TDT4900

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Abstract

Acknowledgments

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List of Abbreviations

AD Anno Domini. 10

ANC Antenatal Care. 19

BC Before Christ. 10

CHD Community Help Desk. 17, 20

CHW Community Health Worker. 4, 17–20

CoIA Commission on Information and Accountability. 12

DHIS2 District Health Information System 2. 12

DOT directly observed treatment. 18

GNI Gross National Income. 9, 10

HC Health Center. 19

HISP Health Information System Program. 11, 12

ICT information and communication technology. 12

MOH Ministry of Health. 17

NCD non-communicable disease. 18

RPF Rwandan Patriotic Front. 10, 11

TB tuberculosis. 18

UiO University of Oslo. 12

Chapter 1

Introduction

1.1 Let's have an argument

1.2 Philosophy

I will try to take on both an interpretive and a positivist view of my research. The reason I do this is that I believe that one does not exists without the other. No one really have a shared reality, and is never completely different. The positive researcher will concentrate on the shared knowledge in a community, while the interpretive will try to harmonize the different realities. The users of the knowledge I am trying to create are the academics, focused in the field of Information Systems and Computer Science. The quality of this research is of course, only evaluated by the reader.

1.3 Purpose

My reason for doing this is divided. Firstly, I am a student using research to add to my own knowledge in the field of computers in order to being able to offer a better service in the computer industry. Secondly, I am trying to add to the body of knowledge in the academic literature. Starting this research project, I have privilege to know the organization HISP. Through HISP I've been participating in the configuration and implementation of a open source software called DHIS2 in Rwanda. After a quick analysis of the requirements I took notice that the software in question should indeed be able to offer solutions to each one of them. So why is it that it is not currently doing so? So this is my purpose, to find out why a software that to me seems to support all the necessary requirements is not doing so.

1.4 Products of this research

By participating in the configuration and implementation of DHIS2 as an intern at the MSH, one of the products of this research will be a working computer application. The other part is an in-depth study of this process. Hopefully contributing to the collection of data existing on the topic of ICT's in developing countries.

1.5 Research Questions

Suggestions

1. Hva gjør det vanskelig for en bruker å benytte seg av IKT som verktøy?

2. Hva er grunnen til at en bruker, i ett land med begrensede ressurser, ikke får utnyttet IKT verktøy maksimalt?

3. Hvilke hinder er det som står imellom bruker og IKT som verktøy i et land med begrensede ressurser og i en helse-setting?

4. Hva karakteriserer utfordringen, "å ta ibruk IKT-verktøy" i helse-sektoren i et land med begrensede ressurser?

5. I denne oppgaven, hvordan skal jeg vinkle målet med IT (Tar gjerne imot forslag)?

    (a) Få slutt på fattigdom?
    (b) Øke livskvaliteten til folket?
    (c) Mer kontroll til staten?
    (d) Øke kunnskapsbasen om informasjons systemer?
    (e) Ved bruk av IT, kan en bruke begrensede ressurser mer effektivt?

1.6 Background

1.7 Motivation

Chapter 2

Literature Review

2.1 Information and Communication Technologies in Developing Countries

It is important to take notice of what kind of development information and communication technology (ICT)'s are supposed to support. And in this notion make conclusions and measures based on that. Like increase a countries competitiveness in the global free market.

Common problems that concerns the Information Systems (IS) in developing countries are:

- Scarce resourses

- Little technology

- Missing skills

2.1.1 Discourses

- The pace and direction is set by the advanced economies in the world, North America and Europe. [1]

- An increasing number of studies in developing countries in Africa, Asia and Latin America.

- Developing countries are highlighting new topics like national culture, global politics, provision of ICT resources for a community.

-

Transfer and Diffusion Discourse The Transfer and Diffusion discourse assumes that IS-innovations in developing countries are achieved by transferring technology and organizational structure from more advanced countries. Much like, "if it works here, it should work there". In order to succeed the receiving part should try to emulate what is being done in the more developed countries. Of course IS these ideas of best practice are somewhat adapted to fit their new context, but the underlying assumption is that the transferred methods result in the same outcomes.

Social Embeddednes Discourse This discourse assumes that IS innovation is about creating new techno-organizational structures given a local social context. The new structures are built on the already existing structures and are a locally socially constructed course of action. The problems are seen from a local perspective and hence the solutions has to be an integrated part.

Transformative Discourse The last discourse is mostly concerned with creating possibilities for improvement of life conditions. It focuses on how IS can be used to facilitate deep socio-economic change. The social embeddednes discourse takes the local context into consideration, but the transformative takes it one step further and includes politics, economics and social conditions.

The transformative discourse raises more explicitly the strategic issues in the development struggle.

A distinctive feature of IS research in developing countries is that it puts focus on e-governments, free and open software and the development of community resources intended to overcome the digital divide.

Issues that received attention in Information Systems in Developing Countries (ISDC).

- IS-failure

- Outsourcing

- The strategic role of ICT

[1]

2.1.2 Success and Failure of ISDC

Are there any evidence suggesting that there are more IS-failures in developing countries?

In the ISDC literature the is an anxiety about failure, and not without reason. Compared to other settings there are additional pressures. The need to catch up with the rest of the world, high opportunity costs and over optimistic expectations.

Categories of failure:

- Scalability failure because of waning political support, technological complexity, human resource capacity.

- Sustainability failure because of starvation of IS resource, loose political commitment, poorly maintained. This could be tracked down to foreign aid-donors that neglected the development of local technological capabilities. The remedy is of course to look at IS as the socially embedded instead of transfer and diffusion. The IS project needs to be an integrated part of organizational practices, secure the required financial and knowledge based resources and political commitment in order to succeed.
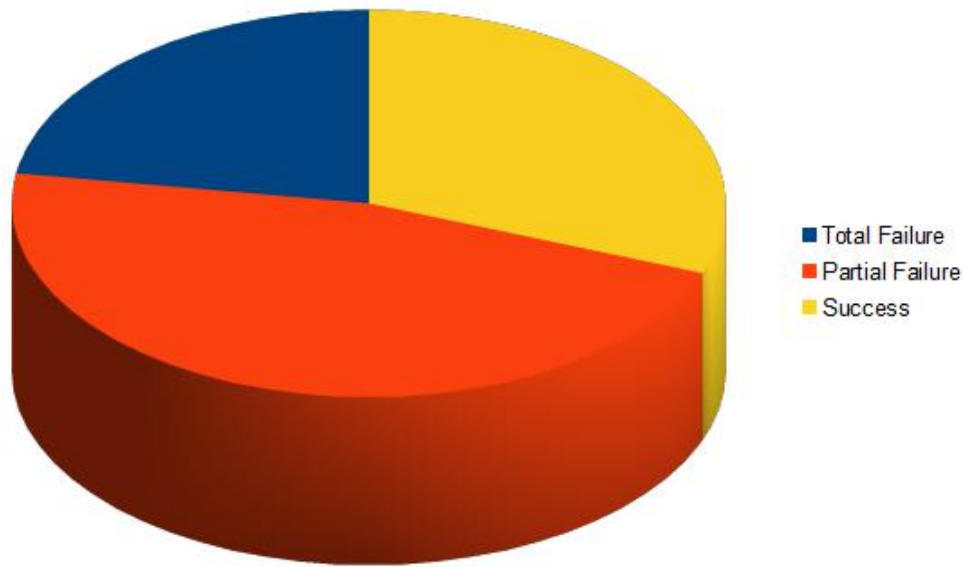
Figure 2.1: Diagram of Success and Failures in Industrialized Countries

- Assimilation in dysfunctional organizational processes, meaning that an already broken system cannot be fixed with facilitating the broken system with IS.

Total Failure An initiative that never is implemented or abandoned immediately after implementation.

Partial Failure An initiative where major goals are unattained or where there are significant undesirable outcomes.

Success An initiative where major goals are attained for most stakeholders and there are no significant undesirable outcomes.

In industrialized countries there is an estimate of $\frac{12}{60}$ to $\frac{15}{60}$ fall into the category of total failure; something like $\frac{20}{60}$ to $\frac{36}{60}$ fall in the partial failure category; and lastly the $\frac{9}{60}$ to $\frac{28}{60}$ are successes. See figure 2.1.

For practical reasons like lack of technical and human infrastructure developing countries should be performing worse than

industrialized countries. The evidence base is not that strong due to lack of literature in general, evaluation and focus on case studies, but it generally points in one direction. High rates of IS-failure.

Failure can be viewed as something positive. Like in a learning process, but it cannot be overlooked that continually failing keeps the under developed countries on the wrong side of the digital divide.

Organizational change can be viewed as a process between two states. The current system and the future. The future system would represent the design of a IS system that are to be implemented. And the current system as a description of how the system is. Between these models there will need to be some change in several dimensions like processes, people, structure and technology in order to reach the a state of the future system. This design-actuality gap usually represents how much risk are involved from moving to a design.

The actuality of the industialized countries and developing countries have in themselves gaps. The design-actuality gap might not be the same for the solutions used in industrialized countries and developing countries.

[4] [1]

2.2 Outsourcing

A number of developing countries have nurtured software and ICT services industries able to compete in the global market, India being the most successful. Factors that account for success in the global market include technology and project management skills, copyright legislation and government industrial policy. By making an effort to outsource, there may be also be an increase to services offered to the domestic organizations. This in turn will have an impact on the overall developments of

the country or region. It is hard to imagine that there are little technological use in a place that are among the top exporters of software. The spill over effect may results in local organizations running better, and this way offering better possibilities in the other fields as well.

[1]

2.3 Digital Divide

2.4 E-Health

E-health is defined as:

> Use of information and communications technologies in support of health and health-related fields, including health-care services, health surveillance, health literature, and health education, knowledge and research.

E-health has many areas of application. Studies have shown that in by using electronic health records it is possible to improve staff productivity, reducing patient wait times, increase staff satisfaction and providing higher quality of data to relevant personnel. Laboratory information managements systems have decreased the time for communicating results and improved the productivity of the laboratory. Pharmacy information systems reduces time to order medications and provides easy access to past information. This is useful for forecasting medication requirements in order to get it at a lower price. Particularly relevant for drug resistant tuberculosis (TB) medications. Also reducing the number of errors. Fingerprint scanners reduced the time to locate records with 74% and barcode scanners reduced the time by 97%. The time to track patients lost to follow-up could with patient tracker systems be reduced by 20–50%. And

patient reminder systems can increase attendance with up to 21%. A cost analysis of data collection systems show that it is possible to save 91% over a paper based system.

These findings clearly argue for the implementation and commitment of e-health in developing countries.

Challenges include:

- physical environment

- power

- networking

- availabillity of technical staff

[3]

2.5 Transition Strategy

With a transition I talk about taking the system as it is and change it to something new. It's the process from old to new. The process of transforming systems or system migration if you will.

Making a transition involves a switch from the old system to the new. There is the source system, also referred to as the legacy system and the target system. At one end of the specter we have the Big Bang strategy, were we taken on an revolutionary approach. A complete new system is developed, supporting all the required functionality. Then one decides a time when all of those involved switches to the new system. This way usually has a high risk of failure. On the other end of the spectrum we have the evolutionary approach. Gradually one introduces new functionality, or the same with a new system, then after the legacy system is not used anymore, one turns off the switch.

2.5.1 Planning and Conducting a Transition Strategy

There are some predefined methods for conducting a system migration which also could be used in a transition strategy plan. Remembering that one moves from a source system into a target system. As mentioned, solutions to transition problems could be characterized by how revolutionary it is. The most revolutionary would be redevelopment, followed by migration, maintenance and finally wrapping. One would choose the most appropriate strategy based on the level of risk. Like wrapping, one takes almost no risk, since it requires no real change to the system, but instead provides an updated interface for the source system. Although this way is low risk, this could complicate things later on. Making use of wrapping not only slows down the system, but also makes maintenance more complicated. The most appropriate use of wrapping is when one wants to make a new Graphical User Interface (GUI). Like when moving from a text based front-end to a graphical based front-end. With redevelopment on one end and wrapping on the other, in the middle we have system migration. This technique allows for a smoother approach while being able to have control.

2.5.2 Migration

When redevelopment is to risky and wrapping is unsuitable, migration usu- ally is the best way to go. This allows for both systems to co-exist while making the transition from one to the other. Migration usually involves moving an existing system to a new platform. Before making the transition one has to decide on some basics. Like how one would like to migrate to the new system. Much of the time is spent on testing the target system. There- fore it is good practice to not introduce new functionality while migrating to a new platform. It also makes the testing easier since one could compare with the old system for output

results. New functionality should be introduced afters the old ones are supported.

The Cutover

The cutover is the last step in the migration process. Here are three main approaches.

The cut and run This is the most revolutionary way of migrating. It is much like redevelopment and seldom used alone. Once the target sys- tem is ready on turns of the source system and enable a new feature rich system.

Phased interoperability In this strategy incremental steps towards the target system is used. Replacing functionality over time and slowly moving towards target system until all functionality is replaced. The last part of the cutover would be cut and run to some degree.

Parallell operations In this strategy both systems are running at the same time. Both source and target system is operational. The target system is continually tested and only when it's fully trusted, the source system is disabled.

The cut and run is very simple, but usaually involves high risk. Parallell operations usually become quite complex, but are fairly safe. Phased interoperability is somewhere in the middle. [12]

Chapter 3

Case Context

Our case is located in Rwanda. Rwanda is on the border of central and east Africa and is located just south of the border of Uganda. The area is $26338km^2$ which makes it $\approx 7\%$ of Norway. Still their population count is over the double that of Norway's. In 2014 the population count in Rwanda was 12337138 citizens which makes their population density $468.42citizen/km^2$. Compared to Norway with a population density at 13.26. There are no strict criteria for calling a country a developing one, but if the term is to be used, Rwanda is one of them. Gross National Income (GNI) is a way of measure how much value is added by all producers who are resident in a country. The world bank did a GNI per. capita ranking of the world's countries in 2012 and Rwanda made it at 195th of the 213th economies ranked. The world bank categories economies in four classes:

High Income: $[\$12616, \$\infty]$

Upper Middle Income: $[\$4086, \$12615]$

Lower Middle Income: $[\$1036, \$4085]$

Low Income: $[-\$\infty, \$1035]$

By this, Rwanda is in the lowest income category with $600 per. citizen, and in this paper, a developing country. It is noteworthy to say that with a population density at 13.26, Rwanda's

population would be ≈ 354509. Rwanda's GNI in 2012 is \$6858$\circ$ 10^6, making their GNI per. citizen ≈ 19345. This would argue for making more cost effective solutions and lowering the fertility rate in order to have a sustainable economy.

[5] [19] [22] [23]

3.1 Brief History

The first inhabitants of Rwanda was probably the ancestors of Twa people. Findings suggesting this goes back to somewhere between 8000Before Christ (BC)–3000BC. Jumping forward to around 700BC–Anno Domini (AD)500 there are evidence suggesting that the Bantu people entering Rwanda. The Bantu's was first farmers and then cattle owners. The Hutu's are believed to be mostly farmers and Tutsi cattle owners so it is natural to assume that this is the source for making any difference between the two peoples. There is a Tutsi rule around AD1800, but at a conference in 1890 Rwanda was given to Germany. They favored the Tutsi people and contributed to ethnic discrimination. After World War 1, Rwanda was ruled by Belgium. The introduced identity cards that would categorize every individual as a Tutsi, Hutu, Twa or Naturalized. Under Belgium the Tutsi was still favored. In AD1959 Hutu activist began killing Tutsi people, making 20000–100000 Tutsi flee the country. In AD1962 Grégoire Kayibanda was the first elected president. He sat out to abolish the Hutu suppression, but that led to Tutsi discrimination. In AD1973 there was a military coup by president Habyaramana. Up until AD1990 there was a pro Hutu discrimination. In AD1990 the Tutsi dominant Rwandan Patriotic Front (RPF) lead by Paul Kagame (current president of Rwanda) invaded Rwanda from the north. This is the start of a civil war lasting up until a peace agreement in 93. In AD1994 president Habyaramana's plane is shot down and started the

history's most brutal genocide. 800000–1000000 Tutsi killed by Hutu in 3 months. Stopped by RPF when they entered Kigali in July the same year. The first president after the genocide was the Hutu president Pasteur Bizimungu, followed by the RPF general, Paul Kagame. After the genocide many fled the country. An estimate of 1 million Hutu fled to Zaire, now renamed and known as Democratic Republic of Congo (DRC). In 1996 Rwanda invaded DRC and assisted on allocate the president and started the first Congo war. In 1998 they were asked to back out their forces, but Rwanda refused. This was the start of the second Congo war. After peace negotiations the Rwandian forces pulled out of DRC in 2002.

3.2   More Recent

[5] [21] [20]

3.3   Health Information System Programme

The Health Information System Program (HISP) is a global network established, managed and coordinated by the Department of Informatics at the University of Oslo. They design, implement and sustain Health Information Systems by a participatory approach. This means including the local users when developing the system in hopes of a more sustainable and successful projects. The system developed aims for supporting health care delivery and information flows in selected health facilities, districts and provinces.

Vision To strengthen the development and use of integrated health information systems within a public health inspired framework in India and the South Asian region.

Mission To enable networks of collaborative action with like-minded actors who aspire to the ideology of open source software, open standards and decentralized decision-making to create complementary strengths in providing integrated and public health friendly health information systems.

In the 1970 and 80's the HISP approach to action research and system design was influenced by a number of union based action research projects in Scandinavia. The focus were on empowering workers who were affected or threatened by new technology. Methods may have changed over time, but the philosophy remains the same. Explore ways in which disadvantaged people could appropriate ICT's for their own empowerment. Original key member of the HISP team had background as social political activists in the anti apartheid struggle and other social movements. DHIS, a software organized and developed within the HISP network, was actually born out of the political processes following the fall of apartheid. During apartheid and until 1994 there were 14 departments of health in South Africa. Because of this fragmentation it was a lot of different procedures, collection tools and data definitions.

[7] [6] [8]

3.3.1 HISP Strategy

The core focus of HISP is District Health Information System 2 (DHIS2). It through this software that HISP will effectively make changes. DHIS2 are now active in 46 countries around the world. This includes 70% of the global fund high impact countries and 55% of the Commission on Information and Accountability (CoIA) countries. HISP are based at the University of Oslo (UiO). This is were the core developers of DHIS2 are located.
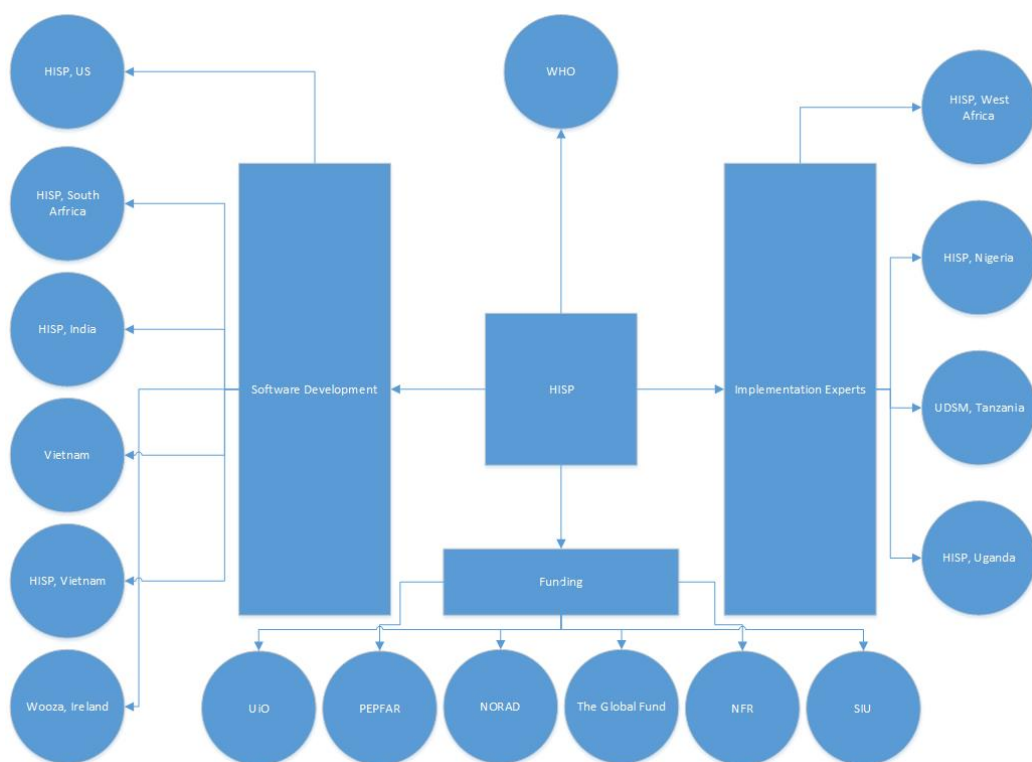
Figure 3.1: HISP Network of Action

One of HISP's biggest strengths is in their network of action. As illustrated in figure 3.1. There is a huge support network for facilitating the development and implementation of DHIS2 and is clearly one of the key success factors of why DHIS2 has been so successful in strengthening the health infrastructure world wide. Recently HISP is trying to add to network the East-Africa region. HISP East-Africa will include countries like Tanzania, Rwanda, Uganda and Kenya. Making relations between countries is essential for sustainability purposes. Sharing experiences and knowledge through neighboring countries is beneficial for sorting out local implementation problems. HISP has been able to arrange for these network building activities with DHIS2 workshops and academies. The primary focus is to train users in the use and implementation of DHIS2, but a beneficial side effect is network building cross countries. With DHIS2 there has been great progress with the process of gathering of data, but two issues remain. Data quality and using data for action. These to areas are now focus areas for the HISP-team at UiO.

[10] [9] [13]

3.4 District Health Information System

HISP's main product is DHIS2. In short, it is an open source software to manage health information data. It also facilitates both the gathering and presentation of the data. With the aid of this program we are able to collect data on site independent of location and to present those data on the same terms. Usually dependent on an internet connection, but it is possible to gather data on a regular Global System for Mobile (GSM) network. The importance of this last quality is *huge* in underdeveloped countries. Internet is nowadays usually taken for granted in most places, but when it comes to villages located outside internet coverage, even a mobile connection cannot be taken for granted.
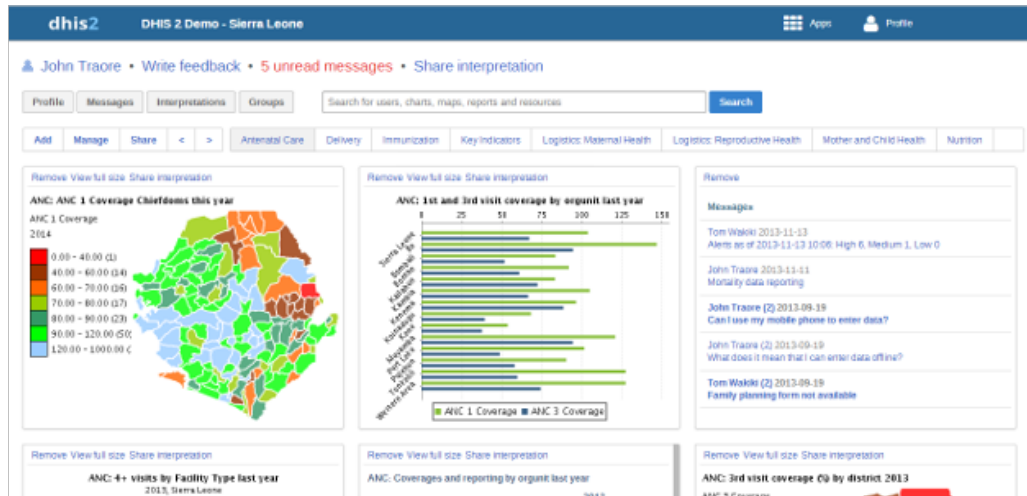
Figure 3.2: Screenshot of Dashboard

In 2012 there was an internet coverage of 33.4% of the worlds population, so assuming an internet connection when working on a global scale is unwise. The system manages data as predefined variables called data elements. These are then grouped together with formulas and description in order to adapt to a health environment. This feature makes it very adaptable to different use cases. We see new systems almost daily nowadays. The smart phone era as boomed the software development, so the need for interoperability is ever increasing. Because of this, a system must be able to work as a piece of the puzzle rather than a silo, but then again new challenges arises. Standardization across departments and health instances needs to be made and it calls for an increased level of cooperation and transparency.

3.4.1 Gathering

DHIS2 allows for data entry for as low-tech as SMS to the new high-tech smart phones. As mentioned earlier, SMS support is very important since over half of our population does not have internet coverage.

28

Phone Number:	2000
Message:	Stock condom11
Send	

Table 3.1: Example SMS

An example SMS in table 3.1. One use case is that a CHW would like to report the stock on condoms at the end of month. The user would usually go through the following steps.

1. Enter the phone number assigned the reporting service.

2. Enter the codeword for this type of report.

3. Enter the codeword for the item that is being reported followed by a integer value.

4. Hit send.

There are some extra features, but this is the basic idea. At a first glance, this seem alright, but in most cases there are more than one item involved. Let's say that our example message could represent an average reported SMS and that the standard SMS is restricted to be 160 characters long. The codeword is 5 chars. The codeword for the item is 6 and the value is 2. One would usually like to have some kind of separator for each item, so we +1 here. That makes room for approximately 17 items pr. message. I don't know about the general population, but I know it is a pain to write 160 char SMS's on a button based phone and if you have more than 17 items one has also to write another SMS. Also, it is very easy to make mistypes. So it is preferable to report using some of the more advanced devices. But, better than not being able to report. A little more sophisticated option is using a simple phone. These are still cheaper than the most basic smart phones and widely used in underdeveloped countries. They offer a basic G (GUI) that offers some

Figure 3.3: Screenshot of data entry in regular browser.

more description than the cryptic codes. A note on the SMS entry is that it is usually supplemented with a reporting card that describes the different codes. The more high-tech devices has support for modern browsers so data entry would be very similar to a any other Hypertext Markup Language (HTML) form.

3.4.2 Managing

Once the data are inside the system it is managed with a data structure designed specifically for DHIS2, see figure 3.4. At the bottom of the hierarchy and the most basic structure is the dataelement. It is essentially a value of a certain type. Any variable value in the system would usually be a dataelement. The dataelement also has several attributes like a datestamp, description etc. Now, with these elements, one can either combine several or make some mathematical manipulations to them. This variable are then stored indicators. Both of these data types can be grouped together in groups as dataelement group or indicator group. The indicator group can further be classified

Figure 3.4: Basic Data Structure
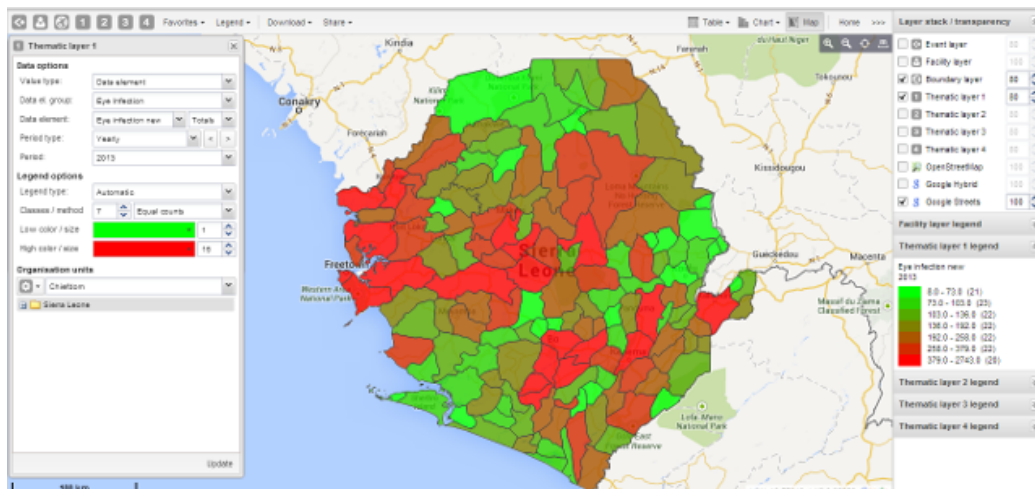
Figure 3.5: GIS Example

in indicator group set. This then a group of groups. The most frequently used group type is the data set. It can be a combination of dataelements and indicators. All of these data structure comes with descriptions and other kind of meta data in order to be able to analyze the data in an efficient manner.

3.4.3 Presenting

There are several ways of looking at data in DHIS2. Of them the most interesting is the Geographic Information System (GIS), as seen in figure 3.5. In the figure one can see a count of eye infection in 2013 based on color and Chiefdoms. Green being low and red high. There is a sense of overview by looking at this kind of map. While getting a graphical visualization one has numbers pinpointing the exact number range. Extremely useful when in need to get an updated status on a situation. Some other tools for analyzing and visualizing data is the pivot table, the basic charts and the generation of reports.
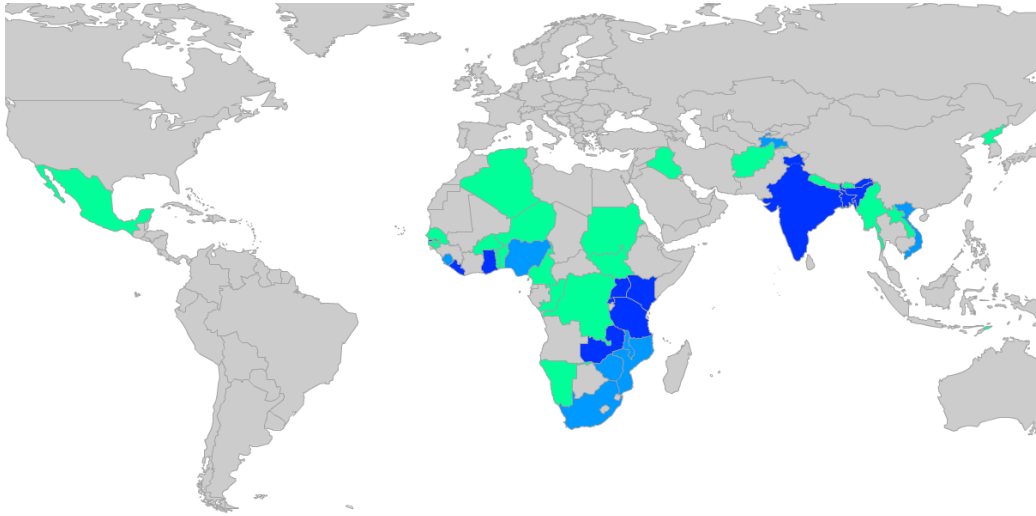
Figure 3.6: (Blue, National rollout)-(Light-Blue, Programs/partial)-(Green, Pilot/early phase)

3.4.4 Application Development

DHIS2 is meant to be a platform for health information. As a result from silos forming in different departments of the health sector, the choice of health information systems are different. This causes a fragmentation that makes interoperability between systems hard to achieve. As a response to this problem, DHIS2 is now being designed to work much like an appstore. This allows users to develop their own applications that meets their specific needs while keeping the core functionality of DHIS2. Not only does this benefit the users, but makes collaboration between developers much easier.

[2] [11]

3.5 Administrative Structure

Rwanda has a strict hierarchical structure in their country. The country is divided in Provinces, Districts, Sectors, Cells and Villages.

Complete national implementation	Adoption by programs or partial national roll-out	Pilot stage or early phase in roll-out
Bangladesh	Colombia	Afghanistan
Ghana	Laos	Algeria
India	Malawi	Benin
Kenya	Mozambique	Bhutan
Liberia	Nigeria	Burkina Faso
Rwanda	Sierra Leone	Cameroon
Tanzania	Solomon Islands	Congo Brazzaville
The Gambia	South Africa	Cote d'Ivoire
Uganda	Tajikistan	DRC
Zambia	Vietnam	Guinea Bissau
Zanzibar	Zimbabwe	Iraq
		Mexico
		Myanmar
		Namibia
		Nepal
		Niger
		North Korea
		Samoa
		Senegal
		South Sudan
		Sudan
		Timor Leste
		Togo
		Vanuatu

Table 3.2: Countries using DHIS2

Figure 3.7: Africa

Figure 3.8: East Africa
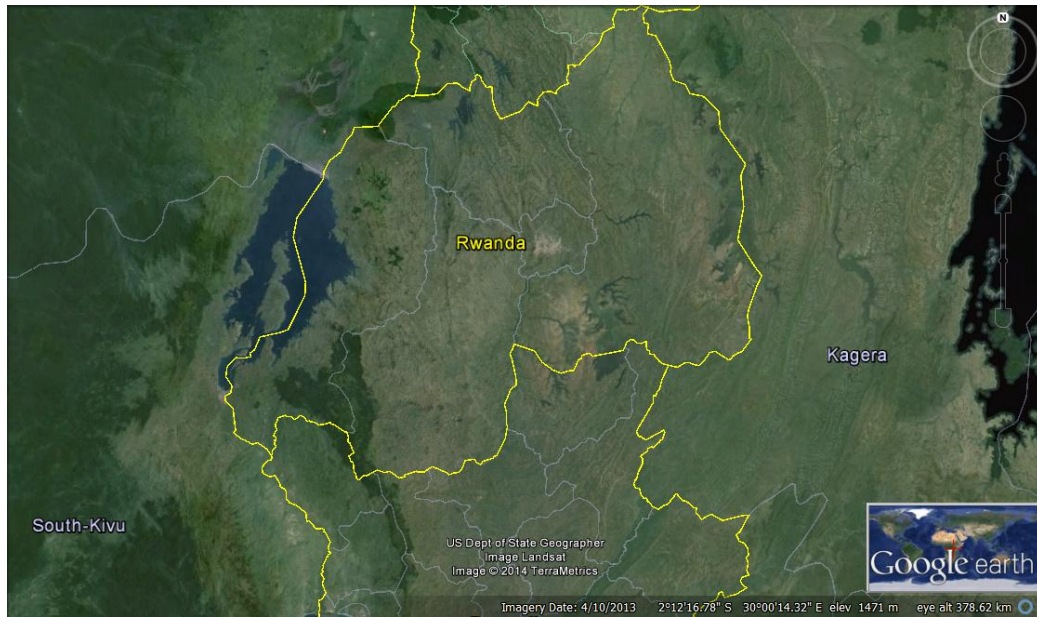
Figure 3.9: Rwanda

The level closest to the people is the Village. Here problems, priorities and needs of the people at a grass root level are identified and addressed. Above is the Cell level. Cells are managed by technicians and and a political team. Technical and key political matters are managed here. Further up in the hierarchy is the Sector level. The people participate here through their elected representatives. Sectors are collected in Districts which are the basic political-administrative unit in the country. Just under the national level the country is divided into five provinces. These serves mainly as advisor to the decentralized entities and coordinates development activities. [17]

This division is used to make areas more multi-ethnic and to decentralize power as an attempt to address problems that arose from the genocide in 1994.
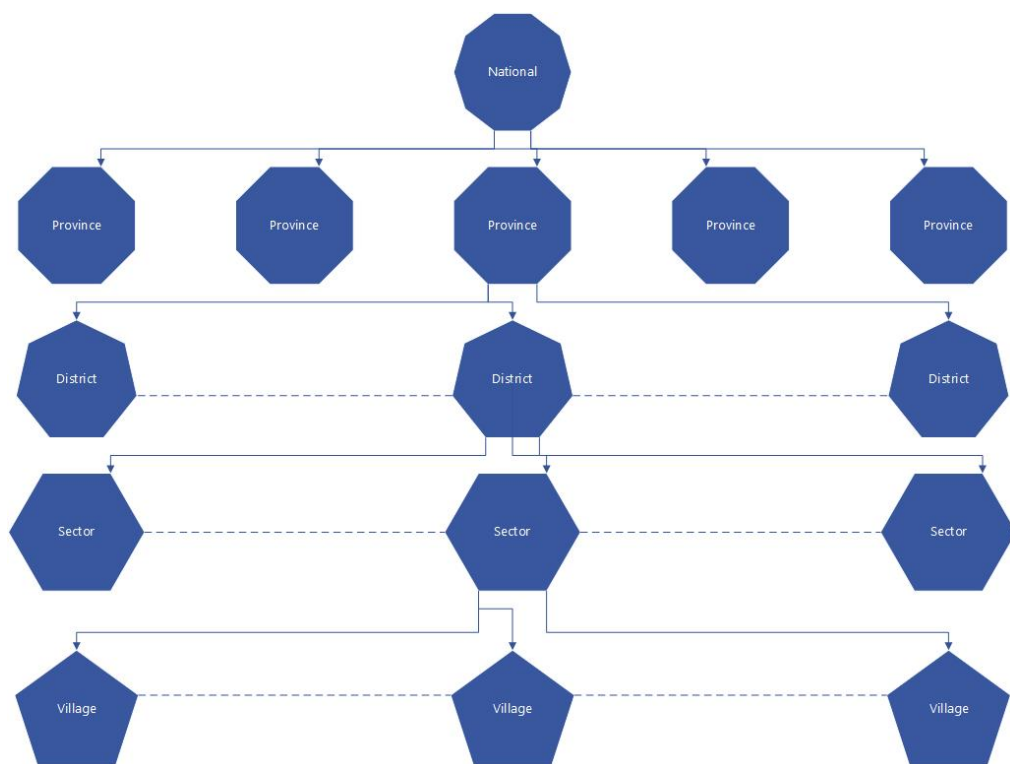
Figure 3.10: Rwandas Administrative Structure

Qualifications	
Read	Willing to volunteer
Write	Honest
20-50 years old	Reliable
Living in the village	Trusted by the community
Elected by the village members	

Table 3.3: CHW Qualifications

3.6 Health Management Information System in Rwanda

The Health Management Information Systems (HMIS) follows the administrative structure in Rwanda very closely.

3.7 Ministry of Health

3.8 Community Health Desk

The Community Help Desk (CHD) is in charge of managing community health activities. This includes planning processes, monitoring, implementing and evaluating.

[18]

3.8.1 Community Health Workers in Rwanda

The community health program started in 1995, endorsed by Ministry of Health (MOH), as a way to bring health care closer to the communities. The program was also a way to address the shortage of health care provider work force. In 1995, the number of CHW's was approximately 12000. Ten years later the number had grown to 45011. In 2013 there were 3 CHW's pr. village which is approximately 45000 CHW's. These are coordinated by the CHD.

Multi disciplinary	Maternal
Integrated community case management	Follow up of pregnant women and newborns
Malnutrition screening	Malnutrition screening
Community-based provision of contraceptives	Community-based provision of contraceptives
Preventive non-communicable disease (NCD)'s	Preventive NCD's
Preventive and behavior change activities	Preventive and behavior change activities
Household visits	Household visits
directly observed treatment (DOT) for TB	

Table 3.4: CHW Tasks

At each village there are 2 women and 1 man having the qualifications listed in table 3.3. The village CHW team has two roles. One man and one woman are multi disciplinary CHW's and the last woman is a maternal health CHW.

Some of their tasks are listed in table 3.4.

[18]

3.9 Cell Coordinators

Above the CHW's at the village level, there are two CHW's who are operating at a cell level with the purpose of strengthening CHW activities. One cell coordinator and one assistant cell coordinator. Their responsibilities are listed in table 3.5.

Cell Coordinator	Assistant Cell Coordinator
Visiting CHW's in order to monitor their activities on a monthly basis.	Monitor if the maternal health CHW has registers and that these registers are filled correctly.
Follow up and verify if CHW's has patient registers, if they are well kept and correctly filled out.	Follow up and see if the maternal health CHW refers pregnant women for Antenatal Care (ANC) visits at the Health Center (HC)
Monitor if drugs are distributed correctly, not expired and well kept.	Follow up and verify if the maternal health CHW has sent RapidSMS reports for pregnant mothers confirmed by health provider.
Compilation of reports of drugs that have been used by CHW in cell and requisition of drugs at health centers.	Verify if the maternal health CHW has Misoprostol drugs and that the drugs are not expired.
Supervision of the household that was recently attended by a CHW.	
Check if the CHW performs post-visit's for the children treated.	
Supervise CHW's on how well s/he is able to sensitize the community on family planning usage.	
Verification of reports brought for compilation if they have been sent by mobile.	

Table 3.5: CHW cell coordinator responsibilities at a cell level

Chapter 4

Research Methodology

4.1 Action Research

[16] [14]

4.2 Diagnosis

The diagnosis in the Action Research model is about identifying the nature of the problem situation, include all interrelated factors, develop a working theory about the situation and how it might be changed.

4.2.1 Situation Report

The CHD at the Ministry of Health would like to make a system that will automatically generate reorder quantities of essential drugs to the CHW. Based on SMS reporting from the CHW's, the system will predict how much of each essential drug that are needed for the next delivery.

Videre følger en fyldig status rapport av situasjonen imens jeg var i diagnose fasen

4.3 Planning

møte, møte, møte

4.4 Intervention

Beskrivelse av hva vi gjorde.

4.4.1 Use Cases

4.4.2 Configuring DHIS2

4.4.3 Algorithm

4.4.4 User Importer

4.4.5 The Essential Predictore

4.5 Evaluation

4.5.1 SMS demo

4.5.2 Algorithm Presentation

4.5.3 Situation Report

4.6 Reflection

Chapter 5

Case

5.1 Background

There has been some interest in the area of SMS reporting from the UiO. The DHIS2 software supporting this functionality has been developed, but not yet been used. The HMIS team at the MOH in Rwanda has for some time been wanting to use DHIS2 in order to make a system for keeping track of CHW's essential drugs and supplies. The system, mmunity Logistics Management Information System), should be able to track CHW's stock and distributions of these items. The HMIS team are actually working for the CHD who are the clients in this case. The current system is primarily a pull system where CHW's make monthly visits to their local HC CHW supervisors in order to resupply.

In order for these CHW's to provide uninterrupted care to their communities, it is essential to have access to the essential drugs and supplies

these health workers dispense.

Rwanda is now in the process of rolling out a national Electronic Logistics Management Information System (E-LMIS) that is supposed to cover all levels of the health system, but this does not include the ≈ 45000CHW's in ≈ 15000villages. This is were the Community Logistics Management Information System comes in. With DHIS2 as a base software CHW's will be able to report data on what they receive and has in stock of the essential drugs and supplies. Further, the plan is to integrate Community Logistics Management Information System with the national E-LMIS in order to have interoperability between systems.

5.2   Networks of Action

As mentioned by Eric, Jørn and Sundeep, one key to make this possible is the network of action. As a student-researcher I've been able to get a position as an intern at Management Sciences for Health (MSH). The core of this initiative is the CHD. They have asked HMIS for support on developing Community Logistics Management Information System. The HMIS team has support from both MSH and HISP.

5.2.1 Description of the different participants here

5.3 Objectives

In order to make the case managable for a research project it was limited to four objectives.

#1: Send SMS and email notifications based on rules.

#2: Send SMS and email reminder if a report is more than 4 days delayed.

#3: If user data does not map correctly user feedback should be provided.

#4: A functional SMS based reporting system.

These objectives are somewhat simplified in order to be easier to work with. A more elaborate description folllows.

5.3.1 Objective #1

Notifications here are meant as in the broadest of meanings. The idea is that the system should be able to communicate with the CHW's based on some configuration. In this case, a notification could mean a resupply order or an alert. Rules would then be related to thresholds or algorithms. For an example, resupply order would be generated by an algorithm that calculates how much of each supply item the CHW needs.

5.3.2 Objective #2

This objective is straight forward. If a CHW in charge of reporting at a village does not report after 4 days of the previous reporting month, a reminder should be sent.

5.3.3 Objective #3

Sometimes when a CHW reports data, syntax error may happen. It is also preferable to have some kind of feedback when everything is just fine. Just to know that everything is working. The appropriate instructions for fixing mistakes should also be in the feedback from the system.

5.3.4 Objective #4

In this case a functional reporting system would be a system that is ready to receive SMS reports from the CHW's. These messages are stored in the Community Logistics Management Information System database ready to be analyzed.

5.4 Refining and Defining the Requirements

As a part of a diagnosis we started out with trying to define usecases for each of the objectives. This would make it more clear what needed to be done in order to meet them. It was very difficult to pinpoint exactly what needed
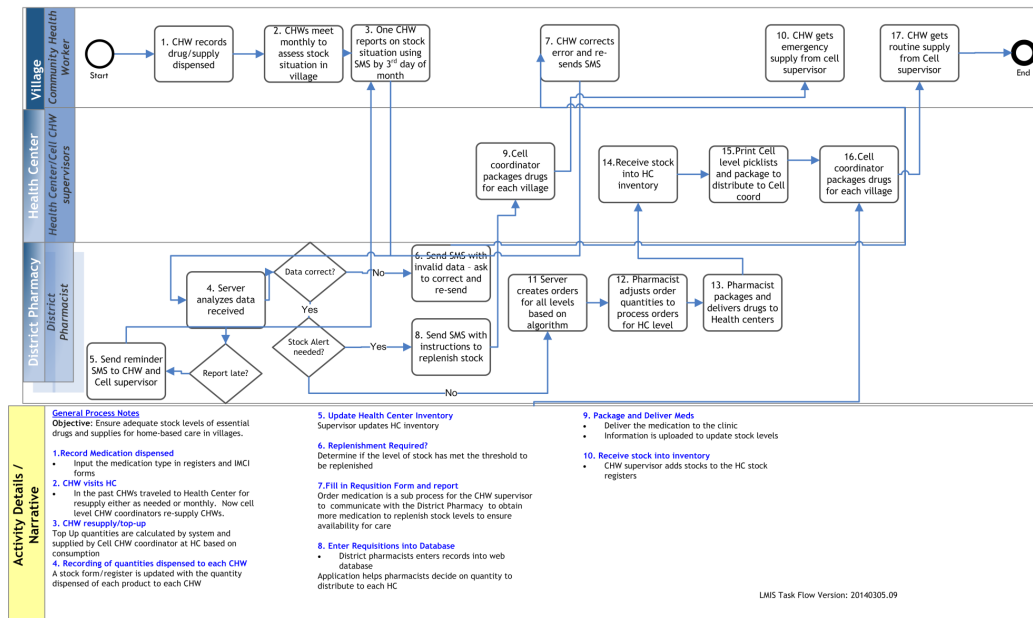
Figure 5.1: CHW Supply Chain in the Future

to be done bacause of the projects size. HMIS was in charge of configuring and develop the system. HMIS was doing this for the CHD, both located in the the same department, MOH. Collecting the requirements would then be based on what we understood from what the CHD could tell us. HMIS had already made some progress on this part.

Figure 5.1 shows the desired Business Process Model (BPM). The specifics did not allways match what had previously been discussed, but the important part was to get an overall picture of how thing should work. For an example we will see that the CHW's would rather report on what they receive instead of what they dispense. Af-

Send SMS and Email Notifications	
Goal:	Create orders
Primary Actor:	System
Secondary Actor:	Cell CHW Supervisor HC CHW Supervisor District Pharmacist
Main Success Scenario:	1. CHW reports distributed and stock values. 2. System processes report. 3. System calculates essential drugs needed for each level. 4. System sends orders to cell, sector and district.
Extensions:	

Table 5.1: Textual Use Case: Send SMS and Email Notifications

ter analyzing the CHW supply chain BPM we found the following. Activity 1, 2, 3, 7 was supported as long as the CHW had a mobile phone. After discussing it with one of CHD's team members, it was fairly safe to assume this. Activity 4 relates directly to objective #4. Activity 6 relates to objective #3. Activity 5 relates to objective #2 and Activity 8 and 11 to objective #1. Activity 9–10, 12–17 should supported as long as the objectives were met. This puts our objectives in context of a bigger picture.

5.4.1 Use Cases

As a seen in use case tables 5.1, 5.2, 5.3 and 5.4, the specifics did change, along with the development process, but it gave us the necessary guidelines to understand

Send SMS and Email Reminders	
Goal:	Send reminder
Primary Actor:	System
Secondary Actor:	CHW Cell CHW Supervisor
Main Success Scenario:	1. CHW misses report deadline. 2. 5 days goes by. 3. System sends reminder by email and SMS. 4. Another 5 days goes by. 5. System sends reminder by email and SMS.
Extensions:	

Table 5.2: Textual Use Case: Send SMS and Email Reminders

Send Report Feedback	
Goal:	Process SMS message
Primary Actor:	System
Secondary Actor:	Community Health Worker
Main Success Scenario:	1. CHW reports data incorrectly by SMS. 2. System receives SMS. 3. SMS triggers feedback message. 4. CHW corrects message and re-sends report. 5. System processes SMS. 6. System updates database.
Extensions:	

Table 5.3: Textual Use Case: Send Report Feedback

Report Using SMS	
Goal:	Update Database
Primary Actor:	Community Health Worker
Secondary Actor:	System
Main Success Scenario:	1. CHW reports stock and distributed values of essential drugs. 2. System receives SMS. 3. System processes SMS. 4. System updates database. 5. System sends confirmation SMS to CHW.
Extensions:	

Table 5.4: Textual Use Case: Report Using SMS

the desired outcome. The obstacles then became somewhat clearer. The CHW's needed a server to communicate with and the server needed to be able to communicate with the CHW supervisors at the different levels in the health hierarchy. The communication channels that should be used between the system and the users would be email and SMS. Email support are possible to setup without involving any other parties, but SMS on the other hand are somewhat tricker. Here we have to include a mobile company in order to proparly test the service. This service also includes using software and hardware outside of the department.

5.5 Planning

With the objectives put in context we could start planning the specific activites for intervention. In our case

Draft work plan for implementation of CHW LMIS on DHIS-2 platform

#	Activity
1	**Design**
	Develop concept paper for CHW LMIS
	Create costed workplan
	Present similar experiences in other countries
	Develop detailed functional equirements for 4 customized used cases
2	**Infrastructure**
	Create new instance of DHIS-2 in NDC cloud
	Finalize contract for VPN connection between MTN and BSC for SMPP transport of SMS messages
	Assign phone shortcode to CHW LMIS
	Configure SMPP gateway in DHIS-2
3	**Phase 1: DHIS-2 configuration and customization**
	Import cell and village hierarchy into the DHIS-2
	Clean up and import all CHWs with phone numbers into DHIS-2 as users
	Create data elements for reporting (on the job training)
	Develop algorithm for estimating resupply amounts
	Design SMS alerts for late stock reports
	Translate SMS feedback messages into Kinyarwanda
	Design SMS alerts for stocklow warnings to Cell and HC CHW coordinators
	Add parameters table for setting minstock, reorderlevel, defaultsupply by drug
	Design triggers to email reports to HC CHW supervisors and District Pharmacy staff
	Workshop to develop reports and dashboards (10 participants CHW desk, selected District/HC)
	Develop picklist reports, stockout reports, consumptions reports for each level
	Develop select maps and graphs for key CHWLMIS indicators
4	**Testing**
	Test sending SMS from nearby community health worker sites
	Test reorder algorithm with 3 months of test data
	Test dashboard
	Test automated transmission of reports via email
5	**Acceptance - presentation at eHealth TWG and sign-off by CHD**
6	**Training and documentation**
	Training of CHW desk data managers in maintenance of system (on the job training)
	DHIS-2 academy for data managers (2 participants x 10 days)
	Printing of plasticised reference cards (1 per village)
	ToT for District CHW supervisors (50 participants x 3 days)
	Training of CHWs - since system is very similar to RapidSMS there should be little learning curve (5000/CHW)
7	**System maintenance**
	Payment for SMS
	Monitoring of reporting completeness (quarterly feedback meetings combined with RapidSMS)
	Server Hosting charges
8	**Phase 2: Interoperability**
	Design interoperability profile with eLMIS - to Upload District Pharmacy/HC level Orders
	Adapt health facility registry synchronization for use with CHW LMIS instance
	Create mechanism to exchange updated CHW information between RapidSMS and CHW LMIS

Figure 5.2: Activity Plan For the CHW LMIS

the HMIS team made the overall plan for the project as in figure 5.2. The objectives then relates to the following points of intervention, take into account that there are dependencies along the different activities.

Objective #1

3.4 Develop algorithm for estimating resupply amounts.

3.7 Design SMS alerts for stocklow warnings to Cell and HC CHW coordinators.

3.8 Add parameters table for setting minstock, re-orderlevel, defaultsupply by drug.

3.9 Design triggers to email reports to HC CHW supervisors and District Pharmacy staff.

Objective #2

3.5 Design SMS alerts for late stock reports.

Objective #3

3.6 Translate SMS feedback messages into Kinyarwanda.

Objective #4

3.1 Import cell and village hierarchy into the DHIS-2.

3.2 Clean up and import all CHWs with phone numbers into DHIS-2 as users.

3.3 Create data elements for reporting (on the job training).

The Community Logistics Management Information System will in its final state run on servers at the National Data Center (NDC). This would then involve another party when trying to configure and develop the Community Logistics Management Information System. Often taken for granted is stable power supply and internet access. In our case, this was not the case. On could experience power cuts on a daily basis. And working directly on a server under these curcumstances is not very productive. Taking this into account we decided to set up a test environment that we could work with. Making our configurations and testing possible instantly before we make the changes on the live server at the NDC. This duplicated our work some, but makes it easier to develop and configure. For an example, one does not need to stop everybody's work if one happens to play with the database to much. Also it makes it easier to divide tasks so that they can run in parallell.

5.6 Intervention

The first thing that needed to be done was to set up the test environment.

5.6.1 Setting up the Test Environment

The test environment was set up using an Android smart phone and a laptop.

Figure 5.3: Figure of SMS-flow
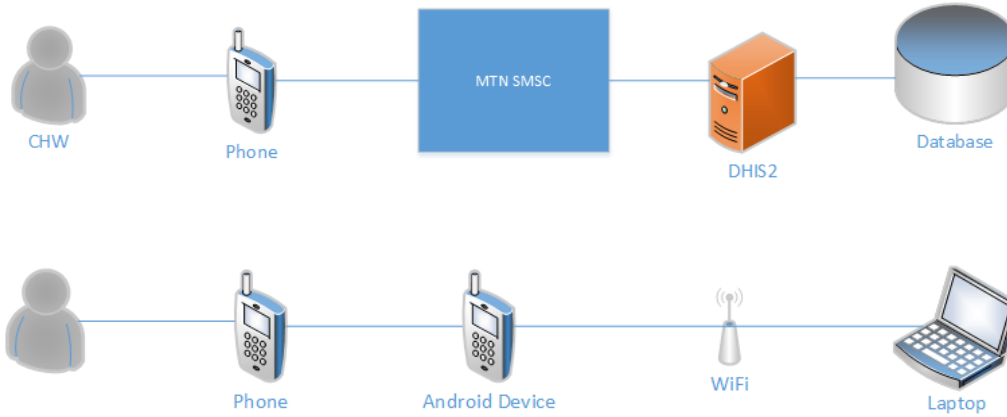
Figure 5.4: Figure of Test Environment

Based on advice from the HISP-team at the UiO we chose to use Short Message Peer to Peer (SMPP) protocol in order to transfer SMS's from the CHW's. In our case, this requires a connection with a Simple Message Service Center (SMSC) at a local mobile operator. Typically the SMS is typed in by the CHW and sent to a telephone number, usually a four digit number. The message is then received at the SMSC where it is forwarded to the server at the receiving end for processing. This is an over simplification, but gets the basic idea across. After processing the server is able to send SMS feedback to the user. In order for us to simulate this at the office space, we chose to use a SMS gateway application running on a Android device. When a SMS with the right code word is received, it forwards the SMS to the server.

Data Element Category Combination	Code
Command	*stk*
amoxicillin_stk_eom	am
condom_stk_eom	cm
injectables_stk_eom	dp
mebandazole_stk_eom	mb
misoprostol_stk_eom	ms
ocp_stk_eom	pp
ors_stk_eom	sr
primo_red_stk_eom	pr
primo_yellow_stk_eom	py
rdt_stk_eom	rd
sureau_stk_eom	se
zinc_stk_eom	zn

Table 5.5: Codes for Drugs and Supplies

5.6.2 Configuring DHIS2

In order to process the reports DHIS2 has to be ready to receive them. This involves creating user accounts with the phone number of the sender, creating data elements and sets that make meaning to the values reported and making the codes for the different supplies and drugs that the CHW reports on.

Table 5.5 shows names and codes for the drugs and supplies in our case. This is data elements for stock at the end of month. A typical scenario would be that a CHW counts each item they have at the village the end of the month. Then creates a text message that is sent to the four digit number provided by the mobile operator. Example message in figure 5.5. In the example message, *stk* is the code word that tells DHIS2 what kind of data
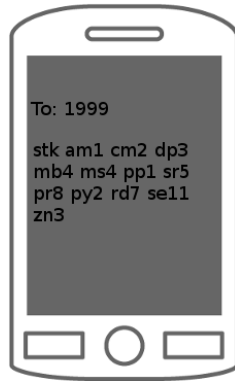
Figure 5.5: Example SMS report

is being reported. The first two letters in the message the maps to the different drugs and supplies in the database with the following value.

5.6.3 Demo 1

After the basic set up we had a short demo for a few members of the HMIS team. This demo showed the most the basic functionality and how we may configure it to fit our requirements. We discussed naming of the different codes and typical issues. One thing was misspelling and user feedback. One thing worth taking note of is that a common spelling error was to type the number '1' instead of the letter 'l' and the number '0' instead of the letter 'o'. We solved this by avoiding the letters in the SMS. Also, we also took note of that many of the users might not be fluid in or even speak English. The local language is 'Kinyarwanda'. An old Buntu language that is very much used even though Rwanda is transitioning to En-

glish. DHIS2 is currently not supporting 'Kinyarwanda'.

5.6.4 Demo 2

5.6.5 Setting up the mobile instance

In parallel with the setting up the test environment we began configuring the DHIS2 in the cloud service provided by NDC. We soon realized that setting up a test environment was worth the time. The NDC is being administrated and operated by another team outside the HMIS team. This caused some delays. Our first goal was to update Ubuntu on our virtual server in the cloud. This took around 6 days from the request was made. Putting this in some perspective. We updated a server during this period. It took about 3 hours. With the test environment in place we could work at our own pace and switch to update the virtual server with pre-tested solutions while work outside our jurisdiction was pending. After updating and setting up the virtual server with DHIS2 collaboration was somewhat easier. Everybody on the HMIS team had their own user accounts on the mobile instace and it became easy to follow our progress as a team. Time spent on configuring was reduced since we already had done it in the test environment. After setting up DHIS2, our progress with the mobile instance, Community Logistics Management Information System, hit the breakes. Reason for this is that the SMPP proto-
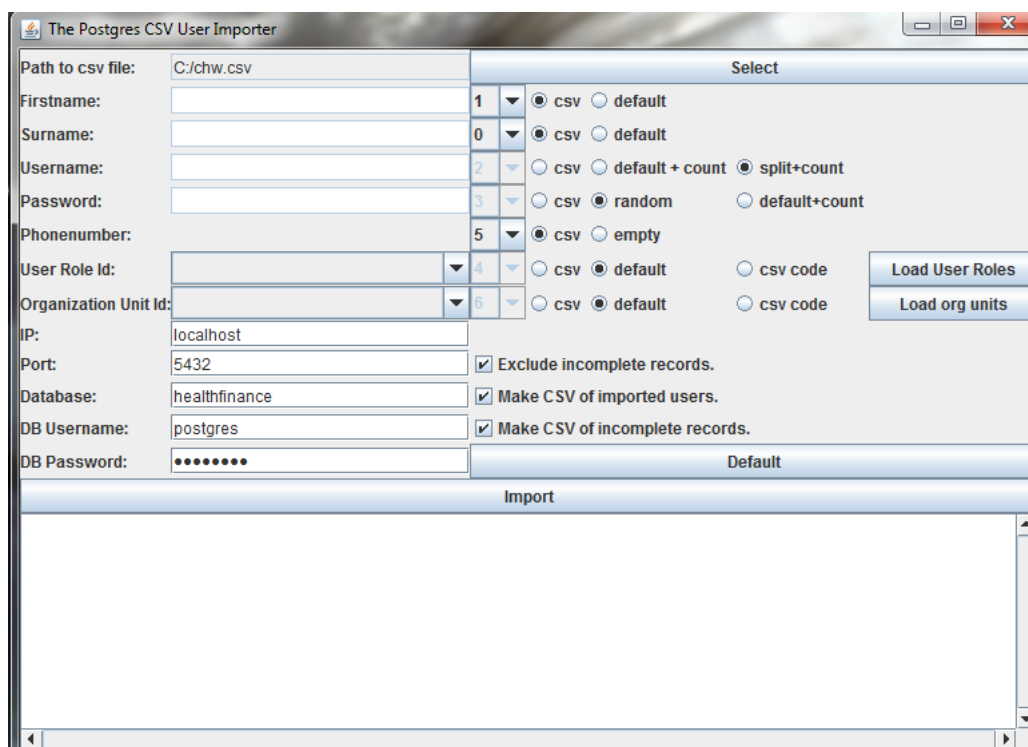
Figure 5.6: Screen Shot of the User Importer

col agreement needed to be signed. There was a disagreement about which department should be responsible for the agreement. As mentioned, the SMPP protocol was very essential to our solution, but this had to be put on hold.

User Importer

With setting up the mobile instance we also had to create the user accounts. The usual way of registering users in the DHIS2 system is for an already registered user to navigate to the create user frame and input the information field by field. Firstname, surname, username, phone

number, password and organization unit. With ≈ 45000 users spread throughout all of Rwanda, this would clearly be a time consuming task. Fortunately we had a list of most of the CHW's currently working in Rwanda. This list included all the required fields except username and password. We therefore chose to develop a small java application that could create the user accounts in the database. This application takes a .csv file as input were each row represents a CHW. The application generates a username based on their names and a random password for each CHW. After running the application, each CHW has a user account. There are some issues with doing it this way, like not involving the users in the process of registration. This might lead to users being registered and even don't know that the system exists and further leading to the system not being accepted. After the user is registered, the system are then able to recevie SMS reports from those users.

5.6.6   Re-Supply Algorithm

The main purpose of the Community Logistics Management Information System is of course to facilitate the process of delivering supplies and drugs to the individual CHW. Stock outs in this case is especially critical! Making sure that supplies are given at the right place at the right time requires a information system. In this case we want to have the information system estimate how

much each village needs based on their consumption on a monthly basis.

$$stk_n = stk_{n-1} + rcd_n - disp_n \qquad (5.1)$$

In equation 5.1 we have the basic formula. How much a village have of an item at the end of month 'n' is what they had from last month, plus what they have received during month 'n', minus what they have dispensed the same month.

By reporting stk_n each month we are able to choose between either reporting the quantity of received or dispensed. By reporting what is received, when received, it is easier to track the items.

$$
\begin{aligned}
reorder_n &= (amc_n \cdot 2) - stk_n & (5.2) \\
amc_n &= \frac{disp_{n-2} + disp_{n-1} + disp_n}{3} & (5.3) \\
disp_n &= stk_{n-1} + rcd_n - stk_n & (5.4) \\
disp_{n-1} &= stk_{n-2} + rcd_{n-1} - stk_{n-1} & (5.5) \\
disp_{n-2} &= stk_{n-3} + rcd_{n-2} - stk_{n-2} & (5.6)
\end{aligned}
$$

Using this formula we are able to calculate both how much should be reordered and the average monthly consumption.

reorder$_n$ This variable represents the quantity of how much is needed at the next re-supply of one village.

n in this case represents the last month. If in May, it represents reorder quantity for the end of month of April.

amc$_n$ Represents the average monthly consumption based on the last 3 months in one village. I in May, that would be the average monthly consumption based on February, March and April.

disp$_n$ This variable is calculated based on the the values reported and is the number of items distributed by one village during one month.

stk$_n$ The quantity in stock at the end of the month of one village. Usually reported within 1–5 days into the next month it represents. Stock in April is usually reported between 1st and 5th of May.

rcd$_n$ This variable is the sum of items received in one village during the month it represents. If a CHW receives 10 condoms 2nd of April, it should be reported the same day. If a village receives another 10 condoms the 13th of April, that should also be reported the same day it is received. rcd_n for April would then be the sum of those values, 20.

$$rcd_n = \sum_{k=1}^{j} rcd_{n,k} \qquad (5.7)$$

.
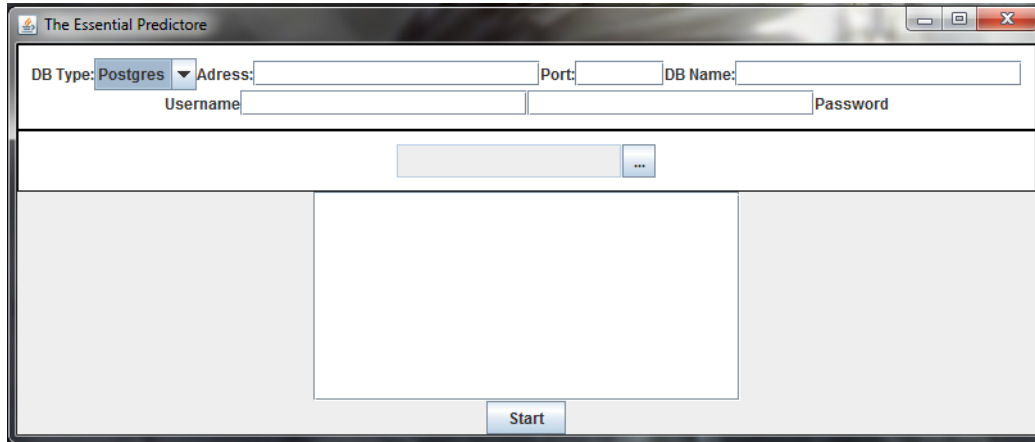
Figure 5.7: Screen Shot of the Essential Predictore

A more mathematical description in equation 5.7, where j represents the number of days in the month.

The Essential Predictore

Based on the reorder algorithm we decided to make an application that would automatically calculate both amc_n, $reorder_n$ and make them available in DHIS2. This application was partly programmed in POSTGRESQL, then wrapped in JAVA. As seen in figure 5.7, the applications takes as input the database information and a date. The application then calculates the values needed to update the tables in the DHIS2 database. DHIS2 has with the release after 2.15 made it possible to integrate DHIS2 specific applications. If there is going to be a next version of the application it's decided that this will be an integrated application rather than a stand-alone JAVA application.

5.7   Demo 3

5.8   Case Summary

5.9   East Africa

5.10   DHIS2 Academy

Chapter 6

Discussion

6.1 Evaluation

In terms of meeting the objectives described in 5.3 there
are still some work to do. In the time frame of this case we
did not manage to make a system that was operable in a
real scenario. This was largely due to delays in the system
of bureaucracy. It cannot be stated clearly enough how
this effects the development cycle of this project. This
system has been planned for a long time. The first time
we initiated the request for the SMPP protocol was at
least 4 months prior to this particular case study. Adding
2 months during the case study we end up at 6 months
of waiting. I will not go into details about the political
decision making, but in order to explain why the project
was mainly realized in a test environment is because of
one signature that never made it to the paper. Because
of this fact, I will continue to evaluate the project based
on what we where able to realize in the test environment.

6.1.1 Objectives

The first objective (see 5.3) was clearly over simplified in the beginning. DHIS2 supports both sending notifications based on rules. The main problem was to generate the values the rules should use as thresholds autocratically. So the objective should rather have stated that we should be able to integrate a customized algorithm that could use data from DHIS2 as input. The output should then be available in DHIS2 for presentation and further use. With "The Essential Predictore" we were able to do just this. The plan was to then use DHIS2 to send notifications based on a functionality called validation rules. We did not have the time to figure out if this was possible, but was told by the support team that it was very likely.

The second objective (section 5.3) was to send a reminder if a SMS report was late. Our initial idea was to use the validation rules in order to check if the report was sent. Like the first objective, we did not get the time to work on the validation rules and therefore were not able to implement this functionality.

The third and fourth objectives (section 5.3 5.3) were realized in DHIS2. After configuring DHIS2 we were able to both send and receive SMS in the test environment. This functionality was also presented to the CHD.

In terms of success and failure as discussed in 2.1.2

we can categorize the objectives. Assuming that the test environment is suitable to simulate reality, we have; Objectve 1 classified as partial failure. We did not meet the main objective, but did clear out much of the work in order to meet the objective in the future; Objective 2 was total failure. We did not meet the main objective in the time frame set for the case; Objective 3 and 4 could be classified as a success. The main objectives were met, although only in the test environment.

6.2 Reflection

The HMIS team had not only Community Logistics Management Information System to consider during the case study. Several projects including data quality, malaria, moving servers to the national cloud were running alongside the Community Logistics Management Information System-project. This resulted in divided attention of the team. Having a positive impact on the collective productivity, the divided attention also results in having to continually update team members. As a result, more meetings are needed and more presentations and more time spent.

6.2.1 Language

Language barriers are common when collaborating across borders. But in this study we found that there are also

symbol barriers. Common misspellings were between the symbol for the letter 'l' and the number '1'. Also, between the letter 'o' and number '0'. These were pitfalls easy to avoid, but hard to take notice of. This was mainly resulted by the lack of schooling of the CHW's. In Rwanda there are currently three languages being spoken. English, French and Kinyarwanda. English is the working language, but both one cannot take for granted that everybody speaks it. This makes automatic feedback an issue. Developers may not be aware that the official spoken language is are not spoken by all inhabitants. DHIS2 has taken some actions to make all their messages customizable and support for customized feedback messages are just around the corner.

6.2.2 Programming

I took notice of the convenience of being able to program the software that we used. DHIS2 is an open source software with frameworks based on JAVA. Being able to customize DHIS2 on this level is essential to meet the clients and users needs. For now HISP has a developer team located in Oslo that is supporting the users requirements. DHIS2 is active in over forty countries. Clearly some local customization is in order. I would propose that every team that are using DHIS2 had some employee that are able make DHIS2 applications.

6.2.3 Power supply and Internet

Often taken for granted in the developed countries are stable internet and power supply. Every other day one could experience power cuts that lasted between 5 and 10 minutes. While not being a critical issue in these short terms, it did affect the productivity. Routers rebooting and interconnections resulting in downtime on servers are not easy to work with.

6.2.4 Creative Use of DHIS2

DHIS2 is developed to be used a certain way. All data should be located in the same database basicly being manipulated through the user interface. Our solutions to our problems did in some way circumvent this. By connecting directly to the database we were able to implement the algorithm and create bulk users. This may create some issues in the future. Like when creating bulk users, the CHW's are not being part of the process. This may lead to unwanted outcomes on bigger perspective. The DHIS2 protocol for doing this is that someone in charge will register users in their area of responsibility. By bypassing the user involvement we are loosing the HISP characteristic of social-embeddednes.

Another example of creative use of DHIS2 is that instead of using one database several are used for different topics. Then, in order to have interoperability between

instances, certain dataelements are transferred between the servers.

6.3 Rwandas ICT Transformation

The government of Rwanda has lately been wanting to become a knowledge based economy. This means that they want to trade knowledge for other kind of resources. The topic of interest is ICT's. In section 2.1.1 we talked about how ICT could be categorized into three different discourses of seeing Information Technology (IT)-innovations. The Rwandans perspective clearly have some similarities with the third discourse, *transformative ISDC*. Since Rwanda mainly exports coffee and tea there will be some significant changes in the way the country is both social and economical. With the goal of becoming the IT capital of Africa raises issues including social, political and economic issues. There are about 90% of the population that works in the agricultural sector where their main export are tea and coffee. Switching from agricultural to an ICT based economy will call for a large scale deep socioeconomic change.

Into this vision of Rwanda becoming a ICT/knowledge based economy, HISP fits right in. HISP's view of IT innovation is more like the social embeddedness discourse. Since these two discourses are much alike they also can co-exist. While the government is focusing the the socio-

69

economic process the country needs to go through, it makes room for organizations like HISP to focus on the social-embeddedness of ICT innovations.

[15] [5]

6.4   ICT to Facilitate Health Services

The motivation for ICT's in health systems are to take advantage of the possibility to increase efficiency, scale up treatment and improve patient outcome. In a LMIS context the primary objective would be to reduce errors and increase efficiency. Studies have shown that a reduction in errors Pharmacy Information Systems when using information systems.

[3]

Chapter 7

Conclusions

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Appendix A

Requirements Document

A.1   The real deal is somewhere else!

A.2   Context

This requirements document is for setting up a environment for a SMS based reporting system with the DHIS2. The system should be able to support these four use cases.

1. The users will be able to receive automated SMS and email notifications based on rules that compare database values.

2. The users will be able to receive an automated reminder if a report is more than 4 days delayed.

3. The users will be provided with a predefined format for reporting.

4. If the user reports values that does not get processed, then he/she will receive a notification of what has

happened and directions for necessary steps in order to complete the report.

A.3 Setting up Testing Environment

A.3.1 Testing without phone

Operating System

Tomcat

DHIS2

The hierarchy has to be at a village level. This is the level we want to be reporting on.

Postgres

Dataelements

When creating data elements we store the zero values.

Testing Script

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http://localhost:8080/dhis2/sms/testSMS.action

A.4 The Rights of The Participants

A.4.1 Not to participate

A.4.2 To withdraw

A.4.3 To give informed consent

A.4.4 To anonymity

A.4.5 To confidentiality

Appendix B

Interviews

B.1 Diagnosis

B.1.1 Randy

B.1.2 Andrew

B.1.3 Venuste

Appendix C

Journal

C.1 Day 1

C.1.1 Breakfast

Missed on the time here today. Wrong time zone. I thought the devices configured themselves, so I just trusted the watch. Randy missed a part of his meeting because of that. Very embarrassing.

C.1.2 MSH Office

Got the first tasks. Should refine and define the requirements. I don't see any problems just yet. A little unclear just who are the ones involved. There are two guys, Patrick and Eric that i should meet with. Both working with logistics I think, at least in stock management. Haven't heard anything on the the SMPP protocol other than it should be there.

C.2   Day 2

C.2.1   New Office

Today we have a population count problem in DHIS2. I would try to make a postgres query to check our implementation of DHIS2. Got a temporary seat. Gloria is out in the field. Gloria is probably checking if the data is correct. I am now at the HMIS's new office. Met, Venus again, Andrew, Adolph, Erick, Olive'something, and another. Got to get better on those names. I think I'm a little further up the road from the old offices :).

C.2.2   Beginning to collect the requirements

It seems like the solutions should in some way be more effective. I've been introduced to several people here.

Names	Institution	Phone	
Deogratias Leopold	ISI - SC4CCM	0788486509	
Wane Olivier	IMOH/MCH/CHD	0788358649	oli
Erick Gaju	MoH/Ehealth	0788517168	ge
Mike Misengo	MoH/CHD	0788482804	mike
Venuste Nsanzumuhire	MoH/HMIS	0788606639	venuste.n

C.3 Day 3

C.3.1 Morning at the office

I am still trying to figure out the requirements or wishes of HMIS. Apparently there is not very much structure. No development cycle. No requirements document. Randy proposed that we need to be able to implement an algorithm. But there is still no sign of the famous algorithm. They don't know what they want I think.

C.3.2 Testing

I think we could start setting up the test environment and show what is possible so that they can see the opportunities.

C.3.3 Setting up the test environment with sms

This first time we will try with the SMS function in DHIS2. We've encountered a bug in 2.12 after setting up the data elements. The elements are there and connected to a data set. While trying to browse the data elements it never stops loading. Tried clearing cache, switch browser, update resource tables. We will try to update the local version to new one, then start over. Unfortunately I were told that we are the support, so I hope the HISP team in Oslo can help.

C.3.4 Tasks

I've got 2 tasks.

- Make the requirements document for the system that is being made.

- Make the testing environment.

C.3.5 End of the day

Try one more time to set up the test environment for tomorrow. The requirements document should be set up by 15th of March.

Got the backup from Randy and have to remember to run the analytic.

C.4 Day 4

C.4.1 Morning

The driver was about 20 minutes late. My goal was to be at the offfice by 08:00. Maybe I should arrange for some other transportation arrangements.

C.4.2 Before lunch

Will continue with trying to set up the testing environment and defining the requirements. I have a new database instance and a new database. If this works, everybody can probably learn how to do this locally, so that

testing can get done much faster. Venuste and I should be able to set up the same system. We did not manage to set up the database. Got several error messages. "psql:healthfinance2014.sql:3450210: ERROR: role "hf-readonly" does not exist"

C.4.3 After lunch

I am still waiting for Randy to arrive so that he can describe the algorithm to Ola. I am really just sitting here doing nothing.

C.4.4 end of work day

I think we've had a very productive day. We've got a description of the algorithm and are trying to set up the testing environment. Tomorrow I will continue setting up a local instance of DHIS2 with Venuste.

C.5 Day 5

C.5.1 Before lunch

Forgot my charger today. We are still trying to set up a local instance. First we had to reinstall a new operating system on Venustes computer. Now we are trying to install postgres so that we can install the database. Venuste proposed that we do not install a DHIS2 instance on all of the computers.

C.6 Day 6

C.6.1 Getting TV

We went to the city to acquire a tv subscription. Patricia knows a guy. We got it for 60k a month.

C.6.2 Market

We shopped at Namukat. Probably the best place for getting supplies here in Kigali. Bought bread from a different store some reason.

C.6.3 Hash

To of the girls got their names today. One is called bend, the other over. It was the international womens day, so one old lady did not like the names. We met at Chez Lando and started running from the facebook pub.

C.6.4 Casino

I got to drunk. I got this note from this girl, Kayli. She is saying she wants to meet. I started out thinking it was not such a good idea, but later I got curios. Was afraid she might set up a kidnapping or something. She is a little bit religious I think.

C.7   Day 7

C.7.1   Waking up

Got up around 10:00 today. Did nothing but some texting with Kayli.

C.7.2   Night time

I should remember to bring along Venustes charger tomorrow. It's in my backpack already. It would be good to continue some on my thesis. Aiming for delivery before 1. July so that I can focus on my other courses.

Would be just perfect if I got finished this summer.

C.8   Day 8

C.8.1   Morning at the office

Should be able to set up a local instance today. It seems like it takes up much time to set up here. I've been here for a week and still I am not able run a local instance.

Installing the software is somewhat difficult. Today I am getting this up and running. Documentation should be better and easier.

I have not yet received a permanent seat to work at.

Gloria said that the data quality was so so.

Set up the testing for mobile reporting. It works, but I cant figure out how I set the received date.

C.9 Day 9

C.9.1 Before lunch

Continued to add to the requirements document. I now have a 10 page document using Fowlers UML Distilled.

C.9.2 After lunch

Trying to get to the core of the requirements so that we can propose a solution based on around DHIS2. Got some feedback from Eric today. It is important to take note that the difference between 0 and o and basic knowledge of Linux. We agreed on first setting up a local test environment. Then suddenly we started to set up a virtual server. I don't get an overview of the situation.

C.10 Day 10

C.10.1 Morning at the MoH/HMIS

Today I will continue finishing the requirements document. The en result should be something enumerated list with all the specifics. Sent a draft of the requirements to all the people that wanted to know what is going on.

I think there will be some positive feedback.

I don't really know what I am about to gather data about just yet. So any data generation methods are not appropriate yet.

C.11 Day 11

C.11.1 Morning

Heard that we've got the signature for the SMPP pro-
tocal last night. Eric advised me to take notice of that
basic knowledge and the difference between '0' and 'o',
'1' and 'l' are important. It seems like touch is neither
used. Wich is the most basic thing in computers. There
is alot that is not mentioned in the docuementation in
DHIS2. Like how we should go about installing on a Win-
dows machine. This might be a reason why this is not as
widespread as it should be. A little note for reasearch is
that communication is not the way I am used to. I am
sitting very much alone without being very involved in
what everyone else is doing. I think I am in the loop, but
it seems like everyone is working on separete things and
just reporting to each other. I don't know why, but we
are still missing that signature that allows us to use the
SMPP protocol.

C.12 Day 12

The virtual server needs to be updated with the new
Ubuntu. Unfortunately this has taken about 2 days I
think. Don't know what the hold-up is.

C.12.1 CHW supply chain meeting

Today I probably holding a demo showing the use case 3 and 4. Next week I will focus my attention on use case 1 and 2. If everything goes after plan, we should have everything ready in about 2 weeks. I think there was a discussion around JSI which is a system like DHIS2. I don't know if this system is already in use or not.

C.13 Day 13

We climbed Visoke this day and I had some good sex. Borah is like very open about sex. I get a boner just thinking about her. Love it. She was like, "take it baby, take it". Just awsome. It's like she's giving something away. I really don't understand why, but that's the way she sees it. Probably the way all girls sees it. The more I try to define it the more difficult it gets. So, we boys are apparently trying to take the girls vagina.

That is what they are thinking. We are trying to get it. I am thinking that girls should give it if they want to. I don't want be with them if they don't really want to. It not like it is a competition of trying to get something. It's enjoying the time we spend together. Sex is definitely a part of that.

C.14 Day 14

Me and Borah took a little longer than expected yesterday. I love being with her, but she spends a lot of money. For me here it's still a lot. And she like says that I should give my money away. Money in that direction is gone, no matter how much I spend. Still, I like her. Maybe I'll see her later today. We first took a cab from the hotel, don't remember it's name. Then we took the bus from wherever we where back to Kigali. The mountain we climbed was called Visoke. It is near where Dian Fossey made the documentary of the Silverbacks. We actually stayed at the same spot as she did, the hotel was the same and it was possible to rent her room.

C.15 Day 15

Alright. Everyday frustrations. Internet is not working. Apparently it should take 30 minutes to update flash player. The driver was only 30 minutes late today. That is hes only job. Drive from A to B. He also took a detour so that we could spend some more time driving. My phone is not working as I paid for. Now I am using airtime in order to be connected to the internet. This was before work. Now, at work things don't run. Like the VISA, I told Felix that I did not have a VISA for my whole stay, why is it necessary for me to say that he

should fix it? It is like people don't listen. That is the essence of why things don't go the way it should. I also had to buy coffee in order to get some. Thing is. I don't think people understand if they are not able to provide for coffee, how can they really be trusted to provide a information system covering the entire nation. And we need working chairs as well as working internet. The problem is obvious, yet nobody is doing anything about it. Stable power is still an issue if one wants everyday life to go around the way we want and that affects work. One cannot separate work from everything else.

C.15.1 Before Lunch

I've got some tasks that should be accomplished.

- Import the users in the excel file.

- Make the hierarchy so that it has 8 levels instead of 6.

Apparently it is not easy to get a the address of the MSH offices. Let's take the time. 10:40. 10:50.

Alright. Now it is not possible to take advantage of technology if one does not get replies. Google maps is almost not responding. It takes forever to sync my google drive.

Internet is the building blocks of network, if this is not working then everything else will not work. The signature

for the SMPP protocol is still missing. And the virtual server is not running. The guys at the National Data Center is still trying to update from some Ubuntu version to the latest. Lunch in 2 minutes.

C.15.2 After Lunch

Today I will deliver my passport to Felix so that he can extend my VISA. Then I have to change my airplane tickets so that I can go home. Looking forward to it actually.

Also I have to see what is wrong with my internet at MTN.

C.16 Day 16

Allright. I'm a little puzzled by the update at the national data center. Still there is no real reason for why this is happening. Also, the requirements should clearly be stated in some computer language like UML. I came here with the impression that what was actually needed was described in UML or the like. Fortunately there were some description of what is happening, but very little. Proper documentation is obviously a key piece in order to get an overview of things. UML FTW! My bad, the virtual server is now up and running. It is a little unclear if the users are actually the HMIS or the CHW. We'll see.

I should mention in my report the process of defining the requirements.

It is a lot of noise here from the outside.

C.16.1   After lunch

I will install Ubuntu on Edith's computer later. It seems like she wants to learn, which is positive. I have to restore my database so that we can find out what exactly is the motherfucking fuckup that is happening. In order to use this database I need a user I think. Maybe I can change the user password by accessing the database and give the right user rights. Probably. Eric is making the letter so that we have confirmation from the university.

I was told before I left that the whole team is in on this. But we have not yet had a meeting for how we will proceed. This is exhausting. And my driver is driving me crazy.

C.17   Day 17

C.17.1   Morning

Went out with Borah yesterday. It was nice, she said something about me not getting attached to things or persons. She said I did not miss her, but that is not true. I do miss her when she is not there. It bothers me that she is to busy for me. Allright. I will try to

make a database restore today. Would be nice to have a working instance. Then I should be able to import the users. I don't think they know about hash functions here. It should be noticed that DHIS2 is not being used as intended. Taking shortcuts like importing users into the database makes the users of the system not involved in the process. Venuste said that some of CHW's did not have the chance to go to school. If we take the shortcut, users will not be involved and we'll miss this oppertunity. The best way to go is to involve all users in the process. This is what is needed. I think I know the problem now. DHIS2 is not being used as intended. Therefore it does not work as it should. Take the databases from last year. Four instances of the program for some reason. This is why the problems are appearing.

It would be beneficial if the team had a specialist on databases. It is weird that all work could be stopped just cause one person is gone.

C.17.2   After lunch

I don't know what Randy's plan is, but I assume that after importing the users, we will have the data managers reset the password. Alright, job well done. Got the users imported, I assume that it will be no problem doing ut again. I will show Venuste how we import the users using postgres in a little while.

C.17.3   Back home

Seriously, people at work just does not know what they are doing. No buts, no explanation. If one is about to use a database called postgres. One should know what it is and how it works. The overall database design is a good thing to understand, but really. Being able to manipulate it and use it is the are a must.

I think now I understand.

C.18   Day 18

C.18.1   Morning

I maybe think I am a little hard to please. To much complaining I think. Today I will probably teach Venuste how to use postgres.

C.18.2   Importing Users with Postgres

This did not happen as it supposed to. We agreed that we should meet at 09:00AM, but apperantly there was another meeting that was more important to Venuste. No point in setting time if one just books over anyway.

C.18.3   Generating passwords

In order to generate passwords we need to have access to an algorithm. This is touching on some security issues

I think. I understand why it is this way. The security should be better i believe. Alright. The password should be contain 8 characters, one capital letter and a number.

C.18.4 Made the Password App

My first executable java program :) password_encoder! That is awsome :)

C.19 Day 19

Today I will find a way to import all the users into the database. A finished solution if you will.

C.19.1 Before lunch

Seems like we will start at the project next week. In the mean time I will get this application started so that we can just import all the users.

I am very unsure on the technical level here.

C.20 Day 20

C.20.1 Going to the mall

Alright, this saturday I was at the mall with Borah. I got a little to much to drink, but it was okay I think. Chelsea won over Arsenal and Liverpool won over Cardiff. Good weekend. Also went back to Sundowner and some grill.

C.21 Day 21

This sunday was tiresome. Did almost nothing. I should learn that I am useless after drinking. I will not do anything. The sex with Borah was awsome, but I want to spend some time with her not in the room. It would be better to like rent a room or something.

C.21.1 Havanna

We ate at the pizza place again. Four seasons was actually perfect. Watched some tv and went to bed. Patricia got some visitor last night. Maybe she is seeing someone :)

C.22 Day 22

Been here for over three weeks now. I do want something to show for. I will make the importer so that it will be easy for everybody to do this for themselves. Will try to extend my VISA today as well.

C.22.1 Before lunch

Really quiet at the office. Will continue to work at the application.

C.23 Day 23

C.23.1 In the AM

Alright, just broke off with Borah. Seemed to me like she had some other motives. Quite convincing though. I really like her though. Today I think I am going to continue on my application so that it will work with the GUI. What else. I need to fix those requirements. Use case 3 and 4 is done. 2, the reminder, I can do through java. 1, the report should also be done through java if necessary. And the product the user importer, for the MSH.

C.23.2 DHIS2 interoperability MEMMS

C.23.3 Proposed meeting

We will try to nail down the requirements tomorrow. Maybe we need some other input as well.

C.24 Day 24

C.24.1 Good Morning

Alright, back in black. My ex had her birthday, tried to let that one just slide. My other, soon to be 'ex' had a no show yesterday, tried to let that one slide as well. She is wierd by the way. Funny, I was called that yesterday. Tomorrow there is going to be a demo. I think the following

agenda is to be userd.

1. Make the data elements

2. Make the data set

3. Assign the set to organization unit on the same level as user

4. Add as a mobile data set

5. Add the command

6. Edit the command

7. Make the service

8. Start the service

9. Open the */sms/testSMS.action and test in data entry

10. Check data entry

11. Try to send one from mobile and test in data entry

12. Check data entry

C.25 Day 25

Allright, seems like I've been living in Africa for a while. Still typing allright wrong. I'll change it, alright. There we go. So, back to the task at hand. After next week we are going to set up the DHIS2 instance. I should probably

make a painting here of the guys that are in on this, but I wont just yet. To lazy to make a drawing. Now that I think about it, I want to draw on the computer. Then again, then I will not draw on paper. Kinda don't like that paper is going out. That would then be my hobby.

C.25.1 VISA

It is actually causing some stress for me that the VISA is not ready yet. Don't really care what happens, it is just that it is not very usefull to not know where I am going to be for the next week. Specifying a country would actually make things a lot better.

C.25.2 For my masters

I really don't know what I will write about. Thing is, there is not very much interesting that is worth mentioning. I should send my supervisor an email. Allright, damn, wrong again, alright. Sending the email. Have no internet, so I will not send the email. Can't really do much then, so I'll make some coffee and wait for Borah!

Txt you later journal.

Kenneth

PS: This is my typing program. Which means, finally I don't have to look for anything else.

!!!

C.26 Day 26

Today is going to be a short day. A trip to the forest.
Nyonge I think it is.

C.26.1 Email brief

No problem, hi Yusuf :)

We are trying to make a sms based reporting system that will collect data from about 45,000 community health workers.

The data that we collect are stock and distribution values of 12 essential drugs. Initially it was 10, but some where added later. This can be a problem since a sms message only contains 160 characters, but we will look into that later.

We have first tested with a local instance that receives sms messages with the "*/sms/testSMS.action" script. After getting this to work with some test data we moved on to test with the sms gateway android application. This was very usefull. We could send messages to the phone with our own numbers and see the data going into the system. This also allowed us to have a demo for the 'clients' were we sent some reports..

We are still waiting for a signature in order to test for real (with a SMPP gateway), but we are moving forward by using the android application, a server at the national datacenter and maybe a test village just outside Kigali.

We will be able to report by SMS on Friday next week which is 1 of 4 use cases/requirements. The next one we will work on is getting feedback after reporting. This is a built in functionality in DHIS2, but I have not yet tested if it works properly. After that we want to send out reminders if reports are late, by SMS and Email, and finally produce some reports based on the reported data.

C.27 Day 27

The previous Saturday was awesome. Early mortning, rise and shine at 4AM. The hotel was perfect, the events were perfect. Nothing to complain about.

C.27.1 Chimps

First me and Judith went to see the chimps. It was alright. Very funny when the chimps started to scream and run around.

C.27.2 Kanalope walk

We walked over some bridge that hang in the air. This was probably the coolest thing to this date!

C.27.3 Dinner

Perfect dinner, a little wierd. I think I was tired. It's strange, I don't feel it myself. I can like analyze it later

that it could be that. But I don't want to excuse myself for being the way I am. It's like people are looking for a reason to explain why I am the way I am. For real, I would rather just stay quiet than succumb to this.

C.28 Day 28

C.28.1 Breakfast

Slept almost as long as I wished. I were kind of in a hurry because Judith called and asked were I was. So I were in a hurry. Didn't like that to much, disappointed in myself in a way.

C.28.2 Car drive

On out way home we had alot of fun. Singing, joking and in a way just having alot of fun :)

C.28.3 Museum in the old capital

This is were the king used to live and the city of Rayon Sports, my team in Rwanda. This were the old capital.

C.28.4 Meeting Borah

Met with Borah for dinner again. It was very nice. Talked a little, she asked if I fucked or kissed anybody, was kind of fun :) Probably since I didn't.

C.28.5 Sunburn

Got a severe sunburn on this trip, holy moly. Alright, let's get back to work.

C.29 Day 29

C.29.1 Good morning

I am working on getting a average consumption by month. Not really getting a instant gratification from DHIS2. This is what we are trying to achieve.

C.29.2 Just got lunch

This is beyond stupid. I've just realized that being here is almost a total waste of time. There is no collaboration here. Just a bunch of people meeting from time to time. I don't feel like being part of a team here. Anyways, I will try to make the last 3 months from the web api. This must be the least user friendly shit I've seen in a long time. Returns nothing, that's its strength. What the fuck is going on here?

C.30 Day 30

C.30.1 Good morning

Today is the meeting with Mike. Should design the codes and text for the Mobile Instance.

C.30.2 After lunch

Ok, we are on route I think. Only thing missing now is the alerts. I refer to the use cases. Randy has skills in the query department.

C.30.3 Closing

There is no culture for keeping appointments I think. Had a no show this morning and a no show later this day. This is not very likely to ensure future collaboration I think. I think it is disrespectful and don't understand the need to waste time. Think I will just say goodbye to any expectation I have from anybody. At least not worry about it anymore. Fuck it, don't care. Hasta La Vista, Baby!

C.31 Day 31

C.32 Day 32

C.32.1 Meeting with the clients

I've got to know the clients yesterday. I was also very tired today for some reason. I basicly explained everything about the solution for Mike, Jean and Louis. After explaining how shit works, we created some data elements, data sets, mobile sets and started the SMS service. Everything went relatively fine. Tried out a test

SMS also. Got some wierd questions that made some-
what frustrated. The level here is not that good, but the
that is not the problem. The problem is that some people
think they know what they are doing, but in reality they
don't. People that know that they can't is easy to teach,
but it's harder to teach them who think they already un-
derstand. After this session I ate lunch and went home to
sleep. I should mention that some people don't get that
using custom made software might not work with future
updates of DHIS2. This may be a problem. I should
start collecting data as well as finishing the application.

C.33   Day 33

Today was very productive. Got confirmation that the
translation of SMS messages will be possible 2.15. Worked
a lot on the java application so that importing users will
be easy next week. Got internet today, that's nice.

C.33.1   Movie

Going to the movies today. Watching Captain America
2. I think it will be fun.