

# Vaccine Supply Chain in Ethiopia

**HST 184: Health Information Systems to Improve Quality of Care in Resource  
Poor Settings**

*Final Paper*

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## Introduction

The Clinton Health Access Initiative operates in many countries including Ethiopia with an aim to save lives from preventable and treatable diseases. In Ethiopia the organization is working to advise the ministry of health in Ethiopia on an efficient logistics supply chain management system for vaccines. Currently the vaccine distribution capacity is five vaccines and will rise to seven with the introduction of a number of vaccines like the Pneumococcal vaccine (PCV10) and Rota next year. The introduction of these vaccines will inevitably affect the organization's stock Management and logistics in Ethiopia since the rate of hospital visits per health center will remain constant.

## Problem Statement (initial)

The task is to specify a logistics and stock management information system to optimize the vaccine supply chain in Ethiopia. As for all national vaccine supply chains, the vaccine's sensitivity to heat poses a risk of waste, especially for the health facilities. The current system is paper based and includes the use of stock cards which is predominant in most health centers, about 80% practice. This system is very inefficient and prone to errors (including transcription errors), is not granular enough to be useful, and cannot forecast demand of inventory and makes it tedious to extract useful information for decision making at any level of the supply chain.

Ethiopia has switched to a number of vaccines like the single dose pentavalent vaccine (a few years ago), the pneumococcal and plans to introduce the Rota vaccine. These vaccines are bulky and more expensive both to purchase and store. Thus, it is essential that an improved and efficient logistics system is put in place to reduce waste, stock outs, overstocking, and expired stock, and to improve on decision and information flow between the national cold storage, the regional health facilities, and every level of the vaccine supply chain.

The current system is highly decentralized for a country with 80 million people with great regional differences, which also affects the distribution of the vaccine. The vaccine is meant to be given to every child under one year with an average of 4 to 5 visits to the health care facility.

The need for better logistics, transportation innovations, and the increase in the distribution costs will have to be taken into account.

## **Background**

### **Main Issues**

#### **Organizational**

Trying to reduce the number of layers and channels that the vaccine passes through before it is used and would eliminate waste as well as cut down on stock shortages. The supply chain starts from the initial quarterly dispatch of the vaccine from the central vaccine storage to the regional stores and goes down to the zone stores and finally to Wereda and Kebel headquarters, where it is picked up monthly by the health posts.

#### **National level**

The existing capacity at national level (67%) is not adequate for storage of vaccine, and is compensated for by increasing the frequency of the supply period, delaying shipment, pushing the stock to regional cold rooms. The main advantage at the national level is the availability of computerized temperature monitoring system.

#### **Subnational level**

At this level, some cold stores have electronic systems used for stock management as well as electronic records of temperature logs that varies across regions. We would like to get more information on what kind of system they use. Other subnational stores, for example in Oromia, lack storage capacity as well and this affects the frequency of their shipments from the national facilities.

## Local facilities

At the service delivery level, challenges include lack of knowledge on how to calculate the vaccine wastage rates. In addition, most stores only use the EFFO method for the vaccines and not for the diluents. Most health facilities have the capacity to accommodate their vaccine needs, even during campaign times, and can rent temporary facilities to store vaccines during peak stock levels. However, there are many facilities maintenance problems.

## Educational Goals

We intend to learn more about how to organize and monitor a computerized supply chain system while taking in to account country specific characteristics. Specifically, we would like to understand best practices in industry and current areas of innovation.

## Approach/ Resources

### Literature sources

- Ulla K. Griffithsa, Viola S. Korczaka, Dereje Ayalewb, Asnakew Yigzawb; (2008) Incremental system costs of introducing combined DTwP–hepatitis B–Hib vaccine into national immunization services in Ethiopia.
- Ethiopia National Immunisation program costing and Financial Assessment (January 2002): World Bank [www.who.int/immunization\\_financing/analyses/.../wb\\_ethiopia.pdf](http://www.who.int/immunization_financing/analyses/.../wb_ethiopia.pdf)
- RPM/SPS and SCMS in Ethiopia: An evaluation; USAID [www.linkpdf.com/.../dl/rpm-sps-and-scms-in-ethiopia-an-evaluation-.pdf](http://www.linkpdf.com/.../dl/rpm-sps-and-scms-in-ethiopia-an-evaluation-.pdf)
- [www.who.int/vaccines-documents](http://www.who.int/vaccines-documents).
- Richard Heeks (2002), ‘Failure, Success and Improvisation of Information Systems Projects in Developing Countries.’
- [www.lggi.org](http://www.lggi.org) Mobile phone-based supply chain system

## Related works

Similar work has been carried out for vaccine chain supply in the following countries and affiliate organizations:

- Hib/ Hep B vaccine in Chile by the Global Alliance for Vaccines and Immunisation (GAVI) and Sanofi Pasture
- Hib vaccine in Ghana by GAVI and the Ministry of Health.

## Proposal

After reading through the literature and acquiring more information about the supply chain system in Ethiopia, we came up with this proposal:

### Use of mobile technology in supply chain management

Logistimo offers a simple and scalable solution without the need for expensive hardware. It allows low-end mobile phones to capture transactional data, track inventory, place orders, forecast demand, optimize inventory, and generate demand analytics. Configuration and management of supply chain entities, relationships, materials, users and authorizations are performed through a web browser-based dashboard. Meanwhile, the mobile app can be pushed to users via SMS, and auto-installed in a matter of seconds. Users can then begin entering transactions, such as orders, receipts, issues, and periodic physical inventory counts. All this information is recorded in an online data store, which can be accessed by authorized members in the supply chain via a mobile phone or web browser. This system is currently used in rural India and could be used in the remote isolated areas of Ethiopia.

## Findings

Our initial task was to identify a logistics and stock management information system that would make the vaccine supply chain in Ethiopia more efficient. As we have discussed in our problem statement, we found the current paper-based system to be highly inefficient and decentralized,

thus hampering record-keeping and communication; resulting in inefficient management of the supply chain. A centralized system will be ideal in order to condense stock-outs and vaccine wastages. There were a few important considerations for any system chosen to facilitate vaccine delivery in Ethiopia. They include: -

- ❖ The lack of national databases in Ethiopia: Stock-outs are particularly common at lower levels such as the health center, and according to several surveys these smaller health centers do not really have any type of database.
- ❖ Financial considerations: we need an inexpensive system that is easy to implement and financially sustainable by the Ministry of Health or whatever organization takes charge of the vaccine delivery project.
- ❖ Shortage and/or absence of skilled workers in supply chain management: Software requiring a lot of skilled resources for maintenance would not be ideal because supply chain management capacity and IT skills are generally low; with very little formal training reported.
- ❖ Visibility of program: supply and demand exists but Central level do not provide information on stock status at the health post level and health facility level.
- ❖ Routine quantification for procurement is done however Health post requirements are not forecasted separately from the other levels.
- ❖ Language barriers when using the software at local health community levels: Since the official language in Ethiopia is Amharic, Arabic as well as other ethnic languages at decentralized levels, it would be hard to transcribe software information even if English is taught in school as the language of instruction.

Though we did not find any large-scale vaccine-delivery systems existing in other resource poor settings, we identified several drug delivery systems such as the pharmacy supply system used in Haiti and India. These systems made use of some of the considerations we needed to take into account such as the availability human and financial resources, and provided models that we could build on.

It was difficult for us to get in touch with people on the field, and we were unable to conduct any interviews. We therefore highly relied on published literature about the supply chain system in

Ethiopia as well as a baseline assessment of the situation done by the John Snow Inc in 2010. Therefore our assessment of the problem may not be as accurate as it could have been.

## **Significant Findings**

We identified two software systems that could be used with our chosen mobile technology system, Logistimo, for stock management and vaccine delivery. These include Rx-Solution and M-supply. Our suggestion was to use one of the proposed software at the Ministry of health and district levels (M-supply & RxSolution) and the mobile technology in the rural health posts in Ethiopia (Logistimo).

## **Mobile technology**

Logistimo offers a simple and scalable solution without the need for expensive hardware. It allows low-end mobile phones to capture transactional data, track inventory, place orders, forecast demand, optimize inventory, and generate demand analytics. Phones with JAVA Script and GPRS including Smart phones can be used with this software. The system also uses GPRS data channel for transfer of information. In low resource settings like the health facilities in rural Ethiopia this technology addresses critical challenges in enabling inventory control, and improvements in forecasting. The system uses a web browser and mobile app which users can download and automatically install in just seconds, enter transactions such as orders, receipts and perform periodic physical inventory counts. All this information is recorded in an online data store, which can be accessed by authorized members in the supply chain via a mobile phone or web browser.

## **Support Software**

**Rx-Solution** is primarily described as a pharmacy dispensary system. It has drug management, dispensing, inventory control, and consumption-based ordering abilities, making it suitable for stock management. It is built in SQL and can run stand-alone or networked, making it a suitable option for vaccine delivery in with or without web access. However, the fact that it is a closed software source that needs a lot of resources for maintenance, and our unsuccessful attempt to



get in touch with the owners of this software disqualified it as a potential candidate for stock management.

**M-supply** is an inventory control system which records each receipt and issue of stock for an item. For products with batch numbers and expiry dates, m-Supply tracks each batch of an item separately so the quantity of each batch is known and recorded. This software allows one to easily issue goods in a FEFO (First expiry, first out) manner which would be crucial for vaccines that have a short shelf life. For less experienced and poorly trained personnel the software has a graphical interface that is easy for people not experienced with computers to learn. M-Supply has proven methods that calculate how much you need to order on the basis of actual usage and stock levels- personnel don't have to set minimum and maximum stock levels manually.

The system also has the advantage of handling unlimited foreign currencies for incoming invoices which would be helpful since Ethiopia gets its vaccines donated from a number of different agencies which may use varying currencies. In addition the system is easily customized for particular needs. It has the capability to be queried by other applications supporting the open Data base Connectivity /Structured Query Language or web services models. It also permits interaction between remote copies of m-Supply using web services which may come in handy for easy monitoring of health facility stock levels by the ministry of health in Ethiopia.

## **Implications of Findings**

The implications of our findings are that, if implemented, Logistimo combined with M-supply can revolutionize vaccine supply chain management in Ethiopia with little or no change to existing infrastructure at minimum costs and maximum cost-effectiveness; and without immediate need for significant capacity building in IT. For any health related use of technology to quickly diffuse, especially in low and middle income countries, it must gain acceptance by the leadership of the public health sector: and to achieve this, it should have recorded significant success in other settings, or have the potential for early success with low start-up costs. With proper application, there will be a near immediate fall in stock-out rates, inequitable distribution of stock, and expiration of stock.

Our proposed combined use of technology in vaccine chain management promises much immediately and in the long term with ‘little’ initial capital investment (cost of computers/mobile devices, internet service provision, constant electricity supply, manpower training/ new IT manpower salaries).

Furthermore, this proposed vaccine chain management system could serve as the beginnings of a National database for vaccination coverage statistics, which could in turn be the basis for monitoring and evaluating diverse health interventions and the deciding direction of future interventions. For example, if it is determined that more vaccines are used in an area where fewer birth certificates are issued, compared to one with a higher population or birth rate; it can be postulated that there is a lower vaccine coverage in that area, and studies could be carried out to understand the root causes for that and their remedy.

Also, being mostly open source and low cost, our program is highly sustainable. Even after the initial round of funding for initiating the program has wound up, unlike many novel ideas which became unsustainable in LMICs, this supply chain management platform is most likely to remain and thrive, because the financial burden on the government for running it will far outweigh the losses (economic, social, and otherwise) of letting it go under. And being open source (MSupply) means that the benefits of updated versions can be applied to enhance the system at little cost overall.

Other implications of our findings will prove to be potential roll-out challenges with which the proposed plan may have to grapple:

- ❖ The cell phones required to run the down-stream parts of this operation will become a lot more valuable than their economic value. And with the current upsurge of cell phone utilization in Ethiopia and cell theft being on the rise, lose of a couple of the phones used in the supply chain management, especially from the same district, could set the operations back a bit.
- ❖ Constant electricity for powering the hardware for providing this service is a must, and should be taken into consideration in implementing at any level as prolonged power outages could result in operational chaos.

## Benefits of Findings

The importance of vaccination as a tool to reduce mortality in children less than five years old in resource poor setting cannot be ignored. For those governments and organizations seeking to rollout extensive vaccination programs in their countries, costs are an important consideration. A sustainable vaccine-delivery system that will prevent stock-outs and eliminate wastage will be a step forward in improving health care delivery in resource poor settings.

Our findings can improve health care quality and delivery in resource poor settings in so many different ways:

Direct implications:

- Near elimination of stock-outs, wastages, and supply-point shortages.
- Better prediction of future demand and having the capacity to accommodate such needs.
- Significant enhancement of vaccine coverage rates.
- Marked reduction in morbidity and mortality from vaccine preventable diseases in children.
- Reduced access costs of vaccination and other health services, in the form of waiting times (with loss of potential income while waiting), transportation costs (especially if they have to return another day due to current stock-out), and any other inconveniences.

Indirect Implications

- Improved health status of the whole population, beginning with children
- Provision of a basis for capacity building in aspects of Healthcare management and health information systems
- Facilitate data base creation, being electronic records which are more easily transmissible and statistically manipulated.
- Provision / management of data for Monitoring and evaluating vaccination campaigns, but also other public health interventions

Potentially this improvement of service can also significantly make changes in the following areas:

1. **Promotion of Provincial/National inter-sectoral collaborations:** Because of ease of scaling to involve other sectors (transportation / storage/ food supply, etc), a couple of other health programs can be added-on to the vaccine supply chain management; e.g. nutritional supplementation for under-fives, provision of formula feeds for HIV negative babies of positive mothers; or provision of cash and non-cash incentives to mothers to incentivize utilization of the health services.
2. **International collaborations in the health sector:** Given the open-source nature of most of the technology, health sector collaborations can be done more easily and regional data bases can be instituted and managed for the betterment of the region, especially among countries that share boundaries. A case in point is the attempt to eradicate Polio in the West African sub-region: if the right technological framework – like this one – had been up and running in each country, collaborating as a region to eliminate the disease would have been much less challenging.
3. **Ease of conducting research in health systems / services:** This will enhance the quality and cost-effectiveness of interventions while improving efficiency.

## Problem Reformulation

Initially when we were told to define a logistics and stock management information system the group quickly thought of transportation and storage of the vaccine. According to the literature most of the waste in Ethiopia of the vaccine arises from storage and transport problems and this was the basis of the group's idea that fixing the storage and transport problems would reduce waste and cost less especially with the introduction of new child vaccines in Ethiopia like the Rota which are highly sensitive to heat. After meeting with our advisors, the task was clearly spelled out- we were advised to concentrate on the information system and ignore the transport and storage issues pertaining to the vaccine.

So basically our job was to address issues to do with communication and stock management between the ministry of health and the local facilities. The current system in Ethiopia has a lot of loop holes since stock cards are used and shortages often arise especially at the local facilities

because the communication with the national storage facility is poor. For this reason an MIS system that can connect the national cold store in Addis Ababa storage with the local health facilities would help reduce stock outs, forecast demand and reduce costs associated with transportation and storage.

## **Problem Statement (Reformulated)**

For this project the assignment is to specify a logistics management information system to optimize the vaccine supply chain in Ethiopia. With the current system in place a lot of inefficiencies have arisen leading to huge losses for the Ministry of Health. Since the system is paper based with the use of stock cards which is predominant in most health centers, it has been prone to errors especially transcription errors, cannot forecast demand of inventory and has made it tedious to extract useful information for decision making at any level of the supply chain. A system that can address such inefficiencies is highly demanded so as to reduce costs.

The logistics MIS would also have to take in to account that the country's supply system is highly decentralized with great regional differences, which also affects the distribution of the vaccine. In addition the system will also have to address the fact that some of the health facilities do not have access to internet, computers and are comprised of staff as with low literacy levels. The need for better logistics, transportation innovations, and the increase in the distribution costs will have to be taken into account but will not be directly addressed in this paper.

## **Process Improvement**

All attempts will be made to conduct interviews with stakeholders on the ground who include practitioners in the field, end-users, and bureaucrats in the health ministry, cell phone dealers, and mobile/internet service providers. This will broaden the scope of our intervention and deepen our perspectives with regards to on-the ground realities: e.g. to what extent is technology currently being used in the health sector, how fast did previous health IT diffuse; were they sustainable, so on.

Other less crucial but still significant conversations will include: which make of phones lasts longest on a single charge; which phone brand and models are more likely to be stolen and as such best avoided; which service providers have the best tariffs, and are most widely spread, and so on.

## Recommendations (Next Steps)

Based on our findings, the next step in this project would be to follow-up on the viability of these finding through a practical pilot project/ experiment in Ethiopia considering that all communication on-ground have been done and approved of as well as project approval from the Ministry of Health and Government of Republic of Ethiopia. Based on the literature, there are no limitations in the access of most of the software and can be obtained at no cost.

The pilot can be carried out in a randomized trial in a number of selected decentralized locations with in Ethiopia. The project can be evaluated by measuring the outcomes of before and after the intervention of the mobile and software technology. Outcome measures can be based on the number of children under five that have been immunized, the quantity of consignment dispatched that has been utilized and the quality of service of a health center through prompt transfer of information.

A lot more research has to be done on the compatibility of the two software models proposed with Logistimo. There is need to study the database transcription, whether the software have the same configurations in software language.

While our emphasis is on the use of this technology combination for vaccine chains, its ripple effect will be far-reaching. We would recommend that vaccine transport and storage operations should not be ignored. It is known that cold chain management affects life-span of vaccines. Therefore, more technology and best practices should be put in place to improve that area which can also be applied to other medicines. One best practice that can be further studies for cold chain management is the use of **microchips from RFID**, used in India in cold chain

refrigerators, which is designed to monitor key environmental parameters, such as temperature and time, for thermally sensitive goods as they move through a supply chain.

We recommend further insight into other best practices like *CoolComply*, a solar-powered wireless detection system, can be used or incorporated with our proposed findings. This system monitors the doses and the temperature of the medication, relaying readings via wireless to the local healthcare workers to track temperature and intervene when necessary. It is currently employed for drug treatment for Multiple Drug Resistant Tuberculosis (MDR-TB).

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