TDT4900

Kenneth Børtveit

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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

Case

1.1 Background

There has been some interest in the area of SMS reporting from the University of Oslo (UiO). The DHIS2 software supporting this functionality has been developed, but not yet been used. The Health Management Information Systems (HMIS) team at the Ministry of Health (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 Community Help Desk (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 Health Center (HC) CHW supervisors in order to resupply.

> In order for these CHW's to provide uninterupted 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 $\approx$ 45000CHW's in $\approx$ 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.

1.2 Networks of Action

As mentioned by Eric, Jørn and Sundeep, on 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 Health Information System Program (HISP).

1.2.1 Description of the different participants here

1.3 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.

1.3.1 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.

1.3.2 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.

1.3.3 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.

1.3.4 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.

1.4 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 diffiult to pinpoint exactly what needed 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 1.1 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. After 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.

1.4.1 Use Cases

As a seen in use case tables 1.1, 1.2, 1.3 and 1.4, the specifics did change, along with the development process, but it gave us the necessary guidelines

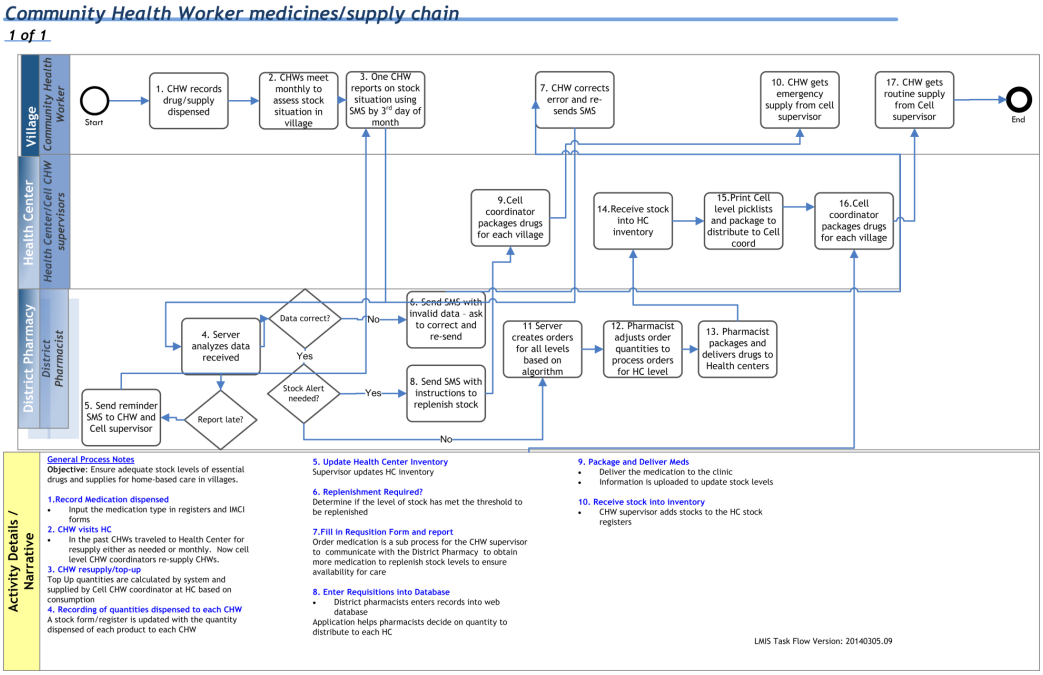

Figure 1.1: CHW Supply Chain in the Future

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 1.1: Textual Use Case: Send SMS and Email Notifications

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 1.2: 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 1.3: 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 1.4: Textual Use Case: Report Using SMS

to understand 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 set-up 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.

1.5 Planning

With the objectives put in context we could start planning the specific activites for intervention. In our case the HMIS team made the overall plan for the project as in figure 1.2. 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, reorderlevel, default-supply by drug.

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 1.2: Activity Plan For the CHW LMIS

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.

1.6 Intervention

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

1.6.1 Setting up the Test Environment

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

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

Figure 1.3: Figure of SMS-flow

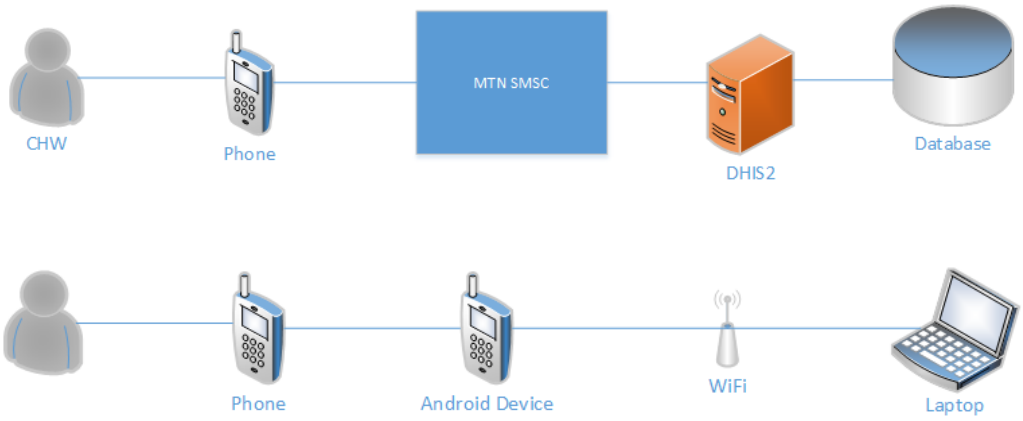

Figure 1.4: Figure of Test Environment

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.

1.6.2 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 1.5 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 end of the month and creates a text message that is sent to the four digit number provided by the mobile operator.

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 1.5: Codes for Drugs and Supplies

Figure 1.5: Example SMS report

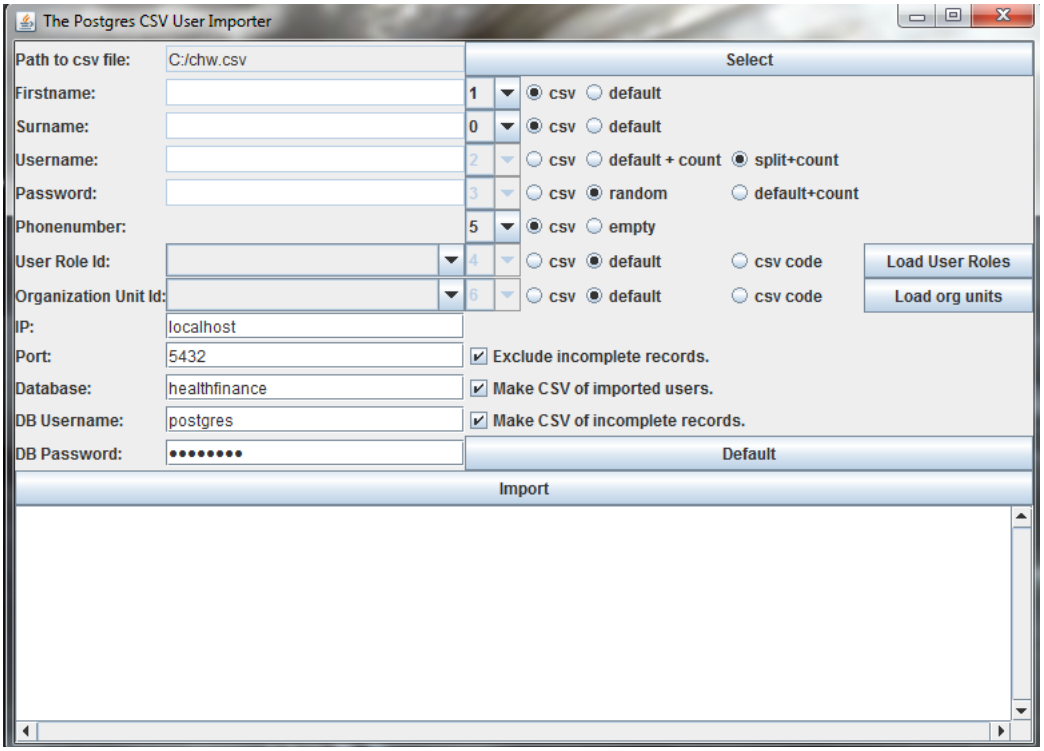

Figure 1.6: Screen Shot of the User Importer

1.6.3 Setting up the mobile instance

1.6.4 User Importer

The Essential Predictore

Re-Supply Algorithm

$$stk_n = stk_{n-1} + rcd_n - disp_n \tag{1.1}$$

$$\begin{aligned} reorder_n &= (amc_n \cdot 2) - stk_n && (1.2)\\ amc_n &= \frac{disp_{n-2} + disp_{n-1} + disp_n}{3} && (1.3)\\ disp_n &= stk_{n-1} + rcd_n - stk_n && (1.4)\\ disp_{n-1} &= stk_{n-2} + rcd_{n-1} - stk_{n-1} && (1.5)\\ disp_{n-2} &= stk_{n-3} + rcd_{n-2} - stk_{n-2} && (1.6) \end{aligned}$$

reorder$_n$ This variable represents the quantity of how much is needed at the

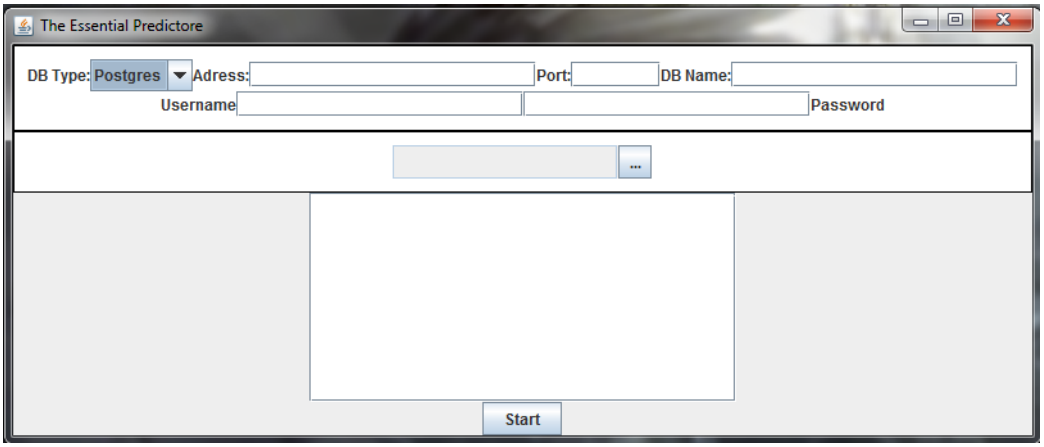

Figure 1.7: Screen Shot of the Essential Predictore

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.

$$rcd_n = \sum_{k=1}^{j} rcd_{n,k} \tag{1.7}$$

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A more mathematical description in equation 1.7, where j represents the number of days in the month.

Bibliography