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

Case

1.1 Background

There has been some interest in the area of Simple Message Service (SMS) reporting from the University of Oslo (UiO). The District Health Information System 2 (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 primarely 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 **??** 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

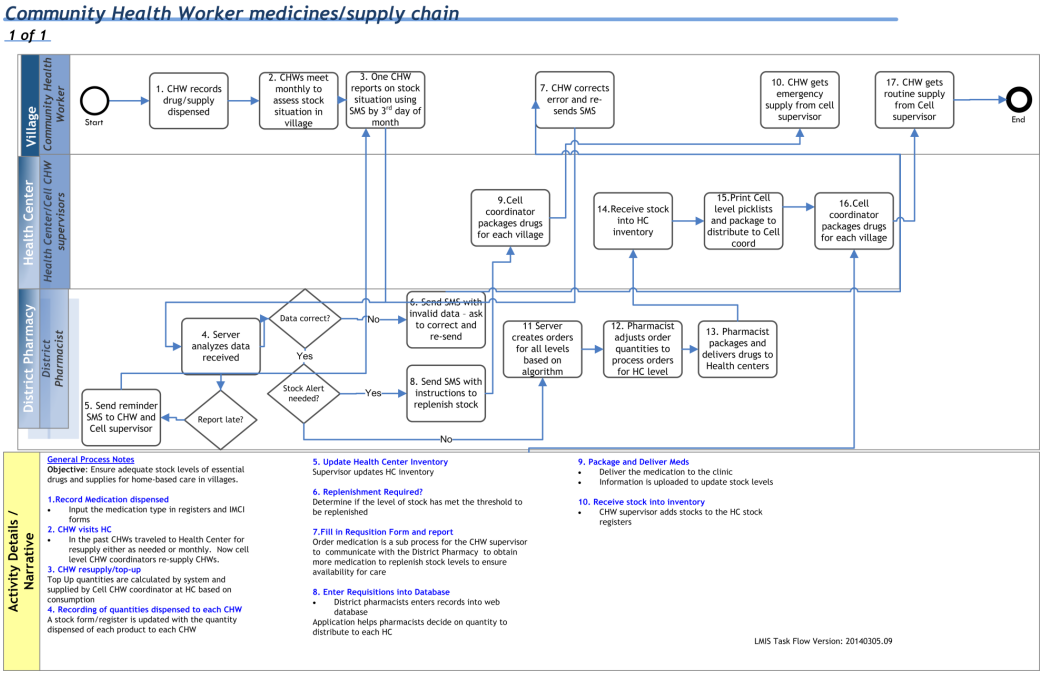

Figure 1.1: CHW Supply Chain in the Future

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, but taken 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).

1.6 Notes

Based on the four objectives we made four use cases that was supposed to represent each one. Objective #1 would be represented with use case 1.1, objective #2 with 1.2, #3 with 1.3 and #4 with 1.4. These use cases worked as guidelines for our further work. They were not updated later on, because of the continuous updated requirements from CHD and other co-workers. That is one of the key characterizations of this project. The requirements kept on updating as more and more people got involved in the process. The more progress we made the less progress we made. As the project was coming more and more realized, more interest were made to the project, and more requirements were added. There were a kind of common understanding in the team. Once you got the picture, you didn't need to operate on a model anymore. Everyone kinda knew what needed to be done. The result of the diagnosis were essentially a clarification of what we were supposed to do and who are involved. The clients are CHD. A meeting took place and a list of contact information was exchanged. The users of the system are CHW's, Cell CHW Supervisors, HC CHW Supervisors and District Pharmacists. The basic idea is that the CHD would like to have HMIS make a system that enables CHW's to report using SMS and based on this have automatic generated orders sent to the HC's and District Pharmacists.

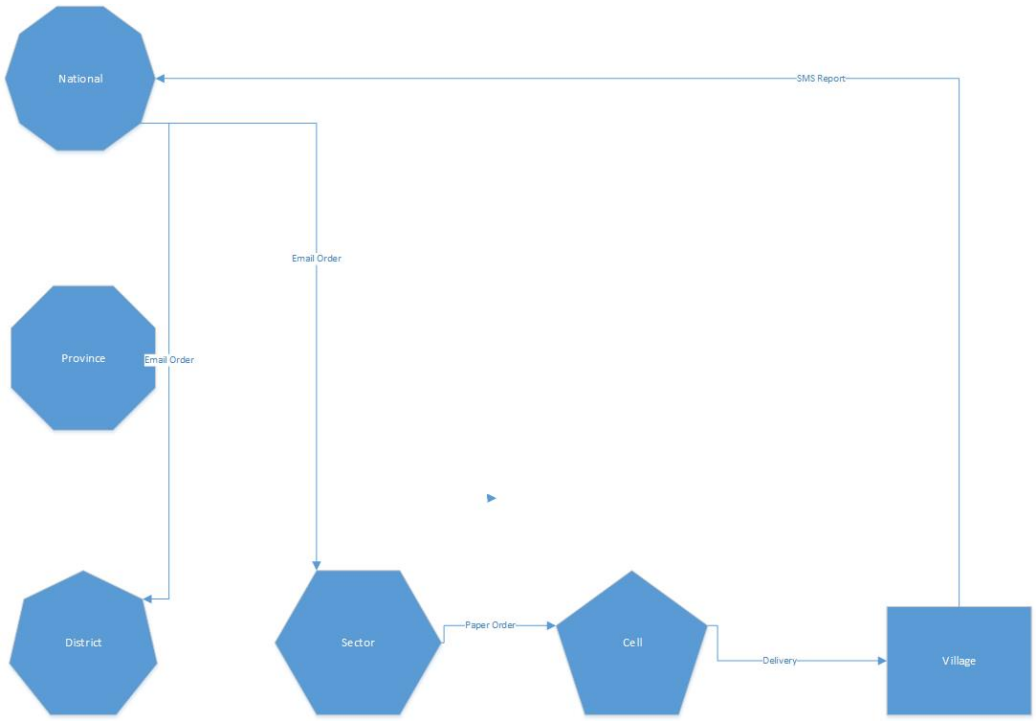

Figure 1.3: Flow of Orders

Figure 1.4: Model of SMS data flow

Our planning phase became somewhat glued together with the intervention. And continually altered. New problems were made visible by the interventions we made, and took us back to the planning phase. Making it very difficult to follow the action research model. In a perfect world, it is possible to plan everything to the point, but in our case new knowledge about the system was discovered along with our interventions and in turn, our plans had to be changed.

As seen in figure 1.3, some overall plan were already in place. The result should be that the CHW's should report what they receive whenever they receive any items. This will be registered in the database at the National Data Center (NDC). This would be straight from a village level to the national level. At the NDC there will be a server running DHIS2, ready to receive data from MTN, the biggest mobile company in Rwanda. The SMS actually has to go through a Simple Message Service Center (SMSC), before being forwarded to the server at the NDC. The DHIS2-instance, from now called "the mobile instnce", will run all the necessary calculations and generate all

the results. So one of the tasks to be done was to set-up the mobile instance. We knew that this would take some time, so in the mean time we sat up a test environment so that we could test our solutions.

1.6.1 Intervention

Setting up the Test Environment

Our initial idea was to set up a DHIS2 instance for testing purposes. This made it possible for us to check if our objectives was in some way already met with the functionality of DHIS2. We knew that DHIS2 already supported SMS reporting, but it had never been tested. This was essentially what we did. Configured DHIS2 to support our case. Turned out that objective #3 and #4 was already met with just configuring DHIS2. One thing that we did not think about that became a problem later was the translation of the feedback messages. CHW's do not generally speak English, but the local language kinyarwanda. Fortunately, the translation of the messages was possible in the next version of DHIS2, so the objective was still met.

Setting up the mobile instance

We sat up the DHIS2 instance at the NDC. This is server that the CHW's will send their reports to. This process was very straight forward. The problem with having our instance running at a different location is that we have less control of our system. Now we have to go through another team to make certain changes to the system. Actually just slows down the whole process. Setting up the mobile instance made our plans more real and allowed us to show our work in real life.

User Importer

The user importer was made in order to import user from a csv file. DHIS2 did not support automatically generating usernames and passwords for bulk users. Therefore we needed a program to do this for us. The down side of this approach is that all the users of the system are not included in the process of creating user accounts. This by passes the HISP philosophy of including local users in the system. Users may therefore have user accounts they are not aware of. Making the the users feel less ownership of the system. Despite of this we decided to take this approach.The amount of resources spent on manually register all the users would be to vast.

The user importer creates user accounts based on firstname, surname, village and phonenumber. After the user accounts are created they are able

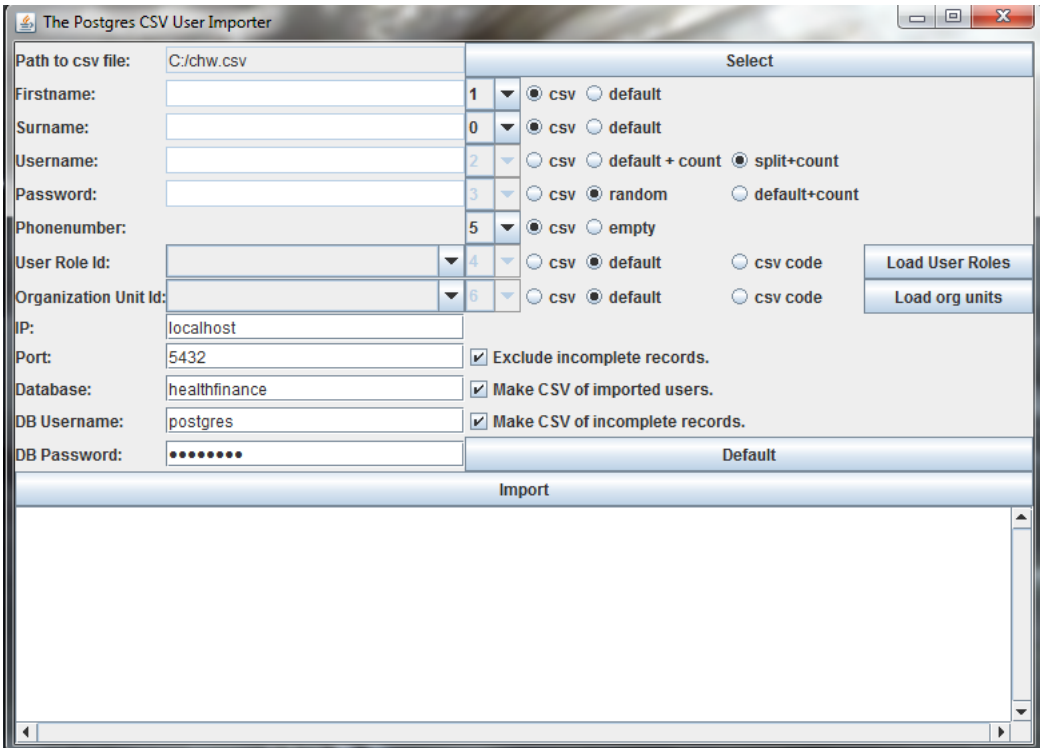

Figure 1.5: Screen Shot of the User Importer

to send in SMS-reports based on the village they work from.

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 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.

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

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

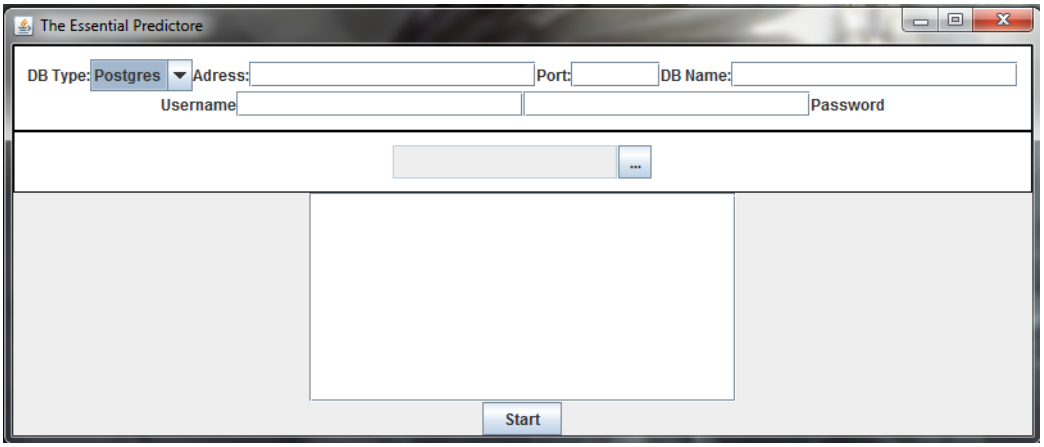

Figure 1.6: Screen Shot of the Essential Predictore

The Essential Predictore

In order to generate the threshold values to send reminders from we chose to make a small application to run the algorithm. The application updates the database directly. The funny thing is that this was the only way we knew how to get our result, despite the support we had. The developer team from Oslo has offer the competence we needed, but due to the time frame we decided that we needed to build this application with SQL and JAVA. The application was kind of split in two. One of the team members at HMIS had a strong familiarity with databases and I had some JAVA experience. The core of the application was made in SQL, then it was wrapped inside a JAVA-G (GUI).

The collaboration in this application is something worth taking note of. Neither one of the team member knew exactly what the other was doing. The application was in fact copy-pasted together after making the the GUI and SQL-functionality separately. The application realizes the re-supply algorithm in a JAVA application and works with DHIS2. So all the tools from DHIS2 could be taken advantage of.

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