network to increase local capacity on HIS and DHIS2. As DHIS2 has become more widely used, the opportunities for regional capacity-building has increased. Consequently, during the period I have worked with DHIS2 in West Africa, there have been two DHIS2 workshops: the "DHIS2 Academy" in Accra, Ghana, November 2011, and "DHIS2 Database Training" in Lomé, Togo, April 2012. These two workshops will be discussed in this section.

I participated in both of these workshops as a facilitator. For the DHIS2 Academy, I was also part of the local organising committee, which helped arrange for and prepare the conference facilities. Both workshops were interesting arenas for me to learn about the DHIS2 implementations in West Africa first hand, through conversations with participants and work on several of the country databases.

8.1.1 DHIS2 Academy

The idea behind the DHIS2 Academy is to establish an annual conference on DHIS2, both for existing and new DHIS2 users. Each year, one Academy workshop will be held both in East and West Africa. The DHIS2 Academy in Accra was the first Academy to be held in West Africa. At first, the idea was to invite only two or three persons from each country, preferably the most experienced. However, the interest was huge and several countries asked to send more participants, and were allowed to do this. A few countries from outside the West African region also asked if they could participate, for example Djibouti. Finally, since the workshop was held in Accra, Ghana ended up including over 20 participants, several of which had never seen DHIS2 before. The event thus became quite a lot bigger than what was initially planned, with over 60 participants and a dozen facilitators. The facilitators were primarily DHIS2 developers and implementers based at the University of Oslo.

The program for the Academy was a combination of presentation on the use of DHIS2 and DHIS Mobile, and practical work on the databases of the individual countries. Most of the presentations were held in plenary sessions, and were translated from English into French on the fly. As one of the least experienced facilitators, I made only one plenary presentation. During the last days there were also some elective presentations on various topics chosen through voting.

At the first day of the event, each country made a poster outlining what their goal for the week was in terms of practical database work. Two facilitators were then assigned to each country. Most of the time, however, we walked around from group to group, and assisted where we could. For my part, I worked primarily with the groups from Ghana, The Gambia and Nigeria.

Ghana had the largest delegation at the workshop, which included the staff at CHIM, some participants from the PPME division and one selected user from each of the ten regions. Because the skill level was quite uneven

in this group, Ghana worked as two separate groups during the practical sessions. One group, with those who had little or no experience with DHIS2, used the practical sessions for private presentations and hands-on practice with DHIMS2. These presentations were made by staff from CHIM. The rest of the CHIM staff worked on finalising the DHIMS2. As I explained in the previous chapter, this included both discussing the requirements for the anonymous events with one of the developers, and importing geographical coordinates to enable the use of the GIS.

The countries at the workshop were on very different stages in their implementations. Some, like Liberia, Sierra Leone and The Gambia had already rolled out DHIS2, and were therefore mostly concerned with making improvements to what they already had. For example, I worked with the two participants from The Gambia, adding a new dataset to their system. They had previously only used section forms for data entry, but now needed to make a custom form for the first time. Other countries were starting with a completely new database, for example Djibouti. They were thus primarily concerned with learning the basics and setting up an organisation unit hierarchy.

Figure 8.1: Participants during a practical session at the DHIS2 Academy.

One of the PhD students who participated as a facilitator had made a feedback survey that was distributed to the participant, which he later analysed and summarised (see appendix B). The overall results are presented here. About half of the participants had seen DHIS2 before, the rest were new to the system. Overall, people stated that they were satisfied with the workshop. The proportion who were satisfied with the presentations were higher than with the practical sessions. The topics that people found most challenging was the process of setting up a database

from scratch and GIS. There were some complaints about the organisation of the workshop. One issue, especially for the Ghanians who had their database online, was that the internet facilities were unreliable. On-the-fly translations were also discussed, as some participants stated that they would prefer separate sessions instead. Furthermore, it was suggested to have separate sessions for users with different skill levels. Finally, there were some users that felt that not enough information was given in advance on what to bring and prepare for the workshop.

8.1.2 DHIS2 Database Training

The DHIS2 Database Training, held 23–27 April in Lomé, Togo, was in many ways a follow-up to the DHIS2 Academy. Compared to the DHIS2 Academy in Accra, the database training aimed to be more focused, with fewer participants from each country - as was originally the plan for the Academy as well. To make sure this plan succeeded this time, two specific persons were invited from nine countries in which DHIS2 is used or considered. This would ensure firstly, that the "right" persons would come from each countries, meaning the persons with most DHIS2 experience. Secondly, it would help keep the number of participants down.

The workshop was paid in full by HISP at the University of Oslo. In total 17 persons from 9 countries participated. In addition, participants from Togo were present at some of the sessions. There were four facilitators: one PhD student at the University of Oslo who live in Togo and one consultant from Senegal to cater for the French-speakers, and one DHIS2 developer and myself to work with the English-speaking participants.

There was a natural division between Francophone and Anglophone countries, not only due to the language, but also because all the English-speaking countries already had a DHIS2 database to work with, whilst all French-speaking countries except Burkina Faso had not used the system before. Thus the French group focused on lectures and exercises, whilst the English group worked on solving issues and making improvements to the country databases.

By the end of the workshop, the French countries had been introduced to all the major modules of DHIS2. Furthermore, they had all configured a working demo database, with a partial organisation unit hierarchy and examples of datasets and reports. This would allow them to better demonstrate DHIS2 upon returning to their respective countries, rather than relying on a generic DHIS2 demo database. Burkina Faso already had a mostly working database, thus the Burkinabè participants focused on finalising user roles.

In the English-speaking group, we started the week by asking each country to make a brief presentation of their current implementation, including problems and improvements they wanted to work on. On Wednesday, the countries gave an update on how far they had come. Friday afternoon, every country in the group presented what they had achieved during the week, and we discussed what they could work on

improving in the time following the workshop.

The rest of the time was spent working on the database, with help from myself and the other English-speaking facilitator. I worked mostly with Liberia, Ghana and The Gambia, but also Sierra Leone. This was thus a great opportunity for me to learn more about the status of their databases, and talk about their future plans. At the end of the week, the English-speakers expressed that they wanted to keep in touch with each other, and agreed that all should sign up to the "DHIS2 Users" mailing list.

I discovered that for the countries with offline installations of DHIS2, Sierra Leone, Liberia and The Gambia, maintaining the correct metadata in the sub-national and national databases is a major problem. When importing data from the sub-national databases into the national database, meta-data from the sub-national databases is copied along with the data values. Thus any attempt to clean up or remove meta-data in the national database is overwritten when importing data from the sub-national level.

With DHIS2 version 2.8, released in April 2012, this import process was improved. It is now possible to import only the actual data, ignoring meta-data differences. However, this requires both the national and sub-national databases to be running version 2.8. At the end of the workshop, we therefore upgraded the databases of the countries working offline to DHIS 2.8. I discussed with each of the countries how to plan the upgrade of DHIS2 at the sub-national level in a way that made sure they would not risk importing the old metadata again. Liberia was the country struggling the most with this, as the counties there had already entered data that needed to be imported into the national database before the counties could have upgraded to DHIS 2.8. We therefore decided that I should manually import data for Liberia until the whole country was running 2.8.

Knowing that we had solved the issue of re-importing old metadata, both Liberia, Sierra Leone and The Gambia worked on removing old metadata from the system. Liberia had the biggest job in terms of cleaning, as was discussed in the previous chapter. The participants from Sierra Leone told me that due to problems with the metadata, they had recently started with a completely blank database, importing only the organisation units from the old database, and re-designing everything else. Thus their main task in terms of cleaning was the removal of closed and duplicated facilities. The Gambia had quite a few duplicated data elements in the system that they were now able to clean out, along with many indicators with invalid formulas.

Besides a general cleaning of the databases, several countries wanted to improve the reporting aspects of their systems. This included Liberia, The Gambia, Ghana and, to a certain degree, Sierra Leone. Except Ghana, none of these countries had any predefined reports in their databases. I tried to work with each of the countries, to get them started on making report tables and standard reports. The participants also asked me to have a plenary session on standard reports, which we did on the last day of the training. Ghana already had quite a few reports in the system, but most of these were monthly. They therefore needed to make quarterly variants of these. Furthermore, I received an email from the director of

IME during the workshop, asking if we could add some reports based on facility ownership. I taught the Ghanian participants how to do this, and they added the reports that had been requested.

Liberia, Ghana and The Gambia all had historical data that they wanted to migrate into their current DHIS2 database. Liberia had data from a DHIS1 database, The Gambia from an earlier instance of DHIS2, and there was still some DHIMS data left to migrate for Ghana. I was able to sit down with each of these countries to work on this. In the case of Ghana, I had been needing assistance on matching data for I while, which I now got. For The Gambia, I was able to help migrate some of the data. However, there are still some data left from 2010 that we did not have the time to finish migrating. Finally, I started working on the migration of data in Liberia, work that was completed during our visit there, described in the previous chapter.

One final issue that we discussed was setting up a central, online server. Sierra Leone, Liberia and The Gambia were all interested in this. Our discussions revealed that it should be feasible to at least start moving online in all countries in the short term, although complete online implementations might not be possible right now.

Nigeria had different goals than the others. There were actually two groups form Nigeria at the training, two participants from HISP Nigeria, and one participant from Ekiti state. HISP Nigeria is working on setting up a national DHIS2 database for the federal government, and worked on setting up the organisation unit hierarchy and configuring GIS. Ektiti state is still using DHIS1, and worked on synchronising the state metadata with the DHIS2 database being configured by HISP Nigeria, as a preparation for their planned upgrade to DHIS2.

8.2 Health Information Systems in West Africa

In chapter five, an evaluation of the Ghana HIS was presented, and the situation in Liberia was described in the previous chapter. Here, I look at the HIS situation in West Africa more generally.

8.2.1 Assessment of the West African HIS

As described in chapter five, I participated in the data collection of an evaluation of health information systems in the West African region, ordered by WAHO and performed by the HISP group at the University of Oslo. Several assessment tools were used in this evaluation. One was the "TALI tool," used to grade HIS functioning and information use. Seven countries were visited by researchers and given a grade for the facility, sub-national and national level, on a three-grade scale (see appendix E). This tool revealed that the health information systems at the local and sub-national level work well. Data is collected and used at the facilities, and reported to the next level. However, at the national level, the systems work poorly, suffering from heavy fragmentation and poor software. In

general, data quality appears to be poor, and use of the data is limited. This was attributed more to problems at the higher levels, not locally as is often assumed. The root cause was found to be fragmentation and donor initiatives (Braa et al., 2012).

A second tool that was used was the "HMN Light" tool. With this tool, countries are given a grade from 0 to 3 on a number of criteria within three categories: context and resources; processes; and results. I will now summarise the main findings in each of these three categories.

The first category deals with the HIS context and availability of resources. The assessment revealed that there is no legal and regulatory framework to guide and govern the HIS in any of the West African countries, bar Ghana and Burkina Faso. Lack of human resources are a problem in all countries as well, again with Ghana as a partial exception. This problem is amplified by the fact that supervision and routines to guide health workers are limited. Staff training is generally focused more on use of IT than on use of information. Career opportunities within the health information field is limited, as we also saw in Ghana.

Infrastructures are another challenge across West Africa, although the problem varies between and within countries. Both power, internet and computers have a high amount of downtime, and the software used for health information management is generally poor. No clear conclusions could be made in terms of financial resources, as this data was not available (Braa et al., 2012).

The second category deals with processes. It was found that there are few mechanisms to promote use of information. First, most countries do not have agreed-upon data and indicator sets used across the organisations. Secondly, the fragmented nature of the health sector means that there are few incentives for sharing of data. Finally, there are no links between performance on one side and budgets and promotions on the other. On the positive side, there are regular review meetings in several countries, which does help in the promotion of information use. When it comes to data management, it is a general problem that too much data is collected, not all of which is ever used. This affects data quality negatively. There are also few indications that the quality of the data is checked, and for example triangulated with surveys (Braa et al., 2012).

The third and last category in the HMN light tool deals with results, meaning dissemination and use of the collected data. The primary vehicle for data dissemination in the evaluated countries is annual statistical reports. These are often delayed, contain mostly raw data and are seldom linked to policy goals. Consequently, their usefulness for management is limited. Furthermore, there are limited sharing of information to external partners and stakeholders. The assessment identified several possible reasons as to why information was not disseminated more widely:

- The focus of reporting is on pleasing superior officers.
- There are fears of criticism if the data show negative trends.
- There is a perceived need in the government to control access to data.

Gaps in the data are often used as an excuse to withhold information. How information is used for advocacy was also discussed, for example in campaigns to prevent the spreading of HIV/Aids. It was found that information *is* used for advocacy, but mostly at the national and international level. However, advocacy is most efficient if done at the local level, with local information (Braa et al., 2012).

8.2.2 The Common Problem: Fragmentation

Many of the common West African challenges discussed above have a common root cause: the vertical fragmentation of the health information systems. The WAHO Assessment in turn identifies two root causes of this fragmentation:

- institutional complexity
- malfunctioning software (Braa et al., 2012).

A primary cause of fragmentation in West Africa is institutional complexity, with Guinea Bissau being a prime example. Because the health sector itself is complex and fragmented, with health programmes and divisions receiving direct funding and acting quite independently, the health information system also becomes fragmented. Each programme creates separate reporting systems for its own use, in part to meet the reporting requirements of its donors. Consequently, data and indicators are not standardised across the health sector, and the information cannot be easily shared or compared. Furthermore, sustainability becomes a problem, as the vertical reporting systems often collapse if the donor funding ends (Braa et al., 2012).

Another important contributor to fragmentation in West Africa is malfunctioning software. When software does not work well, either functionally or because it cannot be adapted to changing requirements, vertical reporting systems are created instead. We have seen in chapter five and six how this was the case in Ghana, and Braa et al. (2012) points to Guinea and Nigeria as other examples. These vertical reporting systems are often made by users with little knowledge of information system design, and are therefore often quite poor.

8.3 Regional DHIS2 Actors

In this section, I present some of the main actors interested in DHIS2 in West Africa. I first look at WAHO, and its relation to DHIS2. I then present the other DHIS2 implementers in the region. The information here is mostly based on conversations with representatives at workshops. Finally, I give a brief overview of the West African countries who consider using DHIS2, but have yet to make a decision.

8.3.1 WAHO

An increasing number of countries in West Africa are now adopting DHIS2. This is important for the West African Health Organisation (WAHO), which has health system integration across West Africa as its main goal (West African Health Organisation, n.d.). WAHO is collecting data from its member states, but the organisation of this data collection is poor: separate divisions within WAHO collect data independently as there is not central database, countries are often slow to report, little feedback is given *if* they report, and the data definitions are not harmonised across the region, making the data difficult to use (Braa et al., 2012).

In February 2011, I interviewed Albert Ouedraogo from WAHO at a workshop in Oslo. He explained that WAHO wanted to support DHIS2 in West Africa. This includes supporting countries to get internet access and standardising definitions of the data being collected. Furthermore, WAHO wanted to use DHIS2 to integrate data collection. WAHO already has a web-based database system, called SIGIS, but this is not primarily for statistical health data.

8.3.2 Other DHIS2 Implementers in West Africa

Previously, I have mentioned bits and pieces of information on various other DHIS2 implementers in West Africa. In this section, I will give an overview of each of these countries. Ghana and Liberia have been discussed previously, and will not be discussed further here.

Sierra Leone

Sierra Leone was among the first countries to implement DHIS2 nationally, in 2008, with support from the University of Oslo and the Health Metrics Network (HMN). The implementation in Sierra Leone was used to pilot DHIS2 integration with other systems, with DHIS2 as a central data warehouse. Using the XML-based SDMX-HD (Statistical Data and Metadata Exchange - Health Data) format, DHIS2 was able to receive aggregated data from OpenMRS, an electronic medial records system that was used for HIV and Tuberculosis patients (Braa et al., 2010). Initially, reporting in Sierra Leone was not integrated, and various health programmes collected the same data on separate forms. To avoid duplication in the database, duplicated data elements were linked "behind the scenes" in DHIS2, as we have done in Ghana (Sæbø et al., 2009). Gradually, a process of developing an integrated, essential dataset began, and today the reporting is integrated (Tohouri and Asangansi, 2009).

At the Database Training in Lomé, I was told that the biggest challenge with DHIS2 in Sierra Leone today is the use of offline installations in the districts. Keeping a large number of databases synchronised is a complicated and error-prone task. We discussed how this process would be improved with DHIS 2.8, but agreed that moving the system online would be the best solution if possible. I was told that the mobile internet coverage

in Sierra Leone has improved lately, and districts already receive financial support for mobile internet connectivity. Planning has already begun with regard to moving to an online server. We discussed whether hosting the database outside Sierra Leone would be viable, and that had already been cleared in the ministry. Capacity to host the DHIS2 online in Sierra Leone is limited for the time being.

The Gambia

The Gambia started implementing DHIS2 in 2009, rolling out the system from January 2010. The Gambia has standalone installations of DHIS2 in six regions (Valbø, 2010). I was told at the Lomé Database Training that all regions were running version 2.1 of DHIS2, released in March 2011. On the national level, DHIS2 version 2.6 was used. Consequently, users especially in the regions, but also at the national level, had been losing out on a lot of new functionality. This also implies that no improvements made on the national database since the first half of 2011 has been moved to the sub-national level. At the Database Training in Lomé, I worked with the Gambian participants to upgrade their server to DHIS2 2.8, and we discussed how to make sure the regions get the updated database as soon as possible.

When working with the Gambians in Lomé, I discovered the same problem I found when first coming to Ghana: the use of data element category combinations did not seem to be properly understood. Consequently, I tried to explain this concept.

As in Sierra Leone, I was told that internet coverage had improved greatly in The Gambia since the initial rollout of DHIS2. The HMIS director is therefore planning to move DHIS2 online. He told us that he planned to use Virtual Private Network (VPN) connections between the regions and the national level to ensure that the data was securely transmitted. This is a very complex process compared to the recommended approach of using secure HTTP, something that we explained to the Gambians. The Gambians reported that everything was more or less ready for moving online and that they had a server and a location to host it. What they needed was only assistance from the University of Oslo to assist in configuring everything.

Nigeria

Nigeria has a long history of using DHIS1. As a federal country, states organise their health information systems independently, although the datasets follow a national standard. The Nigerian participants in Lomé told me that about half of Nigeria's 37 states use DHIS1[1]. One of the main actors in Nigeria in terms of DHIS2 is HISP Nigeria, an independent organisation working as DHIS consultants in the country.

The main focus of HISP Nigeria with regard to DHIS2 is currently a contract for the federal government to set up a DHIS2 database in five

[1]Two representatives form HISP Nigeria participating in the DHIS2 Database Training in Lomé is my main source of information on DHIS in Nigeria.

states, in relation to a donor-funded project. While the project is limited to five states at the moment, HISP Nigeria has told me that they want to promote this database as a national database, with the goal of getting more states on board over time. Because Nigeria is such a huge country, setting up a database is a massive task. In total, there are about 40 000 facilities in the country. For now, about 10 % of the facilities have been imported into the national database.

The main tasks for HISP Nigeria going forwards it to complete the national DHIS2 database and promote it to potential users. At the sub-national level, some states are starting to move from DHIS1 to DHIS2. For example, the University of Oslo is currently in the process of signing a contract with Ekiti state, to support their migration from DHIS1 to DHIS2.

Burkina Faso

Burkina Faso was relatively early with a computerised health information system software, when they introduced the custom-built Ravi system in 2005. However, the Ravi software lacked important functionality, and as a consequence it was decided that they would introduce DHIS2 instead (Braa et al., 2012). Customisation of DHIS2 is currently well on the way, but it has not been rolled out nationally yet. The first impressions among users of the new DHIS2 system have been positive. In fact, the various health programmes seem willing to support the DHIS2 implementation rather than their parallel system, which can give a boost to the national system (Braa et al., 2012).

Guinea Bissau

Guinea Bissau is, like Burkina Faso, implementing DHIS2 at the moment. The implementation process is supported by the University of Oslo through a PhD student. A major challenge in Guinea Bissau is the infrastructure. There are few computers both nationally and especially sub-nationally, and access to the internet is limited (Braa et al., 2012). Another challenge is that not all health programmes participate in the implementation, meaning parallel reporting is likely to continue. However, discussions are now underway to encourage integration (Braa et al., 2012). Due to the recent coup in the country, I have been told that work on DHIS2 has been halted as of May 2012.

8.3.3 Countries Considering DHIS2 in West Africa

In addition to the countries discussed above, there are several francophone countries in West Africa that currently consider using DHIS2 or have yet to start the implementation in earnest: Togo, Guinea, Niger and Benin. Togo is furthest in the process. The country has decided to implement DHIS2, and has started the customisation process.

Guinea, Niger and Benin all got their first introduction to DHIS2 at the workshop in Lomé. Neither of these three countries have made a final

decision on using DHIS2 yet. I have been informed that Niger is close to making a decision, and will hold a stakeholders meeting soon where HISP will be invited. According to the West-Africa-based facilitator at the Lomé workshop, Benin is likely to decide on using DHIS2 soon. The participants at the workshop were enthusiastic about DHIS2, but were not themselves in a position to make a decision.

Chapter 9

Discussion

In the four previous chapters, I have presented the empirical findings from my fieldwork in West Africa. In this chapter, I will use these findings together with the relevant literature to discuss my research objectives:

- Evaluate the Ghana HIS in order to understand how it works at the various levels.
- Study the implementation of DHIS2 in Ghana.
- Compare the DHIS2 implementations in Liberia and Ghana.
- Look at how West Africa can benefit from the increasing interest in DHIS2 in the region.

Each objective will be devoted one section in this chapter, starting with the evaluation of the Ghana health information system. First, however, I will look at how the thesis relates to recent literature within the field of ICT in developing countries.

9.1 ICT Research in Developing Countries

9.1.1 Discourses

According to Avgerou (2008), most research on information systems in developing countries is done within one of three discourses: transfer and diffusion discourse; social embeddedness discourse; or transformative ISDC discourse. I will argue that this thesis falls most closely in line with the social embeddedness discourse. The subject of the study is the local actors and organisations. I look at how these relate to and work within the health information system in general, and how the DHIS2 software is integrated as a component of these systems.

Avgerou (2008) further argues that the ISDC research has focused on IS failure to a large degree, perhaps too much so, specifically on the issues of scalability, sustainability and assimilation. Scalability and sustainability are also of concern to this thesis. Scalability is not discussed in the most common sense, of moving from individual pilot sites to full blown

implementations. However, I look at scaling both in terms of expanding the scope of DHIS2 implementations by integrating more vertical programmes, and also in terms of scaling up DHIS2 in West Africa as a whole.

Furthermore, I have focused my research on how to make IS projects succeed, rather than studying why they fail. In fact, my empirical work has revealed that many positive developments are taking place in the area of IS and ICT in Africa: the internet and mobile networks are drastically changing the ICT infrastructure to the better, enabling a number of information systems such as the DHIS2 project. Consequently, my findings are more positive and thus different from those of researchers that have focused on failures, as Avgerou (2008) says is the dominant trend in ISDC research. The ongoing internet and mobile network revolution may be an important reason why my findings, and general experience from the IS and ICT development in Africa recently, are more "positive" than earlier research in the area.

9.1.2 Addressing the Right Issues

Four issues should always be addressed when writing literature on ICT in developing countries according to Walsham and Sahay (2006):

- what “development” implies
- what the key ICT issues under study are
- theoretical and methodological stance
- the level and focus of analysis used

First, what is “development” in the context of this thesis? I have not discussed this explicitly. However, with the core topic being improving health information systems, a natural perspective is to look at development in terms of improved health service provisions. In turn, improved health service provision can lead to better health for the people of West Africa. Much emphasis has been put on the MDGs lately, and health sector improvements are directly related to several of those.

The second issue to address is what the key ICT issues under study are. The main research topic of this thesis is how to implement a complex information system - DHIS2 - in a developing country context, and that is thus the key ICT issue. More specifically, I look at both how such systems can be implemented through engaging users in participation and relating that to the PD tradition, and how they can scale and be sustained over time. Both scaling and sustainability are topics Walsham and Sahay (2006) argue should receive *more* attention by researchers, contrary to Avgerou (2008).

Third is the issue of theoretical and methodological stance. This thesis is based on interpretative assumptions, as I try to bring in the interpretations of both the objects of study and my own. I have used qualitative methods for data collection. The methodology was introduced in chapter three as participatory action research, with some similarities to case studies.

Walsham and Sahay (2006) argue for more use of AR, partly because of the unique insights it can provide, partly for moral reasons as it is one way in which the researcher can make a contribution to the research setting.

Finally, Walsham and Sahay (2006) argue that researchers need to address the level and focus of analysis, and they argue for more studies focusing on the individual level and on communities. On this issue, I follow the course of the majority of research in this area, as my level of analysis is the organisational, national and international level. Furthermore, the focus of the analysis has been the public sector. Involving individuals and communities in my research would have been difficult given my research objectives.

9.2 The Ghana HIS

How does the current HIS in Ghana function at the various levels? Is Ghana facing the typical problems as presented in the literature, or are the problems different? And does Ghana follow the recommendations in the literature to solve these problems? These are the questions I will try to shed a light on in this section.

9.2.1 Common HIS Problems

In chapter 2, I looked at what the typical problems facing health information systems are according to the literature, and identified the five most typical problems as being:

- irrelevant data is collected
- poor data quality
- duplicate data collection
- poor timeliness and feedback
- low information usage (Sauerborn and Lippeveld, 2000)

From the data I have collected on the Ghana HIS, we see that many of the challenges are similar. The first issue is collection of irrelevant data. No essential or minimal datasets have been developed, thus the reporting requirements are extensive. Comparing one common dataset, for outpatient diseases, the routine dataset in Ghana collects data on 76 diseases divided by gender and 11 age categories - in total 1672 potential data values. The corresponding dataset in Liberia has 67 diseases with only two age categories (134 fields in total), while the one in Sierra Leone has 47 diseases with 4 age groups and gender (a total of 376 field). It seems highly unlikely that Ghana needs 4 or 12 times more data than Liberia and Sierra Leone respectively, two countries which have recently developed standardised, essential datasets.

Poor data quality is the second typical problem. The main culprit to good data quality in Ghana seems to be human resources and lack of training. As an officer at the regional office in Volta region said, "when people don't understand the data, the quality will be poor". People without any training or education are often used to compile reports at the facilities, and there are not enough trained health information officers to cover the needs around the country.

Duplicate data collection is another issue in Ghana. Data collection is integrated in one sense, since all data is now entered into DHIMS2. However, the datasets used on the ground have not been integrated. Thus at the facility level, the same data is collected several times on different forms distributed by various health programmes. Furthermore, at the district level the duplication continues with many health programmes requiring their data to be reported separately to the national level, in addition to being entered into DHIMS2.

Fourth, timeliness is not good in Ghana, and there is a lack of feedback. There are regular review meetings at both regional, district and sub-district level, where data is presented, issues discussed and feedback is given. Thus some feedback mechanisms are in place. However, there appears to be limited day-by-day feedback in the system apart from these meetings. Furthermore, the lack of resources makes monitoring and evaluation visits few and far between. Timeliness is also an issue, at all levels. With DHIMS, it could take months before data reached the national level - by which time much of it would be too outdated to be of any use. Hopefully, this will improve with DHIMS2. However, it is too early to tell at this point, especially since there was a backlog with three months of data when DHIMS2 was rolled out.

Finally, if information is not used, it does not matter if the quality of the data is perfect and it is delivered on time every month. And data is less likely to be used if the quality and timeliness is poor. In Ghana, use of the data at the lowest levels, for example tracking of pregnant mothers and children for immunisation, seems good. Apart from that, however, the focus often seems to be on filling in the reports to avoid getting complaints rather than to use the output for decision making. This has also been the impression when customising DHIMS2: the focus is on making the required reports, not making reports to encourage information use. Among the people we interviewed, several expressed that they did not see any relation between performance as reported and the allocation of resources. Had resource allocation followed performance, it would be a clear indication that information was in fact used for management of the health system.

Looking at the above, it is clear that Ghana does struggle with many of the same issues that are typical for health information systems in the developing world, according to the literature. Efforts are being made to make improvements on some of these issues. These will be discussed next.

9.2.2 Improving the Ghana HIS

The literature has advice to offer when it comes to improving how the health information systems function. Are any of these relevant for Ghana, and is the country already following some of these suggestions?

Rohde et al. (2008) offer several suggestions to increase information usage. This includes regular review meetings, setting of service targets locally and giving users at the national level access to data online. In Ghana, regular review meetings take place at all levels, and through the DHIMS2, data will be available online. While having local targets have been discussed in Ghana before, it does not appear to be common today (Campbell, Adjei and Heywood, 1996). Ghana is thus promoting information use in some ways, but there is room for improvement.

I would also argue that the implementation of DHIMS2 can promote information usage in other ways than making information available online. First of all, it will give more users access to the data - not just at the national level, but also in the districts. The fact that five people have been trained from each district, rather than one as was the case with DHIMS, attests to this. Furthermore, not only will more users have access to the system, the information will be far more accessible by being online and accessible from "everywhere" and through the comprehensive reporting tools in DHIS2. The challenge here is that not enough effort has yet been put into customising some of the reporting tools.

DHIMS2 can also help solve some of the other issues discussed in the previous section. First, it can help make it easier to reduce duplication of data collection and collection of irrelevant data. One of the reasons for duplicate data collection and fragmentation in Ghana today stems from the inflexibility of DHIMS. Because it was not possible to change datasets or data elements, additional reporting requirements had to be met with parallel systems (Kanjo et al., 2009). DHIMS2 is flexible, however, and there is local capacity to make changes as required. This reduces the need for parallel systems.

Furthermore, by working as a data warehouse where data from all health programmes is available, DHIMS2 can be the first step towards a realisation among programme directors that collecting the same data is not necessary. Data in DHIMS2 is already integrated, by behind-the-scenes linking of data elements. This approach was first followed in Sierra Leone, where the data warehouse soon led to the work on developing an integrated dataset because the various actors soon realised they could access all their data in the shared data warehouse, and therefore did not need to have their own paper forms (Tohouri and Asangansi, 2009). Experiencing the advantage of a shared data warehouse in the new DHIMS2 may also lead the actors in Ghana to revise and harmonise their paper based data collection tools.

Secondly, while the introduction of DHIMS2 is not in itself a guarantee for improved timeliness and more feedback, it has the potential to contribute towards both of these aspects. With the previous system, the district data could not be forwarded to the regions before all facilities had

reported, and the regions could not forward the data to the national level before all districts had reported. Now, data can be entered in the districts as soon as data is received from the facilities and be available immediately everywhere.

In terms of feedback, the messaging functionality in DHIMS2 is already used: in several instances, messages have been sent from the national level to the regions with questions about why districts have not reported, and the same has been done from the regional level to the districts. Feedback from the districts to the facilities are not immediately facilitated by the introduction of DHIMS2. However, DHIMS2 could help for example through a standard "facility feedback report" with essential indicators, which the districts would be required to provide to the facilities monthly or quarterly.

Looking at feedback more generally, in the sense of getting access to your own data and being able to compare it to your peers, for example in neighbouring districts or regions, DHIMS2 represents a revolution compared to DHIMS. Getting this data used to take a long time, now the data is available as soon as it entered into the system, presented in a more comprehensible way.

Improving data quality is essential, and DHIMS2 has mechanisms for checking and improving data quality. However, this requires users to make use of these tools. Improvements are also being made in terms of improving the capacity of staff working with the data. The school educating health information officers is one example. In addition, several officers we interviewed reported that there had in fact been increased focus on training in recent years, partly as a consequence of international partners requesting access to data.

Local use of data is generally seen as the best way to ensure data quality (Braa and Heywood, 2012). Having immediate online access to your own data together with analytical tools in DHIMS2 would thus be expected to help increase local use of data, and thereby also increase the data quality. Thus the impact of the DHIMS2 implementation and the potential changes in use of data and data quality will be a very important topic for future research.

9.2.3 Linking Up With the National Health Insurance Scheme

One opportunity for increased data quality lays in integrating the National Health Insurance Scheme more closely with the general HIS. NHIS collects individual data on all morbidity cases from insured patients. Because the insurance coverage is very good in Ghana, this data covers the majority of the population. Furthermore, insurance is the main source of income for facilities, thus the reporting completeness is high. I propose two ways in which the NHIS and the national HIS could be linked in order to improve both quality and completeness of the data in the Ghana health information system.

One option is to aggregate the data within the NHIS and send it in aggregate form to DHIMS2, using the import capabilities of DHIS2. This

would make the high-quality data available to all DHIMS2 users, and because only anonymous, aggregate data is sent from the NHIS, privacy should not be a problem. However, this requires that the paper insurance claims are either available electronically, or that they are tallied. I have not been able to find out if any of this is done currently. If not, it would require a substantial amount of additional human resources.

A second option is to integrated the NHIS reporting fully into the national system. This would have many benefits. First of all, it would increase data quality and completeness in DHIMS2. Secondly, it could reduce the cost of data collection for both parties. Finally, it would increase the importance of DHIMS2, increasing its likelihood of continued support and increasing the pressure of vertical programmes to integrate more closely. In all, however, making NHIS agree to this can be difficult, as it would mean giving up control on part of their data collection system - they appear to be well resourced, given their current data collection scheme, and may see little benefit in improving the national health information system.

Of course, any integration would be limited to morbidity cases, and would not include important areas like child or maternal health, HIV/Aids and so on. Another problem is that replacing monthly morbidity reporting from the facilities with only case-based reports would be a step away from the idea of encouraging local use of data: most facilities do not have access to DHIMS2, and would thus not be able to see the data aggregated from the NHIS. However, I believe the benefits of getting high quality morbidity data into DHIMS2 are big enough to warrant putting an effort into trying to integrate NHIS and DHIMS2 data.

9.3 DHIS2 in Ghana

My second research objective is to study the implementation of DHIS2 in Ghana. In this section, I will first look at the implementation as a participatory design project. Next, I discuss the case of DHIMS2 in the light of Heeks' theories of why IS implementations succeed or fail. Third, I analyse DHIMS2 as an information infrastructure, before looking at how the DHIMS2 implementation has been influenced by the fact that many of the technologies were developed in environments different from Ghana. Finally, I look at the networks of action theory and how it can give insights into how DHIMS2 can scale further and be sustained over time.

9.3.1 Participatory Design of the DHIMS2

PD has been part of HISP research from the beginning. The implementation of DHIMS2 in Ghana is no exception to this. My work in Ghana involved all the three cyclic development processes introduced by Braa and Sahay (forthcoming) to varying degrees: development of software; development of a system; and to a lesser extent development of information for action.

How was PD used in Ghana to improve the DHIS2 software? Perhaps the most prominent example of this was the development of line listing

functionalities, or anonymous event registration as it is called in DHIS2. As was explained in chapter 6, DHIS2 did not have any functionality for entering such data. However, it had been part of the previous DHIMS system in Ghana, and support for it therefore had to be added to DHIS2. The processes started with the staff at CHIM demonstrating and explaining to me how the feature worked in DHIMS. Shortly after, at the DHIS2 Academy, two of the officers from CHIM and myself sat down with one of the core DHIS2 developers, explaining the requirements and discussing in detail in how the line listing could be implemented. For the next DHIS2 release, the anonymous event registration was available. The functionality was implemented on the ground in Ghana, and a period of interaction on improvements and bug fixing followed. This participatory process is still ongoing while this is being written, and a lot of feedback is still coming from end users. It is also interesting to note that other countries are starting to use this functionality, and it is, for example, about to be implemented in Kenya.

There are several other features in DHIS2 that also came as a result of the participatory design process in Ghana. Some of these stemmed from my observations of use of DHIMS2 and some came from the staff at CHIM. Perhaps the most interesting, however, are the cases where the end-users have had suggestions, which through discussions with the staff at CHIM and myself have ended up being implemented in the DHIS2 software. An example of this is improved support for printing of reports, which is being implemented for the next DHIS2 release.

My role in this process was mainly to be a link between the end-users and the local implementers; and the developers, similar to what Sæbø et al. (2011a) call a mediator. Being situated in Ghana has allowed me get a good understanding of the local situation and to work closely with the users to come up with proposals for features in a way that the developers cannot. At the same time, I have an understanding of the DHIS2 software that allowed me to filter out proposals that were impossible to implement, proposals which had already been planned for inclusion in the future, and proposals that had been discussed by the developers but turned down.

PD has perhaps been most prominent in the development of the *system*. Who is the user and who is the designer in this case? I argue that here, the user - designer relationship can be seen in two levels. At one level, the user is the end-user in the districts or hospitals, and the designers are the staff at CHIM and myself. At another level, the users are the staff at CHIM with me in the role as the designer.

The staff at CHIM and myself cooperated with the end-users in improving the design of the system, first and foremost with regard to customising the data entry and the reports. In this relation, the designers are the staff from CHIM. This type of PD was visible at the regional trainings in particular, where the trainers and users cooperated on improving the system. Simultaneously, there were aspects of DHIS2 that the staff at CHIM did not fully master, where I took the role as a designer and together with the staff designed improved datasets or advanced reports. Ideally, the staff at CHIM would have been able to do

these tasks themselves, and this is therefore another example of lack of local human capacity.

Development of information for action was perhaps the least prominent PD process in Ghana. However, it was not completely absent. One example is the design of the end-user trainings. Particularly in the first regions, the content of this training changed substantially, and this was in part as a result of comments and feedback from the users. Another example was the migration of data from the previous system. This was done to facilitate data analysis, and thus use of information, by allowing longitudinal data analysis.

One of the fundamental principles of participatory design according to the literature is that it should empower the users. In my opinion, this was the case in Ghana. The staff at CHIM, which is responsible for running the system, was empowered to adjust and improve the software they use in ways that was not possible before. With DHIMS, they could do nothing to change or improve neither the software nor the system. Now, they can change and influence both.

The end users have also been given the power to influence the system and to some extent the software. During the trainings, all suggestions were heard, even if not all could be implemented. Datasets and reporting is where most of the contributions were made. Some users complained that their input had not been taken into consideration with DHIMS, and were happy to see that many changes in DHIMS2 could be done right away. The main challenge here is the fact that the general content and layout of the datasets are fixed by the various health programmes and divisions within GHS, which put limitations on what changes *could* be made.

Interesting with regard to participatory design in Ghana is the fact that because the system is online, there is a continuos link between end-users, local implementers, myself and the developers. While I have not been in Ghana after the system was rolled out, I have been in active contact with many end-users, sending dozens of messages back and forth using the built-in messaging functionality in DHIS2. This has been invaluable in many ways. It has enable me and staff at CHIM to help users directly if they have problems or need guidance. When users identify problems with dataset or reports, or request additions, these can quickly and easily be addressed and be available to the user immediately. Finally, users provide feedback on the software itself, which can in turn be forwarded to the development team. Braa and Sahay (forthcoming) argue that a cloud infrastructure provides a "tremendous improvement in the condition for PD", and the Ghana case exemplifies this well.

It is of course a dichotomy between the losenessetween the user and the developer in PD, and the concept of "cloud" computing in a countrywide project. In the pre-online projects where, for example, each district had their own standalone installation of the system, the feedback cycles where communication resulted in changes in the system would take very long time. It would for example involve physical transport from the capital to the districts to implement changes, and bug fixing would be complicated. Now, with the online messaging tool combined with having only one

online server to update, both communication and feedback in terms of changes are, compared with before, immediate. I could sit in Norway and communicate with users and perform changes directly on the server in very short cycles. Strangely enough, therefore, PD in the area of cloud computing may bring users and developers closer to each others.

Kensing and Blomberg (1998) argue that PD can take place on three different arenas: the individual project arena; the company arena; and the national arena. The initial stages of the process of moving from DHIMS to DHIMS2 involved stakeholder in different part of the GHS, including the various vertical programmes and health divisions. This could indicate a process on the company arena. However, while it would have been beneficial if these actors had been more involved throughout the implementation, that was not the case. After the initial stakeholders meetings, CHIM and the PPME division has taken over almost every aspect of the system, and involvement from other parts of the GHS - the "company" - has been very limited. Thus the DHIMS2 PD became a process took place on the individual project arena, as a project run by CHIM and PPME. Changing national legislation and regulation has not been part of the process, thus no work has been done on the national arena.

9.3.2 DHIMS2 - Success or Failure?

Heeks (2002) argues that in order to evaluate the chance of an IS implementation succeeding, one has to look at the situation before the implementation and compare it to the future situation as imagined by the designers. The implementation in Ghana has come quite far, and we can already see the contours of the "imagined" future. However, the process is still not completed, and problems might still arise and unintended side-effects can appear.

Among the main issues raised in the literature is the notion of design-actuality gaps, gaps between the actual situation on the ground and that envisaged by the system designer. Given that the development of DHIS2 is lead from Norway with the main developers being Norwegian, this might appear problematic. However, several factors mitigate this situation. First of all, DHIS2 is based on DHIS1, which was developed in Africa with heavy participation from end users. Secondly, DHIS2 has been used for several years in various developing countries, leaving time for "gaps" between the software design and the reality on the ground to be reduced through gradual changes. While the context is by no means identical across the developing world, DHIS2 has been used in several countries that are in many ways comparable to Ghana in terms of issues like infrastructure, for example Kenya.

Perhaps the best example of gaps being reduced is the development of offline functionality in DHIS2. When development started on DHIS2 in the mid 2000s, it was decided that the system should be based on web technologies. However, DHIS2 implementations were still based on offline installations in the first years because of the limited internet connectivity in the countries where it was used. Support for offline functions on client

machines was thus not needed. It was not until Kenya, which has good coverage for mobile internet, wanted to deploy DHIS2 online that work on an "offline data entry" feature began to accommodate areas with unstable connections. This in turn became a very useful feature for DHIMS2 in Ghana.

While DHIS2 had been used in contexts similar to that of Ghana, there were still some gaps between the design of the software and the reality on the ground. The first was that of internet access, which was solved in time for the rollout, thanks to a similar requirement in Kenya. A second gap was that of human resources. DHIS2, especially in an online deployment, requires skills in server administration. This was not available, and is thus still done by HISP members remotely from Europe, including myself. Human resources were also a challenge for the customisation of the system, as more IT skills were required than what was available at CHIM. Thirdly, there was a gap in therms of management structures. GHS is in many ways quite bureaucratic and hierarchical, and on many occasions, tighter control of access to the data was requested than what is available in the system. While we have been able to work around these issues for now, they show how the design and reality differed. Finally, there was a gap in terms of the objectives of the system. The system was designed for routine data, but Ghana wanted to use it for registration of anonymous events as well.

Heeks (2002) suggests *design improvisation* as one mean of closing design - actuality gaps. Such improvisation took place on at least two occasions in Ghana. First with the development of the offline data entry to alleviate the problem of unstable internet connections, although this stemmed from the Kenyan context initially. Secondly, with the adaption of the tracker module to allow it to be used for registration of anonymous events. These improvisations have thus closed two of the gaps in Ghana.

To avoid design-actuality gaps, DHIS2 is designed to be flexible. It thus supports what Heeks (2002) calls design divisibility, that various sub-components of the systems can be used independently in terms of modularity and incrementalism. This allow *local improvisation*, another way of closing gaps. DHIS2 has several modules that can be used more or less independently, such as routine data reporting, tracking, anonymous events, mobile and various reporting modules. Several countries have also developed their own modules to meet specific country requirements, such as India. Furthermore, DHIS2 supports incremental implementations of these functions. In Ghana, the routine system was configured more or less completely before work on the anonymous events even began, and various types of reports were added before coordinates for GIS were available. The flexibility provided by DHIS2 is important to ensure that the system can be useful over time as new requirements arise.

9.3.3 DHIMS2 as an Information Infrastructure

Can the Ghana HIS, and more specifically DHIMS/DHIMS2, be regarded as an information infrastructure? And if so, what can the literature on II teach us? Whether or not DHIMS2 can be classified as an information

infrastructure is not a yes or no question. Rather, DHIMS2 can have properties making it more or less useful to use II theory to analyse it. If we look at each of the defining properties of an II, as defined in the literature, we see that the Ghana HIS does have many of these:

- *Installed base*. With the transition from DHIMS to DHIMS2, DHIMS acts as a powerful installed base. Furthermore, the datasets and reporting routines constitute an installed base with roots even preceding DHIMS.
- *Evolving*. DHIMS2 is evolving, with new actors becoming involved, new types of input and output, and plans for linking with other systems.
- *Open*. While DHIMS is closed in the sense that access to the system is restricted to certain users, it is open in the sense that it can connect to other third-party systems.
- *Socio-technical*. DHIS2 is a technical component of the system, but there are also non-technical components: users, routines for reporting and feedback, the information flowing through the system and so on.
- *Enabling*. While not the most distinct property, DHIMS2 does have some enabling aspects. One example is how the built-in messaging function is used for communication not concerned with feedback on the software or system.
- *Interrelated*. The system is linked to other networks, most notably the internet. There are plans to link it to patient records systems as well.
- *Shared*. DHIMS2 is clearly shared among hundreds of users, and would not be useful if used by a user in isolation.

We see that DHIMS2 has many of the properties characteristic of information infrastructures. How can this help us in the implementation and analysis of DHIS2 in Ghana? The II literature describes how to bootstrap an II, and how to avoid lock-ins. It argues that IIs should be managed through cultivation, rather than strict control and design. Finally, it explains how an information infrastructure is both limited and enabled by the installed base (Hanseth, n.d.).

The latter point, that the installed base has both enabling and limiting effects, can clearly be seen in Ghana. The implementation of DHIS2 was limited by the installed base in the sense that the everything was compared to the existing DHIMS, and requirements were often set based on that system. At the same time, the fact that there *was* a system ensured that there was at least some human resources, routines and technical infrastructures in places, giving the implementation a flying start.

One of the main topics of II theory is how an information infrastructure can be bootstrapped. This might not seem relevant in the case of DHIMS2, as it is in many ways a system that is "enforced" on the users from

above. However, it is still important to get users involved and interested in actively using the system. Thus there are several lessons that can be learnt. First of all, II theory argues that the system should be useful from the start. For DHIMS2, this implied first of all to make good reports that make information easily available in a way that the previous system could not. Next, it is argued that the installed base should be leveraged as much as possible. This was clearly the case in Ghana, with the DHIMS2 taking over for DHIMS in the same offices on the same computers. Furthermore, the fact that many of the users already had internet access through the mobile internet was exploited. Finally, II theory states that the installed base should be expanded before new functionality is added. This was what was done in Ghana. The first priority was to get the routine data collection started. Then, more advanced tools for data analysis and reporting were introduced.

Another major concern in II theory is how lock-ins can be avoided. The key points here are to ensure design flexibility and use flexibility. Design flexibility implies that the system can be changed at any time. For DHIS2, this happens through customisation or through changes in the freely available source code. The fact that the system is developed freely ensures an extra flexibility in a resource constrained settings, as required features can be requested and often added for free.

The second aspect of flexibility is *use* flexibility. This implies that the system can be used to support different workflows without requiring changes in the software design. Use flexibility requires human capacity. In Ghana, such capacity is available to affect the most typical changes. However, external assistance will be required for more far-reaching changes. Furthermore, a system with standardised interfaces gives freedom when choosing other systems in terms of interoperability.

In many ways, the original DHIMS represented a lock-in situation which required action to be resolved. The technology was not flexible enough, especially after the source code was lost - it was not modular, and had no standard interfaces to allow interoperability with other systems. From the onset of the DHIMS2 implementation, there was talk of making sure the mistakes made with DHIMS were not repeated. Focus has therefore been on flexibility, both in terms of the technology and by having local human capacity. Thus in all, DHIMS2 appears to have the flexibility to avoid a lock-in situation similar to that of DHIMS.

From the above, we see that the II theory fits well with the case of DHIMS and DHIMS2, and that most of the advice provided by the literature has been followed.

9.3.4 Technology Inscriptions

Many functions in DHIS2 were built for quite different environments than what they are currently being implemented in, including the anonymous event registration. Does this have any consequences for the implementation in Ghana?

The anonymous event registration (line listing) originates as a

"tracker", developed in India for the Indian context. It was meant to be used as a tool for tracking mothers through antenatal care or children through child health programmes, often in conjunction with DHIS2 Mobile. This tracker module was then adopted to be used for *anonymous* registration in Ghana rather than *tracking* in India. While the anonymous event registration is working in Ghana, it is currently missing some obvious features as a result of how it has been adapted. For example, there is still no way of editing or deleting events that have been registered, and the reporting functionality is limited. This is in many ways in line with the argument made by Akrich (1992) that technologies are designed to fit in a certain model of the world, and in this case this model does not match the reality.

Another example of this is the development of minimal or essential datasets. An essential dataset was successfully developed and implemented in South Africa, the first HISP project. It was also introduced in Sierra Leone, the first country to implement DHIS2 nationally, this time as more of a "maximum" dataset. At the same time, attempts to develop an essential dataset failed in Cuba, where there was skepticism that local access and use of data would reduce the power of the central level (Braa, Titlestad and Sæbø, 2004). Thus the idea of an essential dataset fit the reality in the Sierra Leonean context, but was too different from the situation in Cuba to succeed. My impression from Ghana was that there were many users and officers who wanted to develop a more integrated and possible minimised dataset. However, both politics and mistrust between divisions and programmes make this difficult.

9.3.5 Networks of Action in Ghana

The idea of networks of action was developed by Braa, Monteiro and Sahay (2004) as a response to the problem of scaling and sustainability. It is based mostly on cases where the implementations started at pilot sites, and how these could be scaled and sustained. In Ghana, there were no pilot sites, but an immediate full-blown rollout run by the government. Is a theory dealing with issues of scaling and sustainability still relevant here?

Scaling in the sense of scaling a technology from pilot sites to full implementations is not relevant in Ghana. However, I will argue that scaling is still relevant, not in terms of increasing the coverage of DHIMS2, but in terms of scaling up the *use* of the system. Currently, many of the health programmes that have their datasets in DHIMS2 still in reality use their parallel reporting systems instead. Furthermore, the system can be scaled in terms of introducing new functions such as mobile reporting and tracking. Thus there is room for scaling up the usage of the system.

Although DHIMS2 is the official government system, there is no guarantee that the system will be sustained indefinitely. One aspect is political support for the system in Ghana. While all stakeholders are officially part of the system, they have indicated both in interviews and through actions that they are not all fully committed. Political support for a national integrated HIS should therefore not be taken for granted. A

second aspect is to what extent the needed technical and human capacity is available in Ghana to keep the system running. For example, there is still no local capacity to administer the DHIMS2 server.

In my opinion, the networks of action approach can be beneficial in Ghana. First, what are the potential actors in a Ghanian network of action? CHIM and the PPME division of GHS are obviously participants in the networks. A second actor is HISP, through the University of Oslo, of which I am a representative. The US-based Centre for Disease Control (CDC) is another partner - they provide support for CHIM, and are the donors of the server on which DHIMS2 is running. Yet another participant in the network is WAHO, which is working to support DHIS2 implementations across West Africa, although not playing an active role in Ghana at the moment.

How can such a network of action address the sustainability and scalability issues discussed above? Political support and technical capacity are in my opinion the main threats in terms of sustainability. Both WAHO and CDC can play important roles in ensuring political support. CHIM and PPME can use the support from CDC as a leverage to ensure support for DHIMS2 from other parts or GHS. With WAHO officially supporting DHIS2 as a platform in West Africa, it will be more difficult politically within the GHS to shut down or replace DHIMS2. In terms of technical capacity, the partnership with HISP and the University of Oslo can provide CHIM with technical support visits, and help with capacity building. There has also been some preliminary talks about the possibility of a cooperation between the University of Oslo and the University of Ghana to further increase the efforts of building local capacity.

For scalability, a partnership with WAHO can potentially help convince the various health programmes and divisions to engage more fully in the DHIMS2. For example, the Immunisation programme, one of the programmes not yet fully committed to DHIMS2, reports regularly to WAHO. WAHO could encourage the Immunisation programme to use the integrated system, or even ask to be given access to DHIMS2 in order to have access to the immunisation data directly. Other potentially important actors in terms of scalability in Ghana are the international donors. They would benefit by having immediate access to the data they require online, and could therefore encourage the programmes doing parallel reporting to integrate with DHIMS2.

9.4 Comparing Liberia and Ghana - The Importance of the Internet

While Ghana is a comparatively well developed African country, Liberia is one of the poorest countries in the world and is till recovering from a disastrous civil war. These contrasts are reflected when comparing the implementation of the DHIS2 in the two countries in relation to both infrastructure and human and institutional capacity. Two major differences become immediately obvious when comparing the DHIS2

implementations in the two countries. The first is the use of the internet: The infrastructure in Liberia is much poorer than in Ghana. In Ghana, the goal from the beginning was to run DHIS2 on a central server over the internet. In Liberia, the internet infrastructure was deemed insufficient and it was decided to run DHIS2 using offline, standalone installations. The second major difference is in the datasets. In Ghana, there has not been any reforms or integration of the data being collected. Each division and health programme has included their own different, often overlapping forms. When DHIS2 was introduced in Liberia, on the other hand, the datasets from the facility level and up were changed to a new integrated standard. In this section, I will compare and contrast these differences between the DHIS2 implementations in Liberia and Ghana in more detail, and discuss how they illustrate the important role internet can play for development.

9.4.1 Different Infrastructures

When it was decided to use DHIS2 as a replacement for DHIS1 in Liberia, the internet infrastructure in the country was not seen as sufficient to support the system. Due to its history of civil war, the general infrastructure in Liberia is poor and the internet infrastructure is no exception. The country relies on satellite connections for internet, even in the Ministry of Health in Monrovia, which is slow and expensive. Options for *hosting* a server with DHIS2 in the country was also limited.

In Ghana, on the other hand, internet is widely available. In Accra and major cities, fast broadband connections are available, and there is mobile 3G coverage. Options in other parts of the country are more limited, but some coverage is available across the country. Furthermore, there are several companies offering server hosting, as opposed to in Liberia.

There also seems to be a difference in the attitude of the managers in the two countries. From the beginning, Ghanian managers have been determined to have a fully online system and have rather pushed for improvements in the software to support areas with poor connectivity than to have districts working offline. In Liberia, on the other hand, the internet did not seem to be considered an option anymore when we arrived there. It was more or less coincidental that we were able to put the Liberian server online, as the managers said the internet connection was not good enough. After realising the benefits first hand, however, Liberia now tries to have all counties doing data entry online.

Another difference that illustrates the different role internet plays in the two countries are that of finances. In Ghana, there was often talk of who would pay for internet connectivity, both centrally in Accra and with regard to users in the districts who sometimes used their private modems. In Liberia, however, the financial aspect of internet connectivity was never really raised - the issue here was whether or not using the internet was at all *possible*. This shows how the internet in Ghana has become a regular commodity unlike in Liberia.

9.4.2 Data Standardisation

Another major element separating the introduction of DHIS2 in Ghana and Liberia is in the data that is being collected. In Liberia, the rollout of DHIS2 coincided with the introduction of a new, integrated dataset which includes data for all the major divisions and health programmes. This was an important reform, changing the system from the paper forms used in facilities to the Ministry of Health.

In Ghana, there were no changes in the data being collected on the ground. The only changes in terms of data between DHIMS and DHIMS2 are some smaller revisions, and the inclusion of more datasets. Thus in Ghana, health workers in the facilities are not affected by the change of software at all.

In terms of data standardisation, Ghana followed what Tohouri and Asangansi (2009) call the "maximalist approach": including all the data in the system, integrating some of it behind the scenes in the database. Liberia rather followed the "minimalist" approach of creating an essential dataset. HISP has typically emphasised the importance of developing an essential dataset similar to the approach followed in South Africa, and this clearly has many benefits (Braa, Monteiro and Sahay, 2004). However, in many cases this have proven to be difficult to achieve in practice, and a second-best option has been chosen (Sæbø et al., 2011a). In the case of Sierra Leone, for example, a maximalist approach was first taken, followed by an integration of the data collection later Tohouri and Asangansi (2009). Ghana may prove to be a similar case.

One reason for the different approaches taken might be historical. The Ghanian health system have a long, continous history, and routines and procedure have become institutionalised. In Liberia, on the other hand, much of the system was built from scratch after the civil war, making changes easier to achieve. Furthermore, the country had experience in standardisation work after the implementation of DHIS 1 only a few years earlier.

9.4.3 The Importance of the Internet

Liberia moved from its Microsoft Access-based DHIS1 to a web-based platform without going online. Essentially, DHIS2 was used in the same way as DHIS1. Used this way, DHIS2 is more complex to maintain and manage, and the implementation in Liberia soon faced major technical problems. There was no true central repository where all the data was available at the national level, as individual users in the ministry of health had their own databases which they imported new data into. Maintaining these installations both on individual computers in the Ministry of Health and in the counties was intensive in terms of human resources, and there was not enough human capacity available for this.

In Ghana, DHIS2 was run over the internet on a central server from day one. This is in line with how DHIS2 should ideally be used. As in Liberia, there was limited human capacity available to maintain DHIS2 installations

in Ghana. However, because DHIS2 was used over the internet on *one* server, first, it was easier for the national team to assist users around the country, second, for more complicated issues, assistance could easily be provided by HISP from outside the country.

This shows how the "internet revolution" has reached Ghana, but not yet Liberia. As a consequence, the DHIS2 implementation in Liberia suffers. It will be interesting to see what the result will be now that Liberia is attempting to move online as well. There have already been some positive effects, an example of this is that I have been able to assist in the development of a new dataset on the online server, from Norway, something that would have been quite difficult with offline installations.

The internet infrastructure in Liberia is still limited, relying on satellite connections which are generally available in only one location in each county. However, I will argue that the infrastructural requirements in Liberia is somewhat lower than in for example Ghana. An important reason is the fact that an integrated dataset exists in Liberia. This means there is less data to report and thus less online time is needed to complete the data entry. The integrated data collection also means that once the data is entered into DHIS2, the national reporting requirements have been met. Also, should there be any difficulties or delays with reporting through DHIS2 in Liberia, there is support for and reliance on the integrated system throughout the health service. In Ghana, many of the programmes will simply ignore DHIMS2 should it fail, as they have parallel systems that they use in any case.

Reporting in Liberia is generally done through Excel pivot tables, with data drawn from DHIS2. Once data is loaded into Excel, internet connectivity is not needed. In Ghana, however, many users first enter their data into DHIS2, then want to use the built-in reporting tools in DHIS2, for example to generate reports used for parallel reporting. This requires internet connectivity. Ghana also uses the anonymous event module, for which internet connectivity is required both for data entry and reporting.

Above, I discussed how DHIMS2 was developed using participatory design approaches. An important part of this was the use of the built in messaging functionality of DHIS2 to communicate with users after the rollout. Because the system in Liberia has been offline, this has not been an option there. Instead, users have had to use email or phone, and could only communicate with managers inside the country, not with implementers abroad as in Ghana. Equally important, whilst in Ghana any changes to the system will be visible for all users immediately on the central server, in Liberia the database will have to be changed and then sent to each county for manual updates.

9.4.4 ICT for Development

When comparing Ghana and Liberia, the positive influence of the internet can be seen quite clearly. Data-wise, Liberia has in many ways a superior system, with an integrated dataset with wide support among stakeholders. However, because of the limited internet coverage in Liberia, DHIS2 has

worked poorly so far. In Ghana, on the other hand, it has worked well, despite the system being more complex and adjustments to datasets and reporting being required continuously. The fact that it is running over the internet has been a major factor in enabling this. This supports the argument made by Calderon and Serven (2010), that infrastructure should be a top priority for development.

In the literature on ICT for development, there is also a lot of focus on the need for local human capacity. The size of the population in the two countries is very different - Ghana has about 20 million more inhabitants than Liberia, and it is my clear impression that far more human capacity is available in Ghana than in Liberia, at least at the central level. In Liberia, the whole DHIS2 implementation is practically run by one person. In Ghana, there is a large team of implementers. Increasing the difference is the fact that Ghana has received far more outside support than Liberia during the implementation phase. While limits to the local human resources have not had too severe consequences in Ghana, partly because of outside support, it is the cause of many of the technical difficulties in Liberia. Looking at the three human capacities required to use ICT for development according to Osterwalder (n.d.), it is particularly capacity to maintain the required infrastructure - the server and network on which DHIS2 running - that is lacking, in both Ghana and Liberia.

Adam and Wood (1999) stress the importance of policy-makers in enabling ICT for development. Here, policy-makers in the Ghana Health Service have been determined to utilise the opportunities that DHIS2 provide, for example by pushing to have the whole country use the system online and getting the anonymous event functionality ready. While the situation in Liberia has been more difficult in terms of human resources and infrastructure, managers here have also pushed to make use of more of the capabilities in DHIS2.

The cases of Liberia and Ghana are thus a very concrete example of how ICT infrastructure play an important role for development, in line with what the literature on ICT for development states. Specifically, it shows the potential importance of the internet in Africa. Internet coverage has a positive impact on the health information system of Ghana, this information will hopefully be used to make informed decisions that will, we assume, lead to better health for the Ghanian population. Following the situation in Liberia will give an indication on whether even very limited internet access can be enough to have a positive impact.

The DHIS2 implementations in Liberia and Ghana also show more generally that ICT projects can have an influence on the provision of basic health services, through improving the management of the health system. In this way, DHIS2 follows closely what Osterwalder (n.d.) argues, which is that ICT underpins other sectors and increase the efficiency of these. By providing better management information, DHIS2 implementations in Ghana and Liberia help support and increase the efficiency of the health sector in the two countries.

9.5 Regional Developments

In 2012, more than half of the West African countries use or consider using DHIS2 to support their national health information systems. It seems clear that this fact could be leveraged to the benefit of the individual countries and the region as a whole, and we saw in the previous chapter that there are many common problems in the West African region. But how can the region benefit from the growing use of DHIS2?

9.5.1 Fighting Fragmentation

We have seen that fragmentation is perhaps the biggest challenge to health information systems in West Africa. According to Braa et al. (2012), participatory approaches that let various stakeholders and users influence the system have proven to be critical for HIS reform and integration to succeed. These social and organisational processes can be aided by technical elements: good data warehouse software; use of the internet where possible; and creating standards for data and indicators (Braa et al., 2012).

A good data warehouse software enables users to have a prototyping tool when developing the system. In DHIS2, datasets can easily be added and changed with only limited technical knowledge, making it a useful tool when developing new datasets. Furthermore, good data warehouse software is easy to integrate with other system. This can be important when working to create consensus for integration, as stakeholders that use software systems for data collection or analysis know that the data warehouse can be made to interoperate.

The importance of use of the internet as an aid when using participatory approaches can be seen when comparing Liberia and Ghana. In Ghana, users have participated in the improvement of the DHIMS2 after the rollout, through the use of the messaging functionality of DHIS2. This has proven important in resolving various issues, and receiving requests for improvements. Nothing similar to this has been possible in Liberia, because the system has been running offline.

Agreeing on data standards is also an essential step in the integration process, and also a difficult one. Without standards for what data to include, creating an integrated architecture. As the case of Ghana shows, an agree data standard does not necessarily mean that all data collection tools must be revised. What is essential is for the stakeholders to agree on how to approach the issue.

Not only technical elements can facilitate integration and reform, however. Braa and Sahay (2012) have developed a three-levelled integrated architecture for health information systems. Next, I will look at how countries in the region can benefit from direct and indirect cooperation in creating such integrated architectures.

Data Level

The data level, or data exchange level, is the lowest level in the architecture, dealing with data standards, standards for data exchange and interoperability, and infrastructure supporting software and applications (Braa and Sahay, 2012). For data exchange, the SDMX-HD standard is important, as the official data exchange format promoted by international actors like the WHO. DHIS2 supports this standard, and as the use of DHIS2 as a data warehouse grows in West Africa, the importance of SDMX-HD increases. There is a plethora of systems in West Africa dealing with health information, but few of the local software solutions are likely to have support for this standard currently. However, as DHIS2 is rolled out in an increasing number of countries, efforts should be made to increase the support for SDMX-HD. Having support for data exchange with the national data warehouse can become a major selling point for software providers, and as the use of DHIS2 increases in the region, software providers with regional ambitions only need to support one data standard for all countries using DHIS2.

A standard for exchange of data is important, however, moving data between systems also requires standards for the data itself. While this is related to the development of essential data and indicator sets, it is not exactly the same. The data sets deal mainly with *what* data to collect. At the technical level, it is important to make sure that the data collected from the various systems represents the same thing. The ministries in the individual countries have a paramount role in this work. However, that is not to say that there is no room for regional actors in influencing the process. Much data collection in developing countries are guided by international donors and organisations such as WHO and WAHO. These are thus in a position to influence both what data is collected, and the data definitions used.

A final aspect of the data level is the infrastructure over which the data can be transferred. Here, fixed and mobile internet are the main elements. According to Braa et al. (2012), internet should always be used as far as possible as a vehicle to enable integration by making access to a shared data warehouse possible. How can regional efforts support the internet infrastructure? One way is through international donors. In Sierra Leone, the Global Fund is providing funds for internet access in the districts. As an actor that is active in many West African countries, it could be possible to make similar arrangements other places. This require that internet is accessible however, and not all areas have internet coverage presently. Here, mobile operators might be engaged to improve coverage in critical areas, as is being done in Ghana. However, engaging mobile operators brings out a new set of challenges, as their focus on commercial gains are often in conflict with the goals of actors in the health sector (Valbø, 2010).

Application Level

The application level is where the software and applications to support use of information is found. This includes not only data warehouses,

but also other systems for example for patient management. In an integrated architecture, these systems should be interoperable through the standards and infrastructures defined at the data level. As with the data level, there are major challenges in most West African countries on the application level. One issue is sub-par software that does not support use of information. Another challenge is that few of the systems currently used in West Africa today are interoperable. Finally, the data warehouse approach recommended by Health Metrics Network (2008), Braa and Sahay (2012) and others is not widely used except where DHIS2 has been rolled out.

In West Africa, an important step in the right direction would therefore be for countries to use a good data warehouse software, along with interoperable systems. By implementing DHIS2, many countries are moving in the right direction. The major challenge is thus to find software for areas that DHIS2 does not fully support, such as finances, medical records, human resources and so on, that are still compatible with DHIS2 through standards such as SDMX-HD. There are several ways in which interoperable systems could be promoted in a West African context.

One option is to use the already interoperable systems, such as OpenMRS for patient records and iHRIS for human resources. A case can be made for international actors such as WAHO, donors, HISP and the software developers to promote these compatible applications in West Africa. West Africa as a whole is a large "market," and through cooperation the West African countries would have great leverage to have the applications adapted to their context. Another option is for countries to develop new compatible systems together, for example for electronic patient management. This work could either be led by WAHO or by one or more of the countries in the region. The danger here is the software quality: the home-grown applications we have seen in West-Africa leave a lot to be desired in terms of quality and features (Braa et al., 2012). For example, the SIGIS software developed and used in WAHO has a reputation of being unreliable. Finally, many of the countries in the region already have home-grown software, for example for medical records. If this software is updated to be interoperable with DHIS2, it could potentially be sold or given to other countries in the region. In addition to providing the region with additional software options, this would be a huge commercial opportunity for the software maker.

The area of mobile applications has come into focus lately. Much of the same issues apply here as for the regular applications: data collected using mobile should be interoperable with the data warehouse, and the applications should support the information needs of the users. In the mobile space, DHIS2 Mobile can be one alternative. It is closely integrated with the DHIS2 data warehouse, and is actively developed. Many of the same benefits as increased use of DHIS2 has on the region would also apply for DHIS2 Mobile, such as support for implementations from the HISP networks, as wells as trainings and workshops.

Social System Level

The perhaps most challenging aspect of HIS integration in West Africa is the integration at the social system level, meaning the procedures governing the health information system across organisations, and information needs by the various actors. A primary concern here is for actors to agree on the need for integration. In some West African countries, this agreement is there - for example in Liberia and Sierra Leone - but that is not the case everywhere. Donor funding was identified as one of the main sources of fragmentation by the WAHO HIS evaluation (Braa et al., 2012). Thus donors are important when it comes to reaching a consensus on the need for integration. As the actors funding the main vertical programmes and setting many of the reporting requirements, donors have a lot of leverage in this area.

Once an agreement among stakeholders has been made on the need for integration, the information needs of various users and stakeholders must be identified. Again, donors and international organisations like WAHO and HMN are important. Then, the data collection tools within each country should be integrated. In West Africa, several approaches to integration of data collection have been taken. Which of these are feasible depend to a large extend on the commitment of the involved stakeholders. In Liberia and Sierra Leone, completely integrated data sets covering all divisions and health programmes have been developed. Ghana has instead included all reporting tools from all stakeholders without changes, thus creating an integrated database without integrating the data collection itself. Finally, in Burkina Faso the government developed an integrated dataset in cooperation with the programmes, but the programmes themselves use separate reporting tools. In my opinion, the former approach should be the goal when possible, and I previously argued that Ghana should try to follow that approach. However, it is unlikely to happen without pressure, or at least consent, from the international donors.

In time, it might be possible to create a common minimal dataset for the whole region. Some core data could be collected by all countries based on the same data standards to make comparisons of data possible, and countries could collect any additional data as they required. This will be discussed next.

9.5.2 A Regional Dataset

Developing an essential dataset for the whole West African region with essential data and indicators could be a huge positive development. Data from this dataset could be made available in a regional database online, run by WAHO using DHIS2. This would make the data easily available to stakeholders across the region. It would allow the individual countries to compare their performance with their peers, and encourage cooperation by learning from the best performers in various areas. Potentially, it could also lead to a friendly competition among the countries. The danger with

the latter is of course that it could lead to manipulation of the figures rather than real improvements.

A regional dataset could also be of great use for WAHO itself, as well as international actors such as WHO. As I explained in the previous chapter, WAHO is struggling to get data from the individual countries. A regional dataset, implemented in DHIS2, could potentially facilitate greatly the work of getting timely and complete regional data.

What is needed for a regional dataset is a standard set of data elements to report on, as well as clear definitions for these. Only the most essential data is needed for a regional dataset, and most countries are likely to collect this data already. For example, the immunisation programme in Ghana explained that there is currently a standard dataset being reported to WAHO. There might be minor differences in the data definitions that need to be solved. A common difference between countries is the use of age groups, for example for morbidity data. However, at a regional level, such granularity is unlikely to be needed in any case.

Practically, few changes are probably required on the actual data collection tools used on the ground. As mentioned, most data that is needed in a regional dataset is already likely to be collected. The exception is where different definitions are used and must be harmonised. For countries using DHIS2 already, reporting to WAHO would then just be a matter of picking the right data elements from the existing database and putting these into a new dataset. This could in turn be exported from the country database, and imported directly to the regional database over the internet - an operation that can be done in a matter of minutes. Other countries would either have to make their data available in a CSV-format or XML-format that can be imported into DHIS2, or enter the data manually.

The use of DHIS2 for a regional database can have an additional benefit of promoting integration internally in the various countries using the software. In Ghana, for example, the immunisation programme is continuing to use Excel-templates to report immunisation data to WAHO. This weakens their support for the integrated DHIMS2. If WAHO started requesting that this data be reported in a DHIS2-compatible format, it would push the immunisation programme towards using DHIMS2 rather than relying primarily on parallel reporting. While this is an example from Ghana, it is likely that similar situations exist across the region.

I have argued that the above proposal for a regional dataset has great benefits. With the increasing number of countries adopting DHIS2, the technical aspect does not pose a big challenge. But how realistic is it that a regional dataset can be implemented? First of all, there might be political opposition to the idea from within the individual countries. While the best performers might be positive, it can be problematic for countries struggling with performance to make peer comparisons more easily available. For a Minister of Health, making unfavourable data on the performance of the health sector more easily available might not be tempting. On the other hand, similar data *is* available from international organisations, thus there are few real secrets here. Secondly, while only small adjustments might be needed in the data that is collected, reaching an agreement on the data

definitions to use might be difficult. Furthermore, reaching a consensus on a standard dataset of data to collect might also be difficult. Here, standard definitions and indicators laid out by for example WHO can be useful as a starting point. Finally, a challenge is cooperation internally in WAHO. Different divisions dealing with various programme areas are working rather independently, as discussed in the previous chapter. A common dataset would therefore also require internal cooperation inside WAHO.

A regional dataset will no doubt be difficult to implement, but I argue that the benefits make an attempt to reach an agreement worthwhile. The fact that DHIS2 is increasingly used in West Africa makes the technical aspect less of a problem. A push from international actors such as WAHO, WHO, HMN or donor organisations that are active across the region such as the Global Fund, is likely to be needed to get a process started. In fact, a WAHO workshop was held in Bobo, Burkina Faso, on July 27 this year, with the purpose of developing a draft for a standard regional indicator set. This draft contains a list with definitions of 57 indicators, specifying in detail the data sources of each. While there is a long way to go from a draft developed at a workshop to the actual implementation of this standard, this show that there is interest in this topic and it is a good point of departure for further work.

9.5.3 Creating Networks - the Attractors

In the previous sections, I have discussed how integration can be achieved in West Africa, with a focus on how the increased use of DHIS2 can be beneficial. I also discussed how cooperation among countries as well as national and international actors are important, and looking at the opportunities for networks of action and networks of networks to develop is therefore relevant. Sæbø et al. (2011b) argues that attractors are needed in order for networks of networks to grow. There are several attractors that can potentially create and strengthen such networks of networks in West Africa:

- software - DHIS2
- training and support
- legitimacy
- success cases

The DHIS2 software is becoming an important attractor in West Africa. The last few years, DHIS2 has been piloted and implemented in an increasing number of countries, which has led the software to mature and grow in terms of features. It has become increasingly well known across the continent, in a way creating a self-reinforcing effect.

Another important attractor in West Africa is the training and support provided by HISP to the countries implementing DHIS2 in he region. As the West African user base has grown, the frequency and scale of the

workshops and trainings has also increased. Within the last year, two DHIS2 workshops have been held in West Africa, and HISP has made support visits to several countries. Consequently, countries choosing to make use of the HISP network and DHIS2 know that they will get support for their implementation.

Legitimacy is another attractor, which is also discussed in the article on networks of networks (Sæbø et al., 2011b). Actors at different levels can lend each other legitimacy through cooperation. This is important for example for HMN and WAHO.

Finally, success cases can be important. Proving that something works through an actual implementation can increase interest in both the implementers, the software and the implementation itself. This will in turn benefit all the networks involved in the implementation. The online implementations of DHIS2 in Kenya and Ghana can potentially be seen as attractors both for new countries, and for countries currently having offline installations but who want to move online.

9.5.4 Other benefits of Regional Cooperation

We saw above some of the benefits of regional cooperation, and we can use Liberia and Ghana as examples of this. Both countries have benefited from these regional developments in several ways. First of all, they have benefited through participation in the workshops held in Accra and Lomé in recent months. Especially Ghana, as the host country for the DHIS2 Academy, was able to train a score of users. Secondly, both countries have received support visits from HISP by myself and others, in addition to remote support. In the case of Liberia, the visit resulted in part from the fact that it was only a short flight from Lomé where the database training was held.

WAHO is another potential benefactor of the increased use of DHIS2 in West Africa. The organisation currently has problems collecting data from the member states. Having all member states on the same system, and the data available online will facilitate the process of sharing data in the sub-region. Furthermore, having one widely used system makes it easier for WAHO to provide support for its members.

9.5.5 Challenges to Regional Cooperation

Two general challenges to regional cooperation are language and political instability. Linguistically, West Africa is clearly divided in a French and English group. While this is by no means a complete barrier to cooperation, as for example ECOWAS and WAHO are examples of, it does pose a challenge. This has been evident at the two workshops in which I have participated, where in both cases two camps have emerged. It is especially problematic because human capacity is one of the main challenges facing the countries in West Africa. The language barrier is a hinderance to the exchange of ideas and experiences that could have been very valuable for building this human capacity.

A second challenge is the political instability that is troubling parts of the region. This is primarily a problem internally in the affected countries, where work on implementations can suddenly be halted as was recently the case in Guinea Bissau. However, these same problems are also a challenge to cooperation: a country has little incentive to make cooperation an agreement with another state if it is seen as likely that the government can collapse and the agreement be broken.

Chapter 10

Conclusion

Throughout this thesis I have addressed some central topics of information systems in developing countries. Perhaps the most central of these are the issues of scalability and sustainability, and the use of ICT for development. My work has been done as a participatory action research project. Throughout, participation has been central. The contributions I have made to the DHIMS2 in Ghana, and to lesser extent the other DHIS2 systems I have worked on in West Africa, have mainly been done through participatory design.

10.1 Addressing the Research Objectives

I have had four main research objectives for this thesis. The first was to understand how the health information system in Ghana works at the different levels. This is an important issue in itself, but even more so in relation to the major change that the implementation of DHIS2 in Ghana represents.

10.1.1 Understanding the Ghana HIS

What I found was that the health information system in Ghana shares many of the typical problems of developing world HIS. More data than is needed is collected, much of it is duplicated, the quality, timeliness and completeness is mediocre, and the usage seems to be limited. As I see it, the main sources of these problems are the fragmentation of the reporting and limited resources, especially in terms of *human* resources.

There are also positives, however. At the lower level, for patient management facility management, usage of data seems to be good. There are reports of more focus on training of personnel to increase human capacity. At all levels, there are regular review meetings, which can contribute to increase usage of data. Finally, I believe the implementation of DHIMS2 can contribute to resolve some of the problems the Ghana HIS is facing, as shown in the next section.

A separate issue is the National Health Insurance Scheme. Created in 2003, the NHIS has become a major force in the Ghana health system, as it is

now the main source of income for the health facilities. Almost all Ghanians have insurance trough this scheme, and the NHIS collects morbidity data on all insurance cases. This is very valuable data that is currently not linked the national health information system in any way. If the NHIS could be linked with the national system, this would be a great opportunity for the national HIS.

10.1.2 Implementing DHIS2 in Ghana

Looking at the potential benefits of using DHIS2 in Ghana was one part of my second research question. As I see it, there are three main benefits to the DHIMS2 implementation in Ghana. The first is that it has the potential to improve the quality, timeliness and completeness of the data. The quality because DHIS2 provides tools for checking data quality, and through its reports facilitate feedback and self-assessment. Timeliness because the system is online, thus data will be available to all users as soon as it is entered into the system. Completeness because the new system makes it much easier to identify the facilities that do not report.

The second benefit DHIMS2 can bring is increased information usage, by making the data more accessible and in a more comprehensible way. DHIS2 has a wide range of easy-to-use reports that can present information easily in ways not possible with the previous system. And because it is online, the information is available to any user as soon as it is entered into the system.

The last of the major benefits DHIMS2 can bring to the Ghana HIS is that it, in my opinion, brings integration of data collection one step closer. With DHIMS2, Ghana *has* an integrated data warehouse with data from all programs - even if the programmes rely on the data in their parallel systems for now. If the DHIMS2 implementation succeeds, which I believe it will, the programmes will realise that an integrated system is possible, and that is has benefits. This realisation may in turn facilitate a reform process of the data collection tools that can remove some of the duplicated data collection.

Understanding the benefits of implementing DHIS2 in Ghana was one part my second research objective. However, the main point was to look at *how* DHIS2 could be implemented in Ghana using participatory design, and how to make sure the implementation is sustained.

Users, in this case both the implementers at CHIM and the end users, participated in the implementation process in Ghana at three levels: the design of the DHIS2 software; in the design of the DHIMS2; and to some extent in the design of information for action. I believe that this has made both the software and the system better than it would have been otherwise. More importantly, the participatory approaches has empowered the users, by letting them influence the system design. This case also shows that PD is a viable option when designing a system in the cloud.

I have previously emphasised the importance of the sustainability of DHIMS2. One of the theories I used when discussing this was that of Heeks (2002), on why information systems succeed or fail. The main point here is that there are no *major* gaps between the reality on the ground in Ghana,

and the assumptions about the context designed into the DHIS2 software. Furthermore, because DHIS2 is flexible, it is easy to close such gaps.

Flexibility is also essential according to the information infrastructure theory. II theory present two types of flexibility: design flexibility and use flexibility. I found the DHIS2 has both. This is important in order to avoid technology lock-ins, a situation where the system cannot be changed, as was the case with the first DHIMS.

Avoiding failure or a technology lock-in can be seen as aspects of sustainability, but sustainability is more than that. Sustainability is an important issue in Ghana, and I found that a "network of action" approach can have a positive influence in that regard. Scaling is less of an issue for DHIMS2, and then in the sense of expanding the scope of the DHIMS2 rather than its coverage. Potential nodes in a network of action in Ghana are the international organisations such as WHO and WAHO, international donors, local universities and HISP.

> I think we have finally made it. DHIS2 is going to thrive in Ghana, for that I am pretty sure. (Email received from an officer at CHIM).

10.1.3 Comparing Liberia and Ghana

Liberia and Ghana have both implemented DHIS2 during the last year, but the way the systems have been implemented have been quite different. There are two main differences, the first being the use of internet and the second that of data standardisation.

I found that there were many benefits of using DHIS2 over the internet that Liberia did not benefit from, and the result has been that the implementation there has suffered serious technical problems. Comparing the two countries, using the internet has for Ghana meant that collaboration with end users is easier, remote assistance can easily be provided and there is less need for human resources in maintaining the software, among other things. This can be seen as one way in which ICT and ICT infrastructures can promote development, in line with what the literature on ICT for development states.

The Liberian system has continued working despite the initial technical problems, an important reason for this is the fact that the country has reformed and integrated its data collection. By comparison, Ghana has taken a different approach to data standardisation, by leaving the data collection tools unchanged and including everything in the system. While this has been working so far, a consequence is that the overwhelming reporting requirements facing health workers persist, and much duplicate data is collected.

10.1.4 Regional Developments

Finally, I have discussed how the increased interest in DHIS2 can provide benefits to the region as a whole, and to the individual countries. A major

challenge across the region is fragmentation of the health information systems. Consequently, I discussed how regional cooperation and use of DHIS2 can facilitate the process of creating an integrated health information architecture.

Building on this, I have further discussed the benefits of creating a common minimal dataset for the region as a whole, in order to facilitate comparison of data and further cooperation. While I argue that the making such a dataset would be an important step in the right direction, it is also a difficult task.

Next, I used the networks of action and networks of networks theory to discuss how cooperation in the region can be promoted. The literature states that attractors are needed for such cooperative networks to emerge. I found that several such attractors exist in West Africa today. The DHIS2 software is one, and the training and support provided by HISP is another example.

A large group of countries using DHIS2 will increase the opportunities for training and support in the region, something that has manifested itself for example through two regional DHIS2 workshops in only six months. It can be beneficial for both the individual countries and international actors that the same or at least compatible systems for health data is used in the region.

At the same time, there are challenges to regional cooperation as well. One is the fact that the region is linguistically divided into a Francophone and an Anglophone group. Another is the political instability that still plagues some countries in the region.

10.2 Further Research

Health information systems in West Africa is an area where more research is needed. Following the situations in Liberia and Ghana over time can provide useful insights. Because the systems in these countries are very recent, it is difficult to judge whether the attempts to build sustainable systems have succeeded, and if they contribute to the improvement of the overall health systems in the two countries.

Another important research area is connected to expanding the scale and scope of the DHIS2 implementations in the region. As the *District* in DHIS implies, these systems focus on users at the district level, although it is also used at hospitals and facilities with the required infrastructure. Once a stable district-based system has been established, efforts should be made to improve the systems by also integrating actors at the lowest levels, in rural facilities and out in the communities. One way in which this can be done is through the use of mobile technologies, and this is an area where more research should be done.

Finally, more research should be done on how internet can be leveraged to improve IS and ICT implementations in developing countries. For example, comparing the DHIS2 implementations in Liberia and Ghana show the important role internet can play. More research should be done

in this area to see to what extent Liberia and Ghana was a special cases, or if the internet can prove to be equally important elsewhere.

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Appendix A

CHIM Training Feedback Survey

Training Evaluation and Assessment

1. Please rate this training in terms of **Trainer's Expertise, Believe system of Participants, Time Management,** and **Responsiveness** to your educational needs. Provide any additional feedback in the **Comments** section. Circle the appropriate numbers.

RATING SCALE: **1 = LOW** **3 = MEDIUM** **5 = HIGH**

Trainer Name(s)	Trainer's Expertise					Believe System					Time Management					Responsiveness				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5

Comments:

OVERALL EVALUATION OF PRESENTATION

2. Please take a moment to answer the following questions. Your comments are an **important contribution** as we design learning experiences to meet your professional needs.

What will you do **differently** in your practice/service setting as a result of this training?

What do you feel were the **strengths** of this presentation?

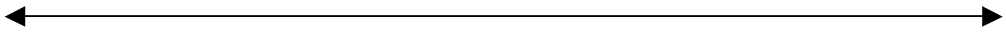
What do you feel were the **weaknesses** of this presentation?

How can we **improve** this presentation?

What **additional** training-development education do you require?

3. Please rate the following statements using a 1 through 5 scale where:

1 = Disagree Strongly **3 = Neither 1 nor 5** **5 = Agree Strongly**



____ The Training Program was **well organized**.

____ I can **apply the knowledge acquired** at my facility with ease.

____ The presentation met my professional **needs**.

____The trainer **actively involved** me in the learning process.

____ As a result of this training, I feel **more confident** in my capacity to retrain my colleagues at work.

Appendix B

DHIS2 Academy Survey

DHIS Implementers workshop

Accra – 7th to 16th November 2011

Post-Workshop Questionnaire

Dear participant,

This questionnaire is intended to obtain a feedback from the participants of the DHIS implementers' workshop in the areas of workshop content, its presentations, organization, and its usefulness. We sincerely expect that you will be able to provide us with a constructive feedback which will help us improve this programme further and address any deficiencies on our part in future workshops as well as to improve on our strengths. Please be kind enough to fill-in this questionnaire and insert it into the feedback box kept at the workshop premises.

Thank you!

The workshop organizers

-Participant details--

1. What is your country of participation? …….

2. What is your designation (e.g Medical Officer, Health manager, Technical officer…etc)?

   We had a mix of technical officers, bio statistics officers, programme officers, monitoring and evaluation advisors, health information officers, medical officers and biostatisticians.

3. What is your role in relation to DHIS in your country (e.g. user, implementer, developer…)?

   About 75% were implementers while rest mentioned their role as user, developer or coordinator.

4. Have you used DHIS before participating in this workshop? **Only 58% had prior exposure to DHIS**

5. How do you grade your knowledge in DHIS before the workshop? (please underline)

   Out of those who have been exposed to DHIS previously, 50% graded their knowledge as 'average' and 30% as 'good'.

6. What is your intention in participating at this workshop?

   Improving the self knowledge about DHIS was cited as the main intention while setting up a database, troubleshooting, setting up the server and managing hospital data were some of the other intentions.

7. Would you like to train others in DHIS in your country? **Almost all have mentioned 'Yes'**

-Workshop content--

Please answer all the questions by placing a (√) mark at the appropriate place.

	Very satisfied	Satisfied	Indifferent	Dissatisfied	Very dissatisfied
8. How satisfied are you with the workshop content?	30%	70%			
9. How satisfied are you with the presentations?	23%	65%		12%	
10. How satisfied are you with the hands-on activities?	23%	41%	18%	18%	
11. How satisfied are you with the group work?	47%	47%		6%	
12. How satisfied are you with the need to submit assignments?	12%	64%	18%	6%	
13. How satisfied are you with the training material?	18%	64%	6%	6%	6%
14. How satisfied are you with having parallel sessions?	30%	46%	6%	6%	12%

15. What additional topics do you think that the DHIS workshop should have covered?

Suggestions were made to include a more detailed session on pivot tables and server configurations. A session to create forms and troubleshooting DHIS was also suggested.

-Usefulness--

Please indicate your level of <u>familiarity</u> in each of these instances by placing a (√) mark at the appropriate place.

	Fully	To a good extent	Somewhat	Very little	Not at all
16. The usefulness of DHIS	50%	50%			
17. Setting up a new database	12%	35%	30%	18%	6%
18. Defining the organizational hierarchy	53%	35%	6%	6%	
19. Defining data elements and groups	59%	35%	6%		
20. Defining indicators	47%	35%	18%		
21. Datasets and forms	41%	47%	6%	6%	
22. Data entry and validation	41%	47%	12%		
23. Reporting	24%	58%	18%		
24. GIS	12%	52%	12%	24%	
25. End user training	18%	52%	30%		
26. Users role and management	24%	46%	30%		

Please indicate your level of <u>satisfaction</u> in each of these instances by placing a (√) mark at the appropriate place.

	Fully satisfied	Satisfied	Indifferent	Dissatisfied	Very dissatisfied
27. How satisfied are you with your ability to teach a colleague on the above topics?	24%	70%	6%		
28. How satisfied are you with your knowledge in DHIS after the workshop?	18%	70%	6%	6%	
29. How satisfied are you regarding the applicability of the knowledge that you gained from the workshop?	30%	64%	6%		

-Organization--

Please indicate your level of satisfaction in each of these instances by placing a (√) mark at the appropriate place.

	Fully satisfied	Satisfied	Indifferent	Dissatisfied	Very dissatisfied
30. How satisfied are you with the information received before the workshop?	18%	46%	24%	12%	
31. How satisfied are you with the support and services during the training?	30%	40%	12%	12%	6%
32. How satisfied are you with the facilities available at the workshop?	30%	34%	18%	12%	6%

33. Do you have any additional comments or suggestions?

Many have suggested to opt for better internet access and conference facility (e.g sound system, power…etc). Few have mentioned that the translation in French was not enough for them and that they should have got a separate workshop, only in French. Some have pointed out the amount of extra time spent when it is done in two languages. Few have suggested separate workshops for beginner, intermediate and expert groups rather than mixing people with different competencies.

Several participants also have suggested holding the workshop again for the same group as a review workshop and several were willing to participate in follow-up workshops. Some countries pointed out that they did not gain adequate attention individually while certain countries have suggested having workshops in their own country as they will benefit in their implementation process.

Some participants were not given pre-workshop instructions or were not communicated in advance and have suggested informing them of a detailed work plan relatively early. One participant suggested informing them of the need to bring their own data to the workshop which might not have been communicated to him as we planned.

Appendix C

Some Example DHIMS2 Messages

challenges

Sylvester Asmah 2012-05-23
1. is difficult to enter data anonymous (inpatient morbidity & Moralities and returns on delivery. west with poor network suggest that, ways to import from dhims 1 to dhims 2 2. with bed state statistics, one have to change format of capturing data, no problem with that. but one also must consider physical change of ward. say general adult ward to male medical, female medical and so on. management will not buy such idea 3. make ways easier to print instead of downloading to pdf and excel.

Olav Poppe 2012-05-24
1) We are working on improving data entry with line lists in areas with poor network connectivity. 3) What do you want to print, the dataset reports? That is being worked on, and will be available in an update soon.

standard reports

Asaah Kofi 2012-04-16
My population distributions are not appearing in the standard reports ie the RCH reports, kindly help me out.

Olav Poppe 2012-04-16
What type of organisation unit is not showing population data - facilities, sub-districts or districts?

Asaah Kofi 2012-04-16
It is the district which is not showing the population data

Olav Poppe 2012-04-17
And you have filled the population dataset for all your sub-districts? I just tested running the RCH 2.1 report now, and all populations are showing. The problem might be that data for reports are generated every night - so if you entered the population data yesterday, it was not available in reports until today.

Asaah Kofi 2012-04-17
thanks very much, is appearing now

Nutrition reporting format

Thomas Sarfo 2012-04-20
there are series of auto generated figures in this reporting format eg. Fielmuo Sub-district February 2012 reports, there were figures already in the fields of the anaemia in pregnancy, Viatmin A supplementation fields, exclusive breastfeeding, birth weights, and growth monitoring and promotion fields respectively. so please if you can update me on that.

Olav Poppe 2012-04-20
Hi, the nutrition form picks data such as Vit A, growth monitoring etc from RCH Form A and C, and from the monthly vaccination report.

Real time data issues

livingstone asem 2012-06-27
Please am receiving the above feedback from my district and facilities that data entered take days and some times weeks to appear. But we were made to believe that data will be in real time thus data will appear for your reports immediatly you upload. As an IT person I want to be sure it is true and it was confirm from Worawora Hospital when I had to go online to check the bed Utilization data on the data entry end you see the data it is complete and was uploaded. On the reporting rate summary sometimes you can see the data appearing but on the dataset reporting no data was appearing all the field was black. Report was seen after 5 days. Can some body help me explain this; if it is the case how long will it take between the date of entry and date of appearing in the Reporting end of the System. Thanks

Olav Poppe 2012-06-28
Data is stored on the server in real time. However, the data entered is only aggregated every night - so reports will be available the next day. As for the reporting rate summary, did you run based on "complete dataset registration" or "data elements"? If running or complete dataset registration, it will be zero unless the "complete button" is clicked.

livingstone asem 2012-06-28
based on complete data set registration

Olav Poppe 2012-07-02
And are you sure the "complete" button had been used during data entry?

In- patient morbidity data set and Report Rate Summary

Obed Nuobe 2012-05-02
Please with the In-patient dataset: 1. In offline mode or when you disconnect the modem you cannot create new event unless it is connected during offline mode and it cannot be saved. 2. There is a regular interference of data from different districts or Regions. eg. date of admission and discharge, etc with exception of cost, insured and surgical procedures eg. Adress, (TAIFA) is in Accra but appears in the Adress column when the patient number is entered 3. The report Rate summary for first three quarters reads actuals as zeros meanwhile aggregate months have data entered and completed. please can you have a look at the above for me

Olav Poppe 2012-05-22
Sorry for the late reply. 1) In-patient data entry does not currently work when offline. 2) Are you making sure you always click "create new event" before you start on a new patient?. 3) Did not quite get what you mean with this, can you elaborate?

Obed Nuobe 2012-07-24
Olave Poppe Am preparing the half year report for 2012 and making reference to 2010 and and 2011. I can't get the top 20 cases of my org. unit for half year 2010 and 2011. Can you help me out?

Olav Poppe 2012-07-24
Are you thinking of the inpatient data for 2010 and 2011? That has not been imported into DHIMS2 yet, so you will have to look in DHIMS1. For the routine data, it should be there.

Olav Poppe 2012-07-24
If the data was in DHIMS1 that is, and the organisation units between DHIMS1 and DHIMS2 matched.

Inpatient morbidity and mortality

Yaw Darko Boateng 2012-06-25
the following facilities cannnot access the inpatient morbidity and mortality and delivery forms at the data entry point. 1.Obuasi Govt hospital 2.St Jude hospital Obuasi

GEEGEE KWAME ADU 2012-06-25
They can access both forms by following the following procedure 1.Select services 2.Select Name-Based data records 3.Select Anonymous Events 4.Select the organisational unit 5.Select program and the report period to access the forms

Appendix D

Terms of Reference from Liberia

Term of reference for The University of Oslo's technical delegation to Liberia /MOHSW

Background

The MOHSW Health Management Information System (HMIS) transitioned from DHIS-1. to DHIS-2 (web-base) version over the past three years. This migration was supported by, GAVI, USAID/RBHS, Global Fund, WAHO and the University of Oslo . The university has since been providing continual remote technical support to the MOHSW HMIS Unit for a smooth transition from the earlier version of DHIS to the new one. To provide onsite support, a team of technicians will come to Liberia as guests of the MOHSW to work with the HMIS Unit to solidify the successful implementation of the DHIS-2.

In 2011 The MOHSW developed an integrated HIS form for collection and subsequent reporting of data from the level of health facility. The new integrated form reflects some new data elements as well as the elimination of obsolete ones and the modification of some existing data elements. Shortly after tools were finalized, the new reporting forms and accompanying ledgers were introduced into health facilities for data collection. This exercise coincided with the migration in the middle of a the year, from DHIS 1.4 to DHIS 2. We have limited technical capacity in country to link the two separate data sets in the current DHIS 2. Ideally, the MOHSW would like to maintain an integrated data in DHIS such that historical data collected using the old HIS reporting form will be harmoniously linked to the data collected using the new reporting forms in the DHIS 2.

As part of its efforts to promoting information use and in a bid to promoting a one M&E and reporting system, the MOHSW now seeks to increase and use of information by opting to host the DHIS 2 on a local server whereby stakeholders can conveniently access the reporting platform and share updates among other things. The MOHSW is of the opinion that this will facilitate expeditious response to such technical challenges like bug fix, amendment to existing reporting forms (data sets), among others.

1. NEIDS form (old) *attached*

2. Integrated HIS reporting form (new) *attached*

This term of reference is developed to guide the team and the HMIS Unit in getting the best out of the visit to meet the needs of the MOHSW as far as information processing, management and utilization is concern using the DHIS-2 platform.

Scope of work / Deliverables

- Harmonize data in DHIS-1.4 to the one in DHIS-2 on a single platform for easy and timely retrieval and processing
- Work with the HMIS, M&E and IT Units staff to setup the server to host the DHIS-2 and install the software in fore view of the technical staff to transfer knowledge and skills
- Ensure the DSS (Decision Support System) functionality in the DHIS 2 is functional and updated to reflect current data in the system; the aim of which is to buttress MOHSW quest to promote a data driven culture and information use through a real time feedback system.
- Provide orientation to staff on the DHIS2 installation and its operations

1. NEIDS form (old) *attached*
2. Integrated HIS reporting form (new) *attached*

Appendix E

TALI Tool from Regional HIS Assesment

Tool 1: TALI tool to assess levels of information usage: This tool was developed by HISP South Africa in early 2000 that helped to identify three levels of information usage, and the detailed criteria by which a facility or a district system could be assessed and placed into level 1, 2 or 3. Assessment can be done using a qualitative assessment supported by a checklist containing the different criteria of each level (See bellow).

Level	Broad description	Detailed description of criteria
Level 1	**The information system is working technically according to its specification:** timely and accurate data is submitted to the district; district manages data in database, reports to region and feedback to facility. Similar at regional and central levels.	Clearly defined Essential datasets for all compulsory reporting have been defined? Has an information manager been identified? Have all the expected routine reports been submitted? Have feedback reports been issued? User friendly guideline including information handling at that level is available?
Level 2	**Data is analyzed, disseminated and used:** Summary reports of data produced and disseminated regularly Indicators are being assessed against performance / targets on a regular basis.	Are summary reports available Are indicators graphed? Are indicators discussed in management meetings?
Level 3	**Information from the system used for planning and evaluation of achievements:** Indicators and information are used by managers to inform their action plans. Indicators and information used to document performance in all written reports	Are indicators interpreted and understood? Are problems identified based on available information? Have any problems been addressed, and can these steps be documented, and an improvement shown using indicators and data?