Interoperatability in Health Information Systems

Report

Specialization Project

TDT4501

Kenneth Børtveit

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Contents

List of Figures

List of Tables

Nomenclature

DHIS	District Health Information System
DHIS2	District Health Information System 2
etc	Et cetera
GIS	Graphical Information System
HISP	Health Information System Programme
HMIS	Health Management Information System
ICT	Information and Communication Technology
OS's	Operating Systems
PBF	Performance Based Financing
SMPP	Simple Message Pear-to-Pear
SMS	Simple Message Service

Abstract

Chapter 1

Introduction

1.1 Research Questions

What kind of tools and method of approach is necessary for optimeizing interoperability in developing countries?

Part I

Litterature

Chapter 2

Interoperability

2.1 Syntactic

Interoperability is the ability of making systems and organizations work together or inter-operate. When talking about information systems the syntactic interoperability is the first step. One system cannot recieve any data in a format it does not accept, although this probably is self explanatory, it should be mentioned. The level of ineffectiveness is enourmous because of this simple problem. I would first relate this to switching-costs and lock-in for users. As of now there is 3 main operating systems, Linux, Windows and OSX. Businesses would have to think twice before deciding on either. First one would have to train personell to use the operating system, so one would be subject to brand-specific-training lock-in [15]. This in turn would make the use of the system a barrier for interoperability, since users are now trained in one operating system and would now prefer this over the others. Now, some software is only supported for some operating systems, or OS's. If one relies on one OS, then uses software that is only supported by this OS, chances are that it would be problematic to exchange information to a different OS. The first thing to consider is that the data representation is likely to be very different from software to software. Just to illustrate the problem, let's say one organisation is running Windows as in in figure 2.1 and another running OSX. The users of each organisation has had training on the operating system of their organisation, making the switching costs substantial. Money is already been invested in software that only runs on the given OS and the data representation is only supported by the software running on the OS. Clearly they would have some work to do before being able to exchange data. This type of scenario represents the formation of silos. Silos are systems which are closed to the outside. These systems have trouble with exchanging data with external systems.

2.2 Semantic

Another part of interoperabillity is semantic interoperability. In this case the problem will be more subtle. The syntax is the same, but the meaning behind it is different. A simple example like when two people are asked to work together. Both understand what it means, but have different understandings on how to

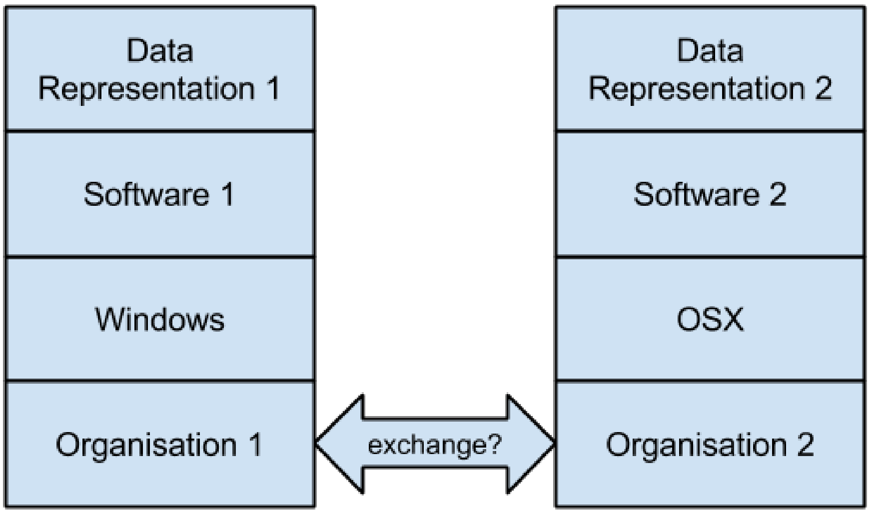


Figure 2.1: The beginning of Silos

do it. Person one will split the work in half an take his share. Person two is constantly askiing person one about his half and sharing ideas on how to do it. When they finish, person one is complaining on how he would have to do almost all the work for both of them. Person two is complaining that person one was reluctant to work together. This exemplefies how different semantics would make less likely for these two individuals to work together in the future, thus decreasing the level of interoperability. Of course in the computer world it would not be that easy to find out if all parties involved are understanding it the same way.

2.3 Solutions and methods

To achieve interoperability between systems one has to integrate one with the other systems in the same environment or context. Systems in the same context is the same as systems in the same bubble. It's just a way to refine our model so we don't have take all systems in the world into account. The general approach to achieving interoperability is to define a common standard between systems. Through these standard channels the system would be able to communicate with echother. I will present four general approaches here that are loosely defined[16].

Vertical integration In this approach we do consider the different systems as silos. Each of the silos contributes with some functionality and as a whole delivers the required functionality. This would probably provide the cheapest solution for gaining interoperability short-term.

Star integration Each system has a one interface for all other systems. Thus, introducing a new system would be quite expensive since one would have to make an interfaces for all existing systems. This method does make it easy to reuse functionality between systems.

EXHIBIT 1
Example Calculation: Annual National Benefit From Level 4 Health Care Information Exchange And Interoperability (HIEI) Between Outpatient Providers And Independent Laboratories

Item	Amount
A—Lab fee billed per test	\$40.00[a]
B—Provider administrative cost incurred per test (included in fee billed for visit)	\$19.25[b]
C—Total cost per test to labs and providers (A+B)	\$59.25
D—Lab test costs billed per person per year	\$86.52[a]
E—Number of lab tests per person per year (D÷A)	2.17
F—Total cost of lab tests per person per year (C×E)	\$128.57
G—Avoidable redundancy in testing, estimate one	20%[c]
H—Avoidable redundancy in testing, estimate two	8.6%[d]
I—Average avoidable redundancy in testing (average of G and H)	14.3%
J—Proportion of avoidable redundant tests that could be avoided at Level 4	95%[b]
K—Tests avoided at Level 4 (I×J)	13.7%
L—Tests avoided per person per year (E×K)	0.294
M—Costs saved from avoided tests per person per year (C×L)	\$17.41
N—Remaining tests per person per year (E−L)	1.87
O—Proportion of lab test administrative costs that could be avoided at Level 4	95%[b]
P—Provider lab test administrative cost avoided per person per year (B×N×O)	\$34.18
Q—Lab administrative cost incurred per test (included in fee billed for test)	\$20.40[b]
R—Lab administrative cost avoided per person per year (N×O×Q)	\$36.22
S—Total avoided cost per person per year, from avoided tests and avoided administrative costs on remaining tests (M+P+R)	\$87.81
T—U.S. population	281,421,906[e]
U—Cost adjustment factor	1.286[f]
V—Annual national benefit of Level 4 HIEI between outpatient providers and laboratories (S×T×U)	\$31,800,000,000

Figure 2.2: Exhibit 1

Horizontal integration In this approach one uses a own system dedicated to facilitate communication between systems. This way only one more interface is needed when introducing a new system.

Common data format This method only requires that one sets a standard data exchange format. It is recommended to provide an adapter so that one could easily transform from the native format to the common bus format.

Of course this just exemplefies how to go about interoperability, as mentioned above, the general approach is to agree of a standard way of communicating cross systems.

2.4 Experiences

To give an estimate of the benefits of interoperability I would like to re-present some data collected and analyzed by a group of scientists in the USA[11]. These numbers are based on upgrading the health information system in USA. The financial gain in figure 2.2 represents the annual gain by upgrading to a system described below.

EXHIBIT 2
National Ten-Year Roll-Out And Annual Costs Of Health Care Information Exchange And Interoperability (HIEI)

	Roll-out cost ($ billions)		Annual cost ($ billions)	
	Level 3	**Level 4**	**Level 3**	**Level 4**
Clinician office system cost	163	163	9.08	9.08
Hospital system cost	27.1	27.1	1.58	1.58
Provider interface cost	124	76.2	9.04	5.40
Stakeholder interface cost	6.41	9.92	0.467	0.467
Total	320	276	20.2	16.5

SOURCE: Authors' analysis.
NOTE: Payers participate in Level 4, making stakeholder interface costs higher than Level 3 during the rollout. Their annual costs are unknown. For explanation of Level 3 and Level 4, see text. All results are stated to three significant digits.

Figure 2.3: Exhibit 2

> Machine-interpretable data—transmission of structured messages containing standardized and coded data; idealized state in which all systems exchange information using the same formats and vocabularies (examples: automated exchange of coded results from an external lab into a provider's EMR, automated exchange of a patient's "problem list").

This is what they call level 4. Figure 2.3 describes the estimated costs for such a system. As one would notice the roll-out costs are substantial, but looking forward stakeholders would probably begin harvesting from their investment withing a decade. Also, not all benefits can be measured in terms of money. The possibilities for new technology to make its appearance is huge. The reduction of error, ease of improving data exchange with other sectors in society and the possibility of reusing functionality should also be considered when measuring the benefits of interoperability.

Chapter 3

Transition Strategy

In order to make interoperability possible one as to transition from the old way of doing to the new. And 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.

3.1 An overview

Making a transition involves a switch from the old system to the new. This switch is usually refered to as the cutover.

3.2 Planning and conducting a transition strategy

3.3 Experiences

3.4 System Migration [2] [8]

3.4.1 Initiation

Who is the initiators and how does this impact the choice of system.

3.4.2 Implementation

What characterizes a successful implementation

3.4.3 Cut-Over

Evolutionary vs. Revolutionary

3.4.4 Migration Methods

The Big Bang

Forward Migration

Backwords Migration

The Chicken Little Strategy

The Butterfly Methodology

Chapter 4

ICT in Developing Countries

4.1 what kind of levels is there?

4.2 Health

4.3 Mobile

Part II

Empirical

Chapter 5

Context

In the center of Africa we find Rwanda. A very small country, only $26338 km^2$. This would be about 7% of Norway. Their population is estimated to be around 12 million wich makes it about 420 people pr. square kilometer. Rwanda is made up of 5 provinces, east, west, north, south and Kigali. Each province is again divided into districts and there is a total of 30 districts. Under districts there is a total of 416 sectors[1], see figure 5.2.

Because of its location it works perfect as a gateway to all countries in Africa. Due to the stable environment, it is very attractive for foreigners to do business here. Making it the 'Singapore of Africa'.

Rwanda has a goal of being transformed to a knowledge based economy with Information and Communication Technology or ICT. This means basicly that they want to offer ICT services for other kind of resources. They want to be the regional center for training top quality ICT professionals. In turn, create wealth, jobs and entreprenaurs. From their perspective they have some competetive advantages in order to achieve this:

- Cheap labor compared to other countries in the Region
- Young and dynamic workforce (98% of the population is under 50 years and 43% is under 16 years)
- Most favorable business environment in the Region (8th best place to do business in the world 2012)
- Low levels of corruption - Zero tolerance (Transparency international Bribery index 2012 ranked Rwanda as least bribery prone in the EAC)
- World class ICT infrastructure
- Strong & visionary leadership
- Bi-lingual business environment (French and English)

[2]

Figure 5.1: Rwanda in the World [14]

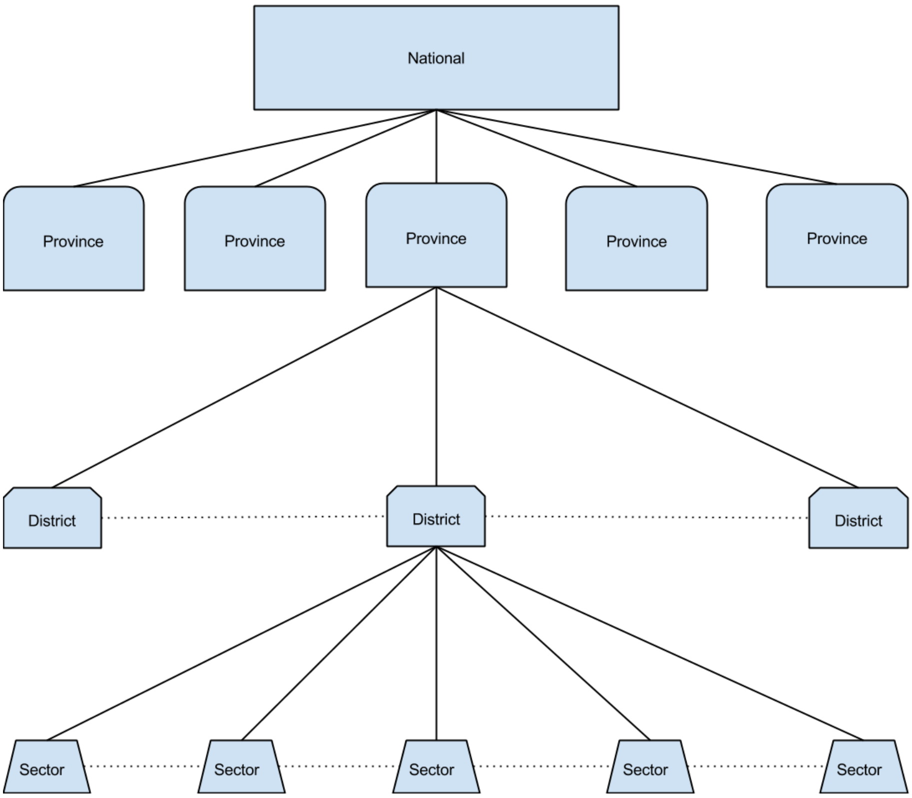


Figure 5.2: Rwanda Administrative Division

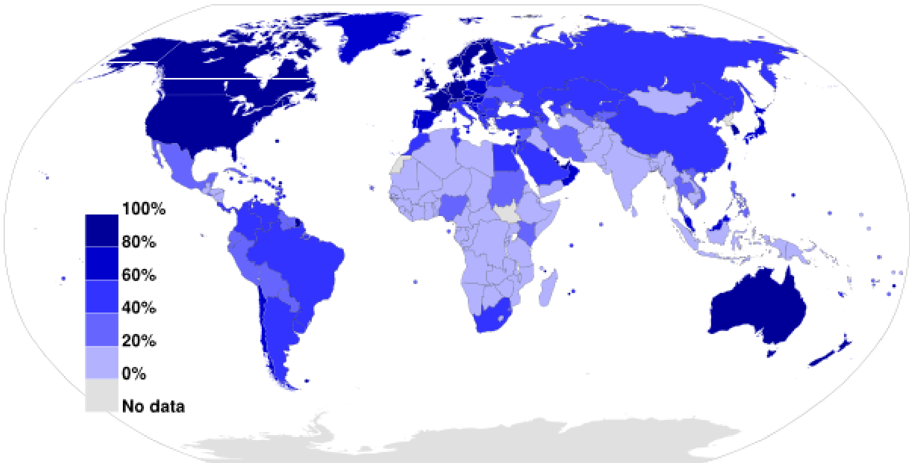


Figure 5.3: Global Internet Penetration in 2012 [3]

5.1 Brief History Lesson

At the 14th centuary, the Tutsies enters Rwanda. Before them there were two other peoples, Hutu, which means farmers and Twa who was the very first recorded prople in Rwanda. There is some disagreement of what the differances are between the peoples, but origanily, Tutsies were cattle owners and the Hutus were farmers. About five hundred years later the first European visits Rwanda and in the same centuary Rwanda becomes a german protectorate. This makes Rwanda under the protection of Germany with some oblegations for their services. Skipping fourth to 1933, now occupied by Belgian forces, all citizens are issued with an identity card defining their identity. In 1962 Rwanda becomes independent and gets their 1st elected President. After this there is turbulent times for Rwanda. The Hutus and Tutsies are having violent reactions towards eachother with a peak in 1994. A geneside primeraly by Hutu extremists, killed over 500,000 people, primeraly Tutsies, in the course of about 100 days. The genocide was triggered by the assasination of the Hutu president Habyarimana. The Tutsie Rwandian Patriotic Front, also known as the RPF, takes action and took control of Rwanda the same year. The current President, Paul Kagame, was a former member of the Rwandian Patriotic Front. [17][18][19]

5.2 Information Technology focus in Rwanda

Rwanda has an internet penetration of 7% in 2012. In Africa there is an internet penetration of 15.6% and for the world it is 34.3% (See 5.3)[4]. Rwanda had an increase of internet penetration from 1% to 7% from 2000 to the end of 2011[2]. More interesting is the mobile broadband development in Rwanda. The subscriber base accounts for 48.1% of the population and the network coverage accounts for 99.79% of the country. Thus, the technology is there, but the hardware is not yet updated. In general, people are using simple phones. Some of these phones supports java and a very simple browser, but it cannot be compared to working with a desktop computer. The government of Rwanda

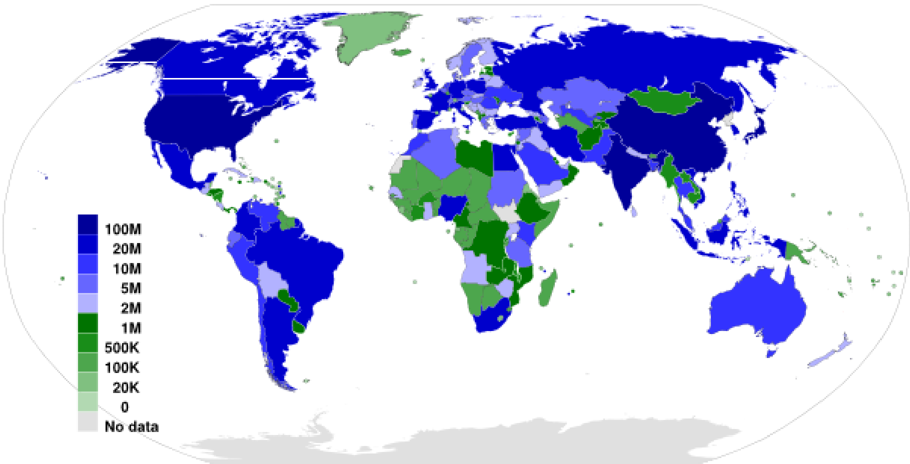


Figure 5.4: Global Internet Users in 2012 [3]

has made the decision to become an ICT hub in Africa. Therefore alot of resources and attention is focused on developing knowledge in the field of ICT. As of january 2013 the Rwandian government is planning to set up an ICT park through the Rwanda Development Board. This park will host technological training, industries research and development. The ICT park will support the growth of the following clusters:

- Energy
- Internet, multimedia and mobile telecommunication
- Knowledge
- E-Government
- Financial
- ICT Service and export

[2] Also there were some rumors about free WiFi throughout all of Kigali. They were in 2012 ranked among the top 6 developing countries in the category of "dynamic performance in ICT development"[5].

5.3 Health Information System Programme

5.3.1 About

The Health Information Systems Programme (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[8]. This means including the local users when develping the system in hopes of a more sustainable and successful project. 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[9].

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[9].

5.3.2 History

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 wich 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[7]. During apartheid and until 1994 there were 14 departments of health in South Africa. Bacause of this fragmantation it was alot of different procedures, collection tools and data defenitions. In order to take this into account, DHIS became very flexible and one can easily see how this has effected the design. This might be the reason why DHIS framework could be used in other countries.

5.3.3 District Health Information System

The latest version of DHIS during the case study was version 2.13. DHIS2 is now used by over 30 countries across the globe and even more organizations. DHIS2 is a tool for governments and health organizations to manage their operations more effectively, monitor processes and improve communication. DHIS2 is mainly a tool for managing aggregate data. It will let you visualize large amounts of data in a GIS implementation, a pivot table and in charts. These data representations can then be shared with other user registred in the same DHIS2 instance. Probably the most powerful feature would be GIS. This feature shows selected data on map based on province, district etc. The regions on the map can then be colored based on the data. If one has data for the hole country one can in seconds get a accurate impression of the current health status. DHIS2 runs on server wich is connected to a database. As long as this server is connected, anyone with a decent browser and an internet connection could access and make use of DHIS2.

GIS

The GIS that is integrated in DHIS2 is relatively easy to use. One selects what kind of regions that are of interest and apply the correct data that should be visualized, see figure 5.5. Heres a list of some of the functionality that the GIS offers:

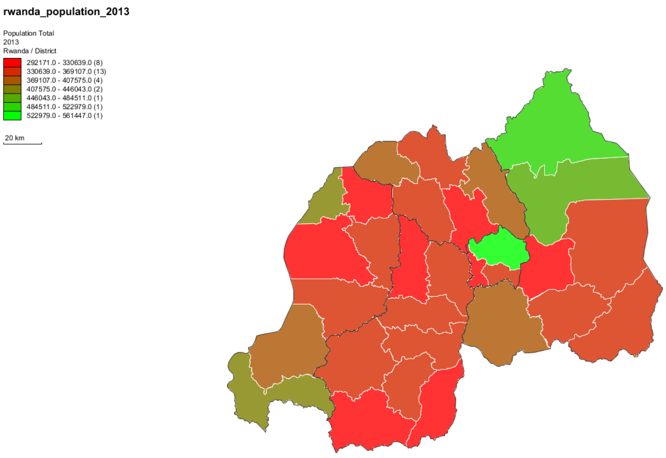


Figure 5.5: A population count using GIS in DHIS2

- Thematic mapping of areas and points.
- Visualize catchment areas of facilities.
- View facilites based on classifications.
- Overlay multiple layers and use googlemaps as a background layer.

[10]

Charts

The charts are a little bit trickier. In short the series is the y-axis and Category is the x-axis. Displaying data as a chart is allright once you get what the words mean. Figure 5.6 shows an example counting population by district. Types of charts supported include:

- Column
- Line
- Pie
- Stacked Column
- Area

[10]

Pivot Table

A pivot table is a data summarization tool. It generally sorts data and show them in categorized table. The DHIS2 pivot table let's you analyse data along all data dimensions and arrange these on columns, rows and filters, see 5.7.

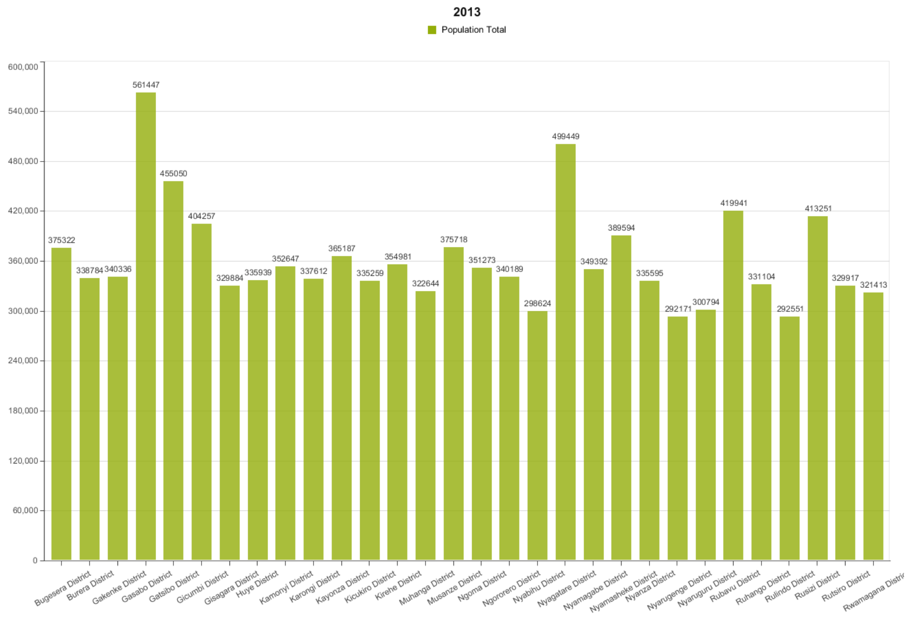
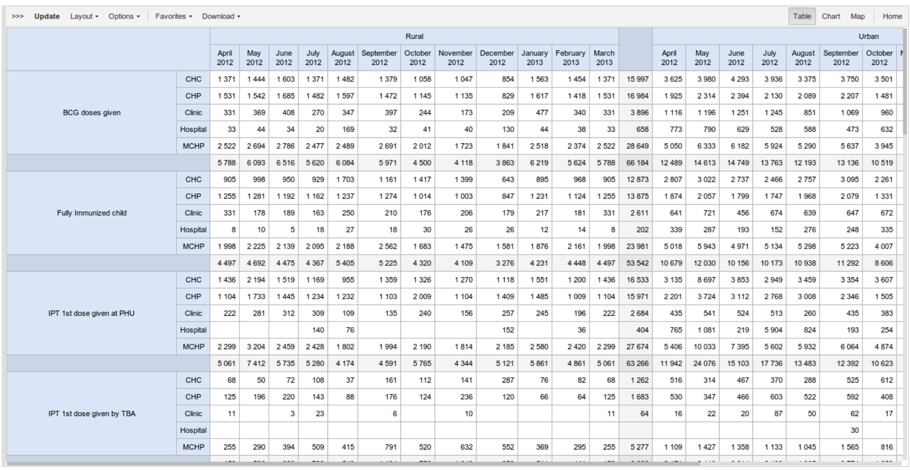


Figure 5.6: A population count using a chart in DHIS2



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		Rural													Urban						
		April 2012	May 2012	June 2012	July 2012	August 2012	September 2012	October 2012	November 2012	December 2012	January 2013	February 2013	March 2013		April 2012	May 2012	June 2012	July 2012	August 2012	September 2012	October 2012
BCG doses given	CHC	1 371	1 444	1 603	1 371	1 482	1 379	1 058	1 047	854	1 563	1 454	1 371	15 997	3 625	3 980	4 293	3 936	3 375	3 750	3 501
	CHP	1 531	1 542	1 685	1 482	1 597	1 472	1 145	1 135	829	1 617	1 418	1 531	16 984	1 925	2 314	2 394	2 130	2 089	2 207	1 481
	Clinic	331	369	408	270	347	397	244	173	209	477	340	331	3 896	1 116	1 196	1 251	1 245	851	1 069	960
	Hospital	33	44	34	20	169	32	41	40	130	44	38	33	658	773	790	629	528	588	473	632
	MCHP	2 522	2 694	2 786	2 477	2 489	2 691	2 012	1 723	1 841	2 518	2 374	2 522	28 649	5 050	6 333	6 182	5 924	5 290	5 637	3 945
		5 788	6 093	6 516	5 620	6 084	5 971	4 500	4 118	3 863	6 219	5 624	5 788	66 184	12 489	14 613	14 749	13 763	12 193	13 136	10 519
Fully Immunized child	CHC	905	998	950	929	1 703	1 161	1 417	1 399	643	895	968	905	12 873	2 807	3 022	2 737	2 466	2 757	3 095	2 261
	CHP	1 255	1 281	1 192	1 162	1 237	1 274	1 014	1 003	847	1 231	1 124	1 255	13 875	1 874	2 057	1 799	1 747	1 968	2 079	1 331
	Clinic	331	178	189	163	250	210	176	206	179	217	181	331	2 611	641	721	456	674	639	647	672
	Hospital	8	10	5	18	27	18	30	26	26	12	14	8	202	339	287	193	152	276	248	335
	MCHP	1 998	2 225	2 139	2 095	2 188	2 562	1 683	1 475	1 581	1 876	2 161	1 998	23 981	5 018	5 943	4 971	5 134	5 298	5 223	4 007
		4 497	4 692	4 475	4 367	5 405	5 225	4 320	4 109	3 276	4 231	4 448	4 497	53 542	10 679	12 030	10 156	10 173	10 938	11 292	8 606
IPT 1st dose given at PHU	CHC	1 436	2 194	1 519	1 169	955	1 359	1 326	1 270	1 118	1 551	1 200	1 436	16 533	3 135	8 697	3 853	2 949	3 459	3 354	3 607
	CHP	1 104	1 733	1 445	1 234	1 232	1 103	2 009	1 104	1 409	1 485	1 009	1 104	15 971	2 201	3 724	3 112	2 768	3 008	2 346	1 505
	Clinic	222	281	312	309	109	135	240	156	257	245	196	222	2 684	435	541	524	513	260	435	383
	Hospital				140	76				152		36		404	765	1 081	219	5 904	824	193	254
	MCHP	2 299	3 204	2 459	2 428	1 802	1 994	2 190	1 814	2 185	2 580	2 420	2 299	27 674	5 406	10 033	7 395	5 602	5 932	6 064	4 874
		5 061	7 412	5 735	5 280	4 174	4 591	5 765	4 344	5 121	5 861	4 861	5 061	63 266	11 942	24 076	15 103	17 736	13 483	12 392	10 623
IPT 1st dose given by TBA	CHC	68	50	72	108	37	161	112	141	287	76	82	68	1 262	516	314	467	370	288	525	612
	CHP	125	196	220	143	88	176	124	236	120	66	64	125	1 683	530	347	466	603	522	592	408
	Clinic	11		3	23		6		10				11	64	16	22	20	87	50	62	17
	Hospital																			30	
	MCHP	255	290	394	509	415	791	520	632	552	369	295	255	5 277	1 109	1 427	1 358	1 133	1 045	1 565	816

Figure 5.7: An example of a pivot table in DHIS2[10]

Dashboard and social features

One can send messages and share all data visualizations with users registrered on the DHIS2 instance. Interpretations of the visualizations can be commented and viewed by all other users. This way DHIS2 let's users experienced in the field help others interpretate the data while they are looking at it. Also one can store charts, maps and pivot table at a dashboard so they can easily be referenced later.

Individual Records

DHIS2 was mainly intended for aggregated data that could not related to anyone person. The need for a system which can track individuals is a requirement that most users of a health care system would want. Therefore the DHIS2 tracker was developed. It let's you sign up people for programs and track them through the process. Also send out reminders so that patients come to their scheduled checkups. One problem with the individual records is that it does not work as a patient record system. Such a system is that it requires a level of confidenciality that DHIS2 currently is not supporting. Also a patient record system needs all health facillities to be users of the same system if it is going to be of any use.

Data entry and validation

DHIS2 let's users entry data even if their not online. This feature is crucial for countries with unreliable connection to the internet. For developing countries with regular power cuts, one can understand why this is. Data entry is done with prepared forms and then uploaded to the server which is running the DHIS2 instance. The forms are highly customizable due to the varying requirements from users. Also there is the possibility to validate the input. For an example shouldn't there be more people under five years than people in the same region, just to give an example. The data entry can be done in alot of different ways. One example is through SMS. In industy countries this may sound odd at first, but in developing countries health facilities might not have access to computers. This is the simplest form of data entry, even though it might require some coding of data representations. Since DHIS2 is accessible from any device with a browser the range of devices that can be used for data entry goes from a mobile phone that supports SMS to a sophisticated computer.

5.4 Healthcare

The health care in Rwanda is still influenced by the genocide in 94, but compared to the state it was in back then, it's is in pretty good shape. The health system is financed primarely the state, insurrance, individuals and direct fees for services. The biggest health program is the Mutuelles De Sante. This is an insurrance based scheme. Individuals pay a fee of 6$ a year pr. family member and 10% fo the service pr. visit. The program started in 2004 and by 2010 91% of the population had this insurrance policy. Users of this system can go to a public and non-profit health centers, but are not allowed to use 'for profit' health centers. Although there's been alot of improvemnet in the recent years, the government still says that they have a long way to go to meet the countries needs[20].

5.4.1 Health Information Systems in Rwanda

The government instance that has the responsibility to maintain and manage health information data is the Ministy of Health. Here there is a team that maintains the Health Management Information System. The HMIS is built around the open source District Health Information System 2. The health ministry has made some modifications so that there is in fact 4 instances of DHIS2 running for different purposes. Besides DHIS2, there is alot of other systems running that in some way has to be coordinated and synchronized. Sharing data between these systems is crucial for maintaining an overview of the current health status in Rwanda.

Chapter 6

Method

The overall research method used in this study is action reasearch. In this case a full iteration through the process was not conducted, time as usual, was not on our side. Nevertheless, some progress was made. This study is scheduled to be continued in a few months as of writing. The work here will serve as the first two steps in the action research process.

6.1 Action Research

Action research is based on an iterative process.

1. Plan
2. Act
3. Reflect

This report will focus on the planning part.

In this study a combination of Case study and a practitioner-researcher would best describe the approach. To start with my research questions was not clearly defined, therefore an exploratory case study was needed. This also suits well because this study will make the foundation for a subsequent study that will take place in the next few months. The practitioner-researcher method as a main data generation method was choosen much because of the circumstances. By actively participating in the day-to-day activities I could then get a feel for what problems that really stood in our way and what theme would best characterize the problem at hand. This approach was well suited since the primary work already is in my field of education. Cases vary in their approach to time, this particular case would best be described as a short-term, contemporary study. Case selection was very much based on a unique opportunity. After I decided that I would like to take a look at the DHIS as a case study, I pretty much had to wait for the oppertunity to participate. With some luck, the oppertunity presented itself and the case was chosen. The relationship to existion theory is to examine all the factors in the case and then see wich pre-existing theory or model best matches what was found in the case [**?**, 13]

6.2 Action Research

6.3 Data Collection

As mentioned earlier, the main data collection is a type of observation. There is two main types of conduction observation, one is systematic observation and the other is participant observation. This case study focuses on the latter. There are also several way of conduction a particpant observation.

- Complete observer
- Complete paricipant
- Participant observer
- Practitioner researcher

[13] I've chosen the Practitioner researcher approach. This is a way of observing while working at the task at hand. This method of working has some drawbacks. For obvious reasons the setting is somewhat artificial when people know that you are conducting a research. Even though I tried to make my presence as natural as possible, I could sense that my co-workers act different around me than amongst themselves. As proposed by Briany J. Oates[13], this could be due to the fact that everythng they do could be recorded. The main output of this kind of research is a theory of what is occuring.

6.4 Reflection & Data Analysis

6.4.1 7 Principles for Conduction and Evaluating

Chapter 7

Case

7.1 Background

The health information system in Rwanda is now going through a transition phase.

> We'd like to transition to DHIS-2 but it will require quite a bit of work on programming alerts - outgoing SMS messages - and setting up an interface for defining alert levels (ceilings) at which point the messages are sent.

They are now in some way trying to transition from a series of systems to an open source software called DHIS2, see section 5.3.3, page 16. The benefits in switching to the DHIS2 is many. For starters it is an open source software. Currently parts of the health information system is contracted to companies in the private sector using proprietary software. Open source is free. Propietary software is not. Clearly the transition will have some finacial benefits. One example is a contract currently worth 300 000$ pr. year will due to the transiton become terminated. As one goverment employee puts it:

> It is costly for the Ministry to maintain their infrastructure and is not open source.

The transition from propietary software also puts the governement in control of their own software and becoming independent from companies as it relates to bug fixes, adding functionality and so forth. The government is made up of different departments. Different departments leads to the formation of silos. Silos makes it hard to co-operate, making interoperability an issue. Also propietary software usually has restrictions, which contributes to the formation of silos. Open source software has no restrictions, which makes easy to modify and fit to the workflow and software of other departments. Thus making interoperability easier. Making the transition also leads to some added functionality, like charts for data analysis, using GIS placing data on the map, but it is also opens a door for alot of possibilites.

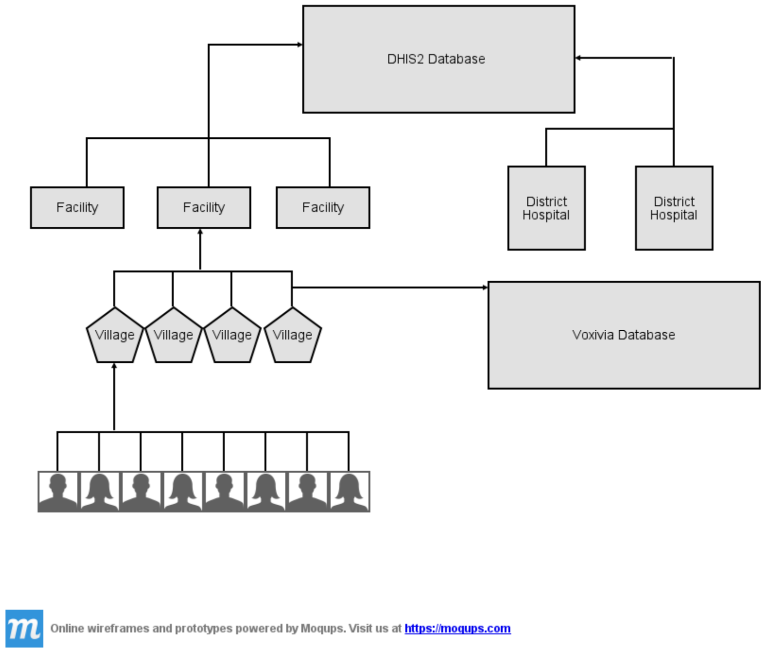

Figure 7.1: Dataflow

7.2 Current situation

This case mainly concerns Health Management Information System and their implementation of DHIS2. HMIS is a part of the Health Ministy in Rwanda. For this paper, DHIS2 servers are run by HMIS, so a DHIS2 server is the same as an HMIS server. HMIS got the main responsibility to manintain and to facilitate the flow of health data in Rwanda. Even though they are the people with the main respnsibililty, as described earlier, there are other actors as well. For an example there is Voxiva. A propietary software company that currently is supporting the data flow to the government using a voice response system, see figure 7.2. In figure **??** you can see how the data flows from users all the way to the DHIS2 database. If you take the route from users to the DHIS2 database, the data from users to health facilites are paper based. The data flow that goes through the paper based system would greatly benefit from transitioning to an electronic based system. Since DHIS2 does not support data specific to villages, another system is used to support this, currently delivered by Voxiva. In short, making the users report data twice at the village level. One time electronicly to the Voxiva system, and one time via the paper based system to the health facility. The paper based data collected at the health facilities are entered by data managers and then pushed to the DHIS2 databases. Data at the health facilities are aggregated by the data managers, so one cannot tell the difference between villages. The government would like to transision to DHIS2, but since data is aggregated at the facility level when using DHIS2, one has to use the Voxiva system for village specific data. One typical scenario is when a village is running empty of some drug. Another village connected to the same health

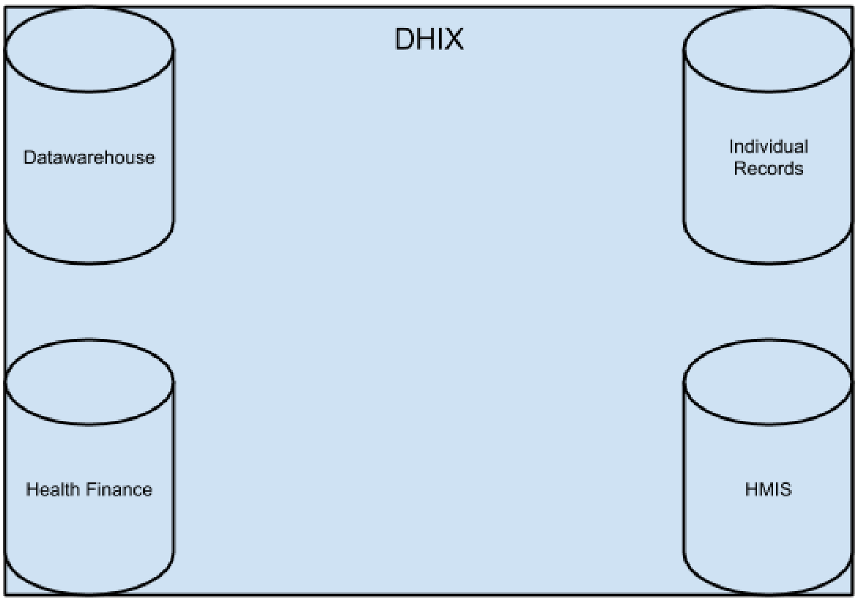

Figure 7.2: An overview of the DHIS2 servers at the HMIS

facility has to much of the same drug. DHIS2 would report the drug stock to be allright since the data is aggregated. One cannot ignore this problem so HMIS is still dependent on Voxiva's system for problems like these. Clearly one could benefit from some interoperability. Since the data is reported twice, the system could exchange data and make life easier for the users.

7.2.1 External Systems and DHIX

DHIX

DHIX is not an abbrevation, but a name for describing the systems at HMIS as a whole. This system include four instances of DHIS2, each running on a separate server with some scripts linking them together.

HMIS This server contains general statistics about Rwanda's health.

Health Finance Contains information about performed health services throughout districts. This data is used for the Performance Based Financing or PBF.

Individual Records HMIS has a dedicated server containing information about individuals using the tracker module in DHIS2.

Datawarehouse This collects data from other DHIS2 instances. Data is pushed to this server about once a month.

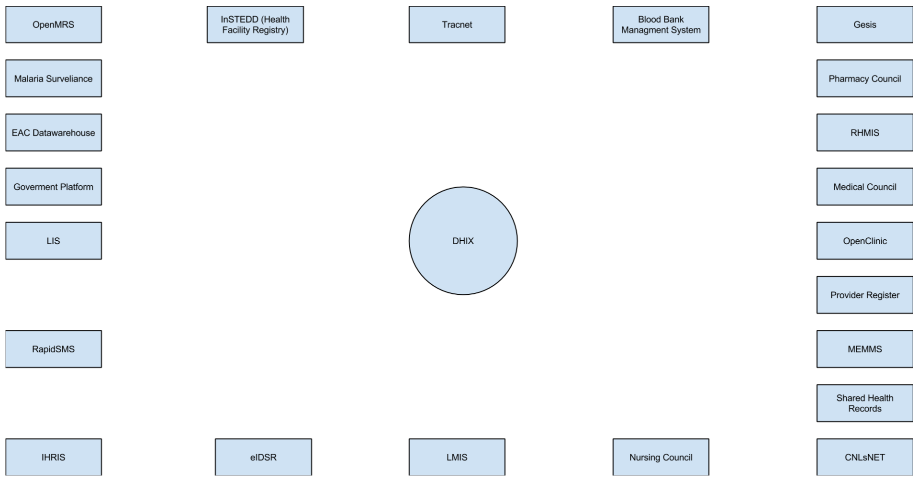

Figure 7.3: Overview of systems included in the Health Information System of Rwanda

External Systems

Figure 7.2.1 shows the systems mapped during the case. All of these systems has some relation to the DHIX and interoperabililty between the external systems and DHIX would be of benefit. As mentioned, the Health Information system in Rwanda is going through a transition. Therefore, it is likely that there is some of these systems that could easaly do the switch from the old system to DHIS2 and easaly be integrated in DHIX. This would require a huge study that I did not have the time to do during this case study, but is definitively recommended. I got the chance to study one of these systems in some detail and it is presented in short here.

7.2.2 Malaria Surveliance

The purpose of this system is to map were there is an outbreak of malaria in order to initiate countermeasures. The malaria surveliance project consists of two main branches.

Sentinel Surveliance

The malaria sentinel project is implemented and is currently reporting weather data and malaria cases, with some extra information. The purpose of this instance is to map all malaria cases based on their geographical location and see if there is a connection with malaria data and weather data. The sentinels are differents stations spread throughout Rwanda, see figure 7.2.2. Adding up the sentinels catchment area they should cover all of Rwanda. Currently these stations data flow is not integrated in DHIS2. The data being reported should happen daily. This is currently supported by DHIS2 and would be solved by making some predefined forms for the staff making the reports. A very simple task, but it needs to be coordinated by the responsible so that everybody is onboard with the solution. DHIS2 is currently supporting all the requirements,

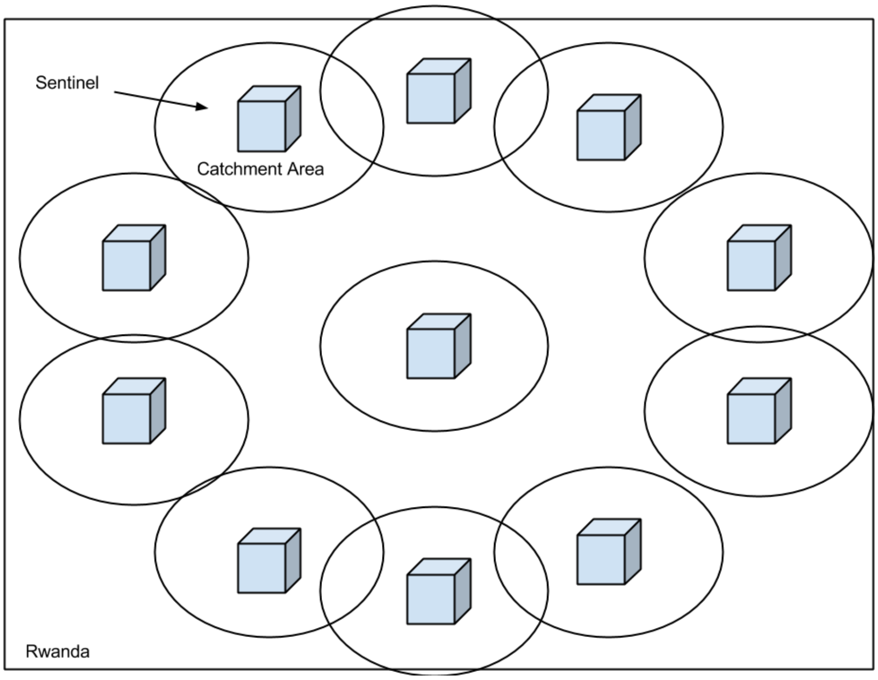

Figure 7.4: Sentinel Surveillance

but in order to make the transistion the personell doing the reporting has to be trained and take part in the transition.

Active Surveliance

Active Surveliance is another branch of the malaria surveillance. The thing is, one wishes for data from the place were the malaria was first noticed. This kind of data would include if the infected person has bednets, if others in the same house has malaria and other contextual data in hope of seing a pattern to what is most likely to make a person infected. Currently the health personell is using a paper based reporting form, but would like to transition to an electronic based report. See appendix A for an example of a paperbased reporting form. The technology that the health workers currently are equipped with is usally regular simple phones that could interact with DHIS2 with SMS. DHIS2 is supposed to support this feature, but it is not been properly tested. A requirement is that one would have to set up a SMPP gateway with a local teleoperator. In this case the most likely teleoperator in Rwanda would be MTN. The technical expertise for this kind of functionality is not the main obstacle. It's the bearucracy of decision making. The decicion process is long and it takes a while just to map who to talk to about what before one could even start setting up the necessary components.

As one would notice, the technology is already in place.

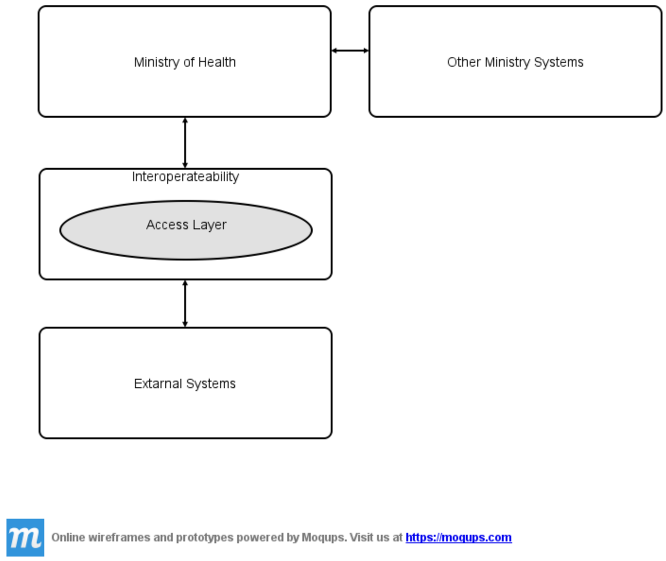

Figure 7.5: Future Design

7.3 Future goal

7.3.1 Intraoperability

7.3.2 Interoperability

Health Facility Registry

The HMIS has a vision on how they would like to interact with other systems, see 7.3.2. HMIS would like to collect all Ministry of Health systems under one roof. Then they would like to make some kind of interface between health ministry and other ministry systems. The specifics of how this is going to work are not decided yet. The ministry of health would like to be able to exchange data with external systems as well. This is done via an access layer. Between this access layer one would be able to synchronize data with external systems. For instance, there is a system called Voxivia that has data that is more specific than what is currently supported by the DHIS2. These data would be of great benefit to the HMIS.

7.4 Challenges

7.5 My role and case results

7.5.1 4 projects

7.5.2 The Landing

Result

7.5.3 Future Project

Part III

Discussion

Chapter 8

Conclusion

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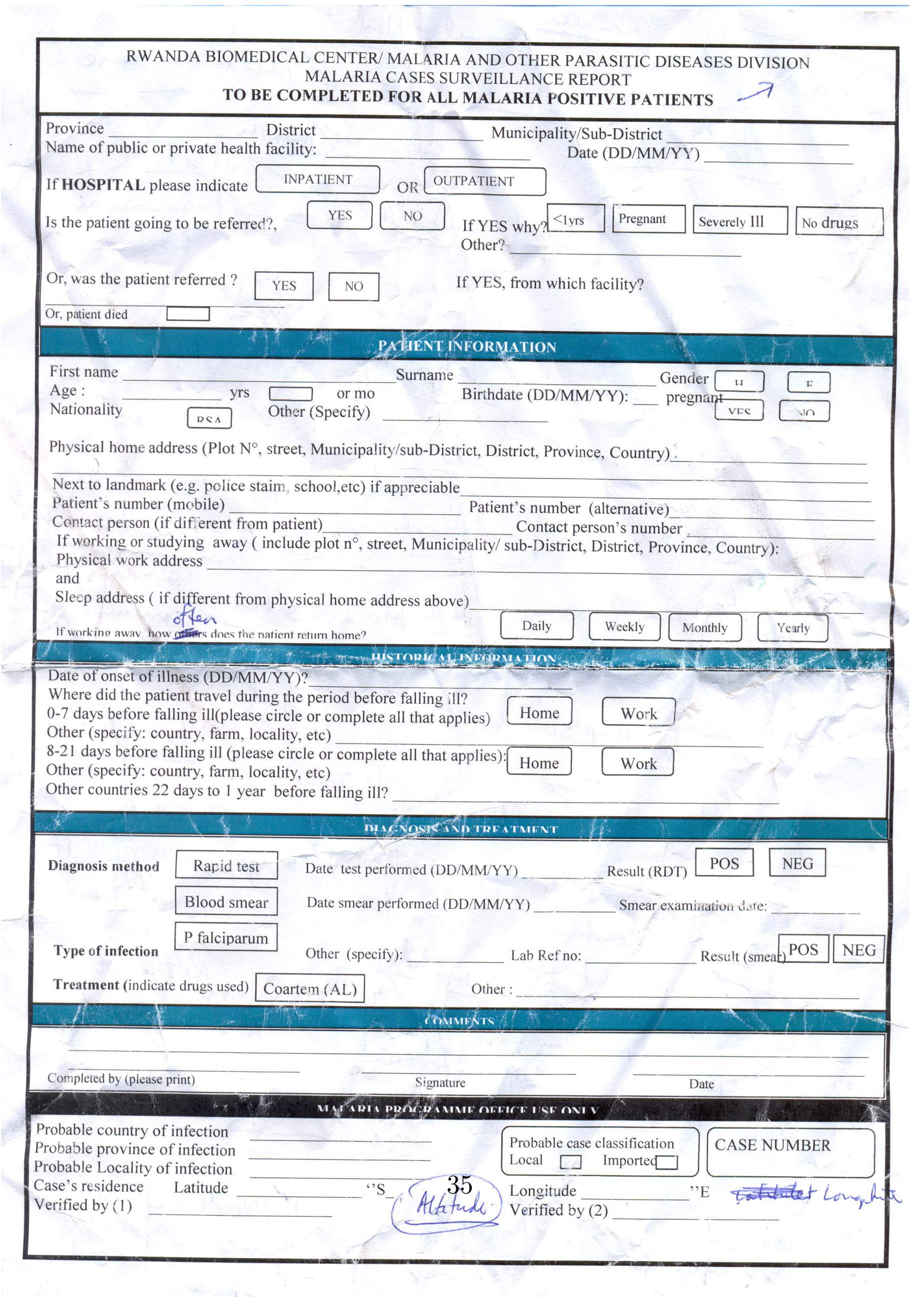
Appendix A

Malaria Reporting Form


RWANDA BIOMEDICAL CENTER/ MALARIA AND OTHER PARASITIC DISEASES DIVISION
MALARIA CASES SURVEILLANCE REPORT
TO BE COMPLETED FOR ALL MALARIA POSITIVE PATIENTS

Province ______ District ______ Municipality/Sub-District ______
Name of public or private health facility: ______ Date (DD/MM/YY) ______

If **HOSPITAL** please indicate [INPATIENT] OR [OUTPATIENT]

Is the patient going to be referred?, [YES] [NO] If YES why? [<1yrs] [Pregnant] [Severely Ill] [No drugs]
Other? ______

Or, was the patient referred ? [YES] [NO] If YES, from which facility?

Or, patient died [ ]

PATIENT INFORMATION

First name ______ Surname ______ Gender [M] [F]
Age : ______ yrs [ ] or mo Birthdate (DD/MM/YY): ___ pregnant [YES] [NO]
Nationality [RSA] Other (Specify) ______

Physical home address (Plot N°, street, Municipality/sub-District, District, Province, Country) ______

Next to landmark (e.g. police staim, school,etc) if appreciable ______
Patient's number (mobile) ______ Patient's number (alternative) ______
Contact person (if different from patient) ______ Contact person's number ______
If working or studying away (include plot n°, street, Municipality/ sub-District, District, Province, Country):
Physical work address ______
and
Sleep address (if different from physical home address above) ______
If working away how ~~others~~ often does the patient return home? [Daily] [Weekly] [Monthly] [Yearly]

HISTORICAL INFORMATION

Date of onset of illness (DD/MM/YY)? ______
Where did the patient travel during the period before falling ill?
0-7 days before falling ill(please circle or complete all that applies) [Home] [Work]
Other (specify: country, farm, locality, etc) ______
8-21 days before falling ill (please circle or complete all that applies): [Home] [Work]
Other (specify: country, farm, locality, etc)
Other countries 22 days to 1 year before falling ill? ______

DIAGNOSIS AND TREATMENT

Diagnosis method [Rapid test] Date test performed (DD/MM/YY) ______ Result (RDT) [POS] [NEG]
[Blood smear] Date smear performed (DD/MM/YY) ______ Smear examination date: ______
Type of infection [P falciparum] Other (specify): ______ Lab Ref no: ______ Result (smear) [POS] [NEG]
Treatment (indicate drugs used) [Coartem (AL)] Other : ______

COMMENTS

______
Completed by (please print) ______ Signature ______ Date ______

MALARIA PROGRAMME OFFICE USE ONLY

Probable country of infection ______
Probable province of infection ______
Probable Locality of infection ______
Case's residence Latitude ______ "S Altitude Longitude ______ "E ~~Latitude~~ Longitude
Verified by (1) ______ Verified by (2) ______

Probable case classification Local [ ] Imported [ ]
CASE NUMBER