

# Lessons Learned

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## ICTs for Supply Chain Management in Low-Resource Settings

VILLAGE REACH®

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# Glossary

ACT	Artemisinin-Based Combination Therapy
CCM	Community Case Management
CHW	Community Health Worker
DHIO	District Health Information Officer
EWS	The Early Warning System
FP	Family Planning
FRHP	Focus Region Health Project
GHS	Ghana Health Services
GSM	Global System for Mobile Communications
HSA	Health Surveillance Assistant (Community Health Worker in Malawi)
ICT	Information and Communication Technology
ICT4SC	Information and Communication Technology for Supply Chain
LMIS	Logistics Management Information System
MOH	Ministry of Health
MOHSW	Ministry of Health and Social Welfare (in Tanzania)
NGO	Non-Government Organization
ODK	Open Data Kit
RDT	Rapid Diagnostic Test
SIM Card	Subscriber Identity Module Card
SC4CCM	Supply Chain for Community Case Management
TOT	Training of Trainers
USAID	United States Agency for International Development

# Introduction

This report is intended to be a useful reference for NGOs or governments seeking to improve the management and visibility of logistics data through the use of open-source information and communication technology (ICT). This report summarizes our experiences working on a variety of open-source ICTs for supply chains (ICT4SC) in low-resource settings from light mobile applications to simple information systems. It also includes a focus on cross-cutting lessons learned that may be relevant to future applications of similar technology. These lessons are divided into the following four categories: technology design, program design, training and support, and scale-up.

The lessons featured in this document are based on the implementation of six projects. All six projects have different purposes, and were designed on a variety of technology platforms for numerous partners.

These projects include:

- The Early Warning System for preventing stock-outs of essential medicines (Ghana)
- The Integrated Logistics System (ILS) Gateway, a mobile extension of the paper-based ILS (Tanzania)
- cStock, a mobile system to resupply, monitor, and manage community-level essential medicines, part of the Supply Chains for Community Case Management project to address pneumonia and other common childhood diseases (Malawi)
- mTrac, which monitors essential medicine supply using mobile phones and RapidSMS (Uganda)
- The ODK Scan Study for the Agentes Polivalentes Elementares (APEs) Program to track consumption data for malaria and family planning commodities (Mozambique)
- vrMIS, the provincial-level information system supporting the Dedicated Logistics System for vaccine distribution (Mozambique)

A short description of each project and more information about the platforms are included at the end of this document. This report has been prepared by Dimagi and VillageReach for the Bill & Melinda Gates Foundation. The lessons learned are based on Dimagi and VillageReach's collective experiences supporting and implementing ICT4SC projects, and the views expressed herein are not intended to reflect the views of other key partner organizations that supported the projects featured in this report.



Home Visit: © Dimagi 2011, Uganda

# Technology Design

The lack of data available to support supply chain decision-making in many countries has led to an increased emphasis on using mobile technologies to capture service delivery level data on medicine usage and availability. Despite the proliferation of mobile projects in this space, some project managers of new ICT4SC projects may struggle to understand the long-term trade-offs associated with early decision-making around technology platforms and data transmission methods. The following sections summarize these major decisions faced by project teams during the technology design phase of an ICT4SC project.

## SMS VS GPRS: SHOULD DATA TRANSMISSION BE VIA SMS OR GPRS?

One of the main technology design decisions ICT4SC initiatives face is whether to transmit data via Short Message Service (SMS) or General Packet Radio Service (GPRS). SMS is a tool built into any modern cell phone, which allows its users to send short messages—typically between 70 and 160 characters—over the voice network. GPRS is a mobile data service that allows certain phones to send and receive information using the Internet protocol (IP), the same messaging technology, which powers the World Wide Web. While an SMS-based system has no specific phone requirements, a system that relies on GPRS data transmission requires Java-enabled handsets that are capable of supporting mobile applications. Both options have tradeoffs in terms of cost, ease of use, and coordination and management.

SMS is the lowest common denominator for data transmission and this makes it very attractive to projects with limited budgets or large user bases. Because SMS capability is a standard built-in feature of all GSM phones (phones supported by SIM cards), a project that relies on data transmission via SMS does not require implementers to invest in project-dedicated handsets for end-users. This reduces up-front costs for new project implementation. In addition, using existing phones bypasses the significant coordination that is required to ensure appropriate use, maintenance, and security of project-specific phones. Another advantage to an SMS-based system is that it relies on a well-recognized communication medium that can run directly on off-the-shelf, unmodified phones. This decreases training costs if the information being transmitted by users is simple. An SMS-based system typically also provides a lower barrier to entry for projects without the technical capacity to install and troubleshoot a mobile application, which would be required for more complex data collection on Java-enabled phones. Overall, an SMS-based system's minimal set-up costs and low training barriers may be suitable for projects collecting a small amount of information from a large user group.

But SMS also has significant limitations that some projects overlook during the planning phases. The free-form nature of SMS text messages can lead to significant user input error and poor data quality for those projects that collect specific data points from users or rely on coded data to trigger an action or a response. SMS messages are limited to a small number of characters and this restricts the robustness of the data that can be collected and puts more responsibility on the users to use the abbreviations or codes to transmit data. For example, in logistics projects using SMS, we have found that tracking stock levels of 20 commodities is the maximum that can be handled in a single SMS. Entering that many products in SMS is a challenge for users who have to remember two-letter product codes to allow for the tracking of this quantity of commodities. SMS-based systems for national programs

typically also require negotiating a toll-free shortcode and this can mean an arduous, long-term, and expensive negotiation process spanning months, or even years, if the SMS aggregator industry is not well evolved. Finally, while the transaction cost of individual SMS is small, as systems go to scale this cost adds up quickly and needs to be weighed against the anticipated benefit.

Using GPRS has significant advantages for certain types of projects. Data transmission via GPRS enjoys lower transmission costs than an SMS-based system and hence reduces significant operational costs as projects scale. While SMS is a ‘best-effort’ transmission medium that frequently results in delayed or dropped messages, GPRS provides guaranteed delivery using the Transmission Control Protocol/Internet Protocol (TCP/IP). The use of GPRS-enabled handsets can also allow for richer and better quality data by supporting multi-step data validation and the ability to track a higher number of commodities than with SMS. Users can also save data on their phone when GPRS networks are not available and then transmit saved data later, something that is not possible with SMS.

*The main drawback of choosing GPRS as a communication medium is that it typically requires installing a software application on the phone.* This can be anything from a browser or email client to a custom software application. In the case of custom software applications, it is quite common to supply phones to end-users instead of relying on users’ personal handsets, in order to ensure a consistent, functional tool for the entire user base. The phones themselves are more expensive and would likely need to be purchased for the project in order to support the appropriate application. This results in greater effort and technical support for installation and troubleshooting than for an SMS-based solution. In addition to these upfront costs, expenses around maintenance, loss, replacement and recovery of phone sets can also be especially high in projects dealing with significant staff turnover.

GPRS-enabled handsets can provide for a more user-friendly experience in allowing project coordinators to incorporate pictures or audio to support low-literate users. Using an application allows end-users to bypass the need to follow the strict syntax of an SMS and can make data entry highly user-friendly. Mobile applications also help secure data by allowing for data encryption before transmission and then decryption on receipt. There are also fewer limitations on how much data can be transmitted over GPRS-based systems. In use cases involving frequent messaging, such as on a daily basis, the upfront cost of a GPRS-enabled phone can be offset by savings in data expenditures in as little as a few months. A more extensive analysis of tradeoffs within each system are discussed in, “Mobile Technology for Community Health in Ghana,” a report published by the Grameen Foundation.

Many of the projects featured in the case studies below chose to use SMS to reduce the initial startup costs, technical support needs, and implementation challenges around phone management. However, this decision also limited the complexity of the data the systems could manage and limited the ability to store data while offline or when the network connectivity was poor. This choice was appropriate given the small amount of data that required mobile collection, but as each system scales and additional reporting requirements are added, all the projects will need to explore the option of transitioning to a more robust GPRS-based system.

### *Lesson Learned*

SMS-based systems are less expensive to initially deploy and easier to maintain, especially across a large number of users. SMS systems also require minimal training particularly when users are already familiar with the technology. However, compared to GPRS systems, they are limited in the amount and

quality of data that can be transmitted. While GPRS systems typically require a greater investment in mobile phone hardware and support, the transaction cost of SMS systems are higher as systems scale and increase in complexity.

## CHOOSING A MOBILE PLATFORM

The most common kinds of mobile phones can be divided into three broad categories: basic non-Java-enabled phones, feature phones, and smartphones. The phone type will lead to different choices in the selection of mobile platforms and developer environment. Each project will need to look at its technical requirements, budget availability, and user-base to determine the appropriate platform for the project. As discussed in the previous section on data transmission, a project that requires GPRS data transmission must use a Java-enabled feature phone or smartphone. But, there are still many mobile platform choices for projects that require GPRS capability, and many implementers find these choices difficult to understand and navigate.

The price of a basic phone drops every year and in many countries is now within the purchasing power of user groups at lower income brackets. The decision to use a system that revolves around phones that users already have means the intervention will need to rely on SMS or voice calls. Voice calls allow for rich communication. An example of a voice feature useful in the supply chain sector is closed user group calling by which members of a group can make free calls to one another. This can be used for a variety of tasks including real-time reporting of stock levels or ordering of new supplies. In most countries, however, voice calls are many orders of magnitude more expensive than sending an SMS, which has limited their use in formal ICT4SC projects.

One option that addresses the data limitations found with SMS-only systems is the feature phone: a phone capable of accessing Internet service and basic multimedia. A project using feature phones has the potential to create a rich user experience. Feature phones are commonly employed in applications involving complex interactions; for example, to facilitate a workflow which requires monitoring and tracking a significant number of commodities across a number of facilities, to provide decision-support to mobile workers, or to generate graphs based on collected data accessible by phone.

Smartphones typically allow for the best user experience. Smartphones have the most sophisticated interfaces and advanced features of the three options and include additional features like GPS, barcoding, touch-screen interfaces, and improved memory and performance capabilities. Smartphones provide the ability to browse the web and communicate via email and text. In addition, most smartphone platforms have a group of developers developing custom applications for that platform, and these applications can often be used as the basis for the features and functionality needed by an ICT4SC projects. For example, the Open Data Kit (ODK) suite of tools for the Android platform can be easily customized to collect and analyze the data needed for a logistics project. The drawback, of course, is that smartphones represent the largest upfront investment due to the high cost of handsets. Additionally, installation and maintenance of new features, bug fixes and broken handsets may require technology expertise not locally available. Finally, while many users are familiar with feature phones, a smartphones may also require additional training for even basic features (such as how to make a phone call).

The following table summarizes respective advantages and challenges of all these three mobile platforms.

Phone Type	SMS	GPRS	Advanced Features (e.g., Barcoding, GPS)	Multimedia Capabilities	Decision-support	Cost	Maintenance and Tech Support Costs
Basic Phone	✓	✗	✗	✗	✗	\$	\$
Feature Phone	✓	✓	✗	✓	✓	\$\$	\$\$
Smartphone	✓	✓	✓	✓	✓	\$\$\$	\$\$\$

#### *Lesson Learned*

Projects using SMS-based systems have demonstrated considerable success and scale, even with users who had to rely on personal phones and used widely varying phone models. For GPRS-based systems, feature phones are appealing due to the lower hardware costs, unless there is a specific feature or performance constraint that necessitates the use of smartphones. In order to minimize training and maintenance costs, we have found it very helpful to choose a consistent mobile phone platform across users or groups of users, ideally one in line with existing policy and already familiar to end-users.

# Program Design

In designing systems for ICT4SC projects, it can be difficult to identify which core requirements a system must minimally meet to work at optimal efficiency. *What features are end-users most likely to use? How will the introduction of new technology impact the current workflow?* To answer these and related questions to user experience often requires an understanding of end-user motives and how closely the ideal diverges from the actual workflow.

## FOCUS ON CORE WORKFLOWS TO START

In designing the functionality for a new ICT4SC project, we have found there is a temptation to try to anticipate a variety of different needs and meet them all from the outset. This inclination to “over-design” often arises as a result of a desire to respond to all current and future needs. In the projects highlighted in this report, over-designing in the early stages often led to spending time and budget on features that were not critical to the actual impact of the solution for end-users and stakeholders. Starting with the core workflows and uses first, testing them, and then building from there may have led to a better end product and less wasted development time. At the same time, it is critical that solutions are designed for appropriate scale and allow for the addition of new functionality to avoid expensive rebuilds in the future. But many projects, as described in the examples below, try to build all functionality upfront before the solution is tested with users in the actual implementation environment. A comprehensive solution will almost always require several iterations in response to frequent field-testing, and project managers must set this expectation with end-users and stakeholders early in the process.

A common theme emerged as we reviewed the lessons learned from the projects highlighted in this document. A lot of design work invested up-front typically led to a system where a small set of core functionality was used extensively while the majority of more complex features ended up not being used regularly. For example, in cStock, the basic ordering workflow is used extensively. Significant design work initially went into specifying additional SMS workflows for tasks like giving stock from one health surveillance assistant (HSA) to another, or receiving stock from a source outside of the regular supplier, such as the private market. These features have rarely been used in implementation, and those users who were trained to use them would likely need retraining at this point to implement those features. Similarly, in ILSGateway, the team spent a lot of time in the early stages of the project to support integration with Google documents and scanners in order to digitize paper records. This ended up being more involved than was practical – and also required better connectivity and resources than were available – and so these features have not been implemented. In Version 3 of vrMIS in Mozambique, the database was designed to allow for future uses that never materialized. As a result, Version 4 actually removed some of those features and simplified the underlying database to remove unused features and functionality in order to make technical support and future additions of new features easier.

Yet in some cases, cursory initial design efforts might also lead to missing functionality. This was partially the case for the Malawi cStock project, where the initial specifications during the design phase underestimated the potential utility of performance reports. After nine months of implementation, the

team had to step back and spent considerable time planning how the data could be analyzed and presented in performance and supervision reports. Because these data were not available at a credible level of accuracy initially, the designers had trouble understanding how the data could be translated into usable reports for monitoring and decision-making. It was only after field-testing that the data were available to design quality performance reports.

### *Lesson Learned*

Going forward we would recommend that programs focus on implementing core functionality first and then scaling functionality and sophistication over time. This will help to get to prototyping and field-testing quickly which helps to identify what aspects of the planned intervention will have the most value. This approach saves time and energy on developing functionality that may not ultimately be used or adopted by the end-users. At the same time, certain components – such as the future scale of the system, the ease with which new functionality should be added, and the long-term vision for the application – must be considered upfront in order to ensure that the solution will meet long-term needs.

### **REINFORCING HUMAN FEEDBACK, ESPECIALLY AT THE LAST MILE**

A lot of emphasis has been placed on the use of mobile technology to get access to better data, faster. At the same time, the best data can be gathered by integrating the technology with existing workflows so that the feedback loops and incentives are aligned to ensure the system is used. We have found that technology solutions that provide regular feedback to users are more likely to be used over time.

In the cStock Malawi pilot, where HSAs used SMS reporting to order medicines from the nearest health center, there have been very high reporting rates and adoption levels. HSAs in the study were broken into two groups: one group received enhanced supervision on a regular schedule in the form of regular SMS reminders throughout the month; while the other group had a more flexible resupply schedule so that they could order supplies whenever they went to the health center and were only reminded to report if they had not reported in the last 28 days. The system demonstrated that the first group, which enjoyed enhanced management, regular reporting, and more feedback throughout the month demonstrated much higher reporting rates than the second.

For the Early Warning System, users indicated they would like to receive direct feedback from the district or regional medical stores in response to their continuous reporting. Many users requested that the SMS reports sent should also trigger a new order. For the ILSGateway system, users did not receive direct feedback from the medical store or from their district supervisors in response to their reports. This infrequent feedback may account for the comparatively lower reporting rates for the ILSGateway project than for a project like cStock where the submission of an SMS report triggered a response and a resupply from the receiving health center.

Providing the right feedback to the right people includes making sure that teams and supervisors have all the information they need to support one another. In Ghana, responsibilities were divided up within larger facilities so that different staff members were responsible for submitting data on different commodities. Nurses reported on family planning commodities, laboratory staff on rapid diagnostic kits (RDTs), and pharmacists or supply officers on the remaining commodities. The initial version of the software notified a supervisor if no SMS stock reports were submitted during a given reporting period,

but no feedback was given to the direct supervisor for incomplete reporting. The rate of incomplete reporting skyrocketed over the course of the pilot to over 75% as no feedback was provided to users for submitting or not submitting a report. Once this trend was recognized, the system was updated to provide incomplete reporting feedback to everyone registered for SMS at the relevant facility. The incomplete reporting rate dropped, by up to 60% in some districts, as a result of this change.

### *Lesson Learned*

When designing a system, a failure mode analysis can be a useful exercise to ensure that the system sends the right information to the people who are responsible for taking action. A failure mode analysis, a common exercise in software development, is a process that prompts managers to analyze ways in which a system could malfunction by listing possible system failures and devising a detection strategy for each possible failure. For example, in designing a basic SMS stock reporting system, one might list out each of the actors involved anywhere in the system and the set of responsibilities they are expected to fulfill. Then, for each responsibility, list out what indicators would demonstrate a failure in that responsibility and what strategies should then be used to mitigate that failure. The technology should be designed in such a way that reported data transmission triggers a communication or action that directly affects the reporting party within a reasonable timeframe. This kind of feedback reinforces the value of reporting and ultimately leads to data of higher quality.

## COORDINATING NEW TECHNOLOGY WITH CHANGES IN WORKFLOW

Technology can be a means of process improvement, but introducing new processes and new technology simultaneously increases the amount of time and support needed for adoption of the technology. In planning the implementation of new technology, implementers should consider the optimal timing for introducing new systems.

With vrMIS in Mozambique, the information system was supporting a new logistics process, which was a change from the system that had previously been used to distribute vaccines. In order to ensure strong data quality, the team first worked on the paper forms with the logistics staff collecting the data to ensure that it was easy to use in the field. From there, the screens and workflow in vrMIS was designed to mirror the paper forms with which the staff had become familiar. This made the introduction of vrMIS easier because the introduction was done in stages. In the first stage, the field staff used only the paper forms to collect the data which helped them get used to filling out the correct data. In the second stage, the field staff started entering the data from the paper forms into the computer with offline data entry screens that mirrored the flow and data fields of the paper form. In the third stage, mobile data collection was added using ODK Collect, but the screens in ODK Collect still followed the exact flow of the paper forms.

There are times when rapid change is better and there can be benefits to making bold changes all at once to improve processes. Implementers just need to be realistic about the time it will take for the end-users to learn both a new process and a new technology at the same time and ensure that appropriate support is available to make both successful.

There are also times when introducing a technology into an existing process highlights gaps in knowledge of the underlying process being automated. This was a case with ILSGateway, where the team realized during the training portion of the pilot that many of the health workers attending the

training had never received basic training on the paper-based logistics system itself. For this reason, a conscious decision was made to merge training for ILSGateway with general logistics refresher workshops. Synchronizing the training modules on both ILSGateway as well as the existing paper-based logistics system allowed implementers to capitalize upon a coordinated approach to process change and also save on training costs.

### *Lesson Learned*

Introducing a new technology can be done as part of an existing logistics system or it can happen as part of a broader redesign of logistics processes. Whatever the approach, it is valuable to consider the technology aspect independently of changes in other processes and weigh the benefits of introducing one first or introducing both side-by-side – particularly since both will likely require considerable effort to implement.

While integrating directly with existing workflows will likely require the least amount of training and process change, it is also important not to automate inefficient processes. Introducing technology is a chance to introduce process improvement, as long as appropriate time and support is available to support these process and technology improvements. In addition, we recommend ICT4SC project managers cultivate an awareness of how the introduction of new technology often results in the disruption of work for end-users. Implementers should carefully consider if the technology adds additional work for users and, if so, communicate the benefits clearly to the user.

### **DASHBOARDS ARE NOT ENOUGH**

Many projects are built around the assumption that increasing data accessibility will naturally lead to end-users reviewing and acting upon the data. We have found that even a visually-engaging dashboard with actionable data does not sufficiently guarantee use of the data. While well-designed interfaces are important, an evaluation of our collective experience demonstrates that central dashboards are not enough to prompt end-users to view and use data in their work.

Data analysis, although critically important, is often the last item field staff have time for when they are solving ongoing crises and reacting to pressing priorities. Instead of depending on users viewing the data on their own – regardless of how nicely displayed data are – we have found that SMS or e-mail alerts are an important ‘push’ mechanism that can effectively engage end-users with small subsets of actionable data. For example, one of the features that ILSGateway users appreciated was that SMS message served to provide information to district managers on facilities that had not yet reported. This was actionable data and something that the district managers could easily follow-up on without having to visit the website. In adding an SMS alert feature, it is important though not to send too many alerts as an overwhelming amount of SMS alerts may desensitize users. This was initially the case for the Malawi cStock project, in which district alerts were originally sent each time a health surveillance assistant encountered a problem. The numbers of alerts sent to the districts were eventually reduced to two messages a week by aggregating multiple troubleshooting instances into just a few weekly emails.

In many cases, particularly for high-level administrators, reports also need to be directly emailed to key stakeholders or printed and brought to users in hard copy. Both ILSGateway and vrMIS has taken this approach, emailing the monthly data to key stakeholders who would find the data valuable but

do not often take the time to access the dashboard online. Building in feedback mechanisms into the web-based interface, can also serve as effective prompts for managers to log in. For example, cStock's group messaging feature, which fosters free-form communication, enabled central managers to send congratulatory messages to districts with high reporting rates and successfully triggered more frequent visits to the dashboard by district-level personnel.

Even with SMS and email alerts and reports built into the system, none of this is a replacement for effectively engaging and integrating with the human processes around supervision and feedback. Sufficient training must be given to new technologies and supervision must be conducted to ensure adoption, feedback, and evolution of the systems. Collecting feedback after the system has been implemented is also particularly important because it incorporates users' suggestions following their first-hand experience with the new interface. Finally, efficient human processes and practices are necessary to realize the full benefit of these solutions.

#### *Lesson Learned*

SMS and email alerts can be an effective way to 'push' data to users who might not be used to using such systems or might be more attuned to a reactive model of addressing supply chain failures, rather than preventing them. However, none of these electronic tools are a replacement for human monitoring, encouragement, and feedback around technology adoption and the integration of the usage of such systems into human workflows.

### **IDENTIFYING THE END-USER**

This report has so far addressed several assumptions on program design and technology design that generally hold long-term implications for supporting open-source ICTs for logistics projects in low-resource settings. A related question that needs to be considered carefully prior to implementation and continuously through the training phase, is deceptively straightforward: "Who is the end-user?" Selecting the appropriate end-user for a logistics technology carries benefits, challenges and implications.

Logistics and supply chain affect all actors of a health system, from community members to community health workers, facility staff, supervisors, administrators, and government officials. Deciding whom to target in this hierarchy is usually determined by looking at where these data are created and who creates them. In most cases this is the health worker at the service delivery point. One factor that is often overlooked is the time and effort it takes to train the clinical health worker or even community health worker at the service delivery point as the end-user of a technology solution. The training, support, and maintenance of a system increase, as the user base grows larger. Thus, selecting a large group of clinical health workers to report data may or may not be the best use of time. Although there are several advocates who believe data needs to come from the person who created that data, the trade-offs of acquiring data sets from this level and the impact on other aspects of health service delivery should be weighed.

In Uganda, the UReport system, which is a supplementary service to mTrac, designates community members as the end-users. Community members are asked to provide validation of facility-reported data on service and stock availability. This perspective is vitally important, since health services are ultimately responsible to the community and it is this project's mandate to raise the voice of the

community and accountability towards them. At the same time, low levels of education, lack of resources, and lack of dedicated time to use the system require that surveys be short and simple: surveys are typically limited to a single multiple-choice question per reporting period.

cStock targets community health workers at the farthest reaches of the health system. Stock level reporting and visibility here is typically a greater problem than at other levels of the health system, so the promise of mobile technology to improve visibility is particularly appealing. These CHWs maintain their own stock and report on it. The challenge with this approach lies with the steep learning curve sophisticated mobile technology represents for many low-end-users and the large number of end-users that need to be supported. The costs associated with training, retraining and ongoing support necessary to troubleshoot issues with a large group of low-end users often represents significant portion of the initiative's budget.

One alternative approach to minimize training and increase data quality and reporting is to target a small number of focal people who are responsible for data collection. These focal people might be responsible for supervising or surveying sets of facilities or CHWs and can collect data as part of their routine duties. Both vrMIS and the ODKScan implementation in Mozambique have taken this approach, as VillageReach's experience has been that centralizing data collection responsibility into a smaller group of trained personnel can greatly improve data quality, decrease costs associated with training, and still provide the necessary results in terms of increasing timely access to data or making data more visible at all levels of the system. Training can be accomplished very quickly and support streamlined with a small set of dedicated users. More sophisticated tools can be used when working with a smaller user base, while still keeping costs down. This approach can be particularly effective if such a supervisory or supportive role exists and can be leveraged within the pre-existing logistics workflow. One drawback is that it places an intermediary layer between health service providers and logistics management, a layer that can reduce data quality or cause delays in the event that that focal person is unavailable or poorly trained. The opportunity for failure - or success - is concentrated in that critical focal person.

### *Lesson Learned*

There are many successful projects that have taken different approaches to identifying the end-user. The successes of various case studies validate that both approaches can be valuable and ought to be considered based on project needs. Given the unique aspects of each project, we foremost recommend that implementers identify all the potential users within a system and consider the tradeoffs in regards to the quality of data, ongoing training, support requirement and data collections issues that come along with selecting a high or low-level personnel as the target end-user.



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# Training and Support

## PLANNING TRAINING

Determining who to train, how to train them, and what to cover in the training is critical to implementation. Many ICT4SC projects start with a single training plan and then quickly learn that a diversified approach is needed. In the Early Warning System (EWS) in Ghana, the trainings initially focused almost exclusively on how to use the SMS system, with a short refresher on the logistics process within the Ghana Health Service (GHS) at the outset of training. It quickly became evident that very few attendees had received previous logistics training and many seemed surprised that logistics was within their realm of responsibilities due to a high turnover rate among health staff. In subsequent trainings, the agenda was revised to focus more heavily on revisiting and reinforcing regular logistics practice; this occurred all before the SMS component was added. This approach resulted in much better assessments by participants of the workshops and improved practice and retention beyond training.



Training Session © Dimagi 2007, Zambia

Similarly, a targeted training program was developed on the ILSGateway SMS system geared towards logistics staff and supervisors in a compressed timeframe. During the initial pilot trainings, it quickly became apparent that staff attending the trainings were unfamiliar with the paper logistics system. In response, JSI and the Ministry of Health and Social Welfare quickly amended the training program to be more comprehensive and cover the logistics system as well as the ILSGateway system. This was a much more significant investment, but it was also more efficient to do both trainings at the same time since staff would be traveling and taking time to attend.

Determining who should attend training is also important. The trainings for the EWS deployment in Ghana initially included everyone involved in any aspect of logistics management: the family planning nurse, lab technician, pharmacist, supply officer, and one or two other staff members. After the first set of trainings, the number of invitees was reduced significantly since only one or two people were ultimately responsible for reporting. The agenda for the training was also changed to indicate where supervisors and facility in-charges would get value, and what sections only required attendance by staff responsible for reporting. These changes did not have any negative impact on uptake or reporting rates, and it reduced training costs significantly.

For any program at scale, training is likely to happen over a long period of time and will have to be repeated. Determining who can be responsible for ongoing training and how to fit this into currently established roles is critical to rolling programs at scale. Ongoing support is also needed, so the closer trainers are to the users, the more they can help with additional refreshers or ongoing training after

initial deployment. For ILSGateway, which will eventually serve all of Tanzania's 5,500 facilities, training all health facilities will happen over more than a year. A regional training-of-trainers (ToT) model was designed to reach this large number of users over time.

In addition, finding facilitators with the correct level of technical skills to support users can also be a challenge. In Ghana, trainings were initially run by a combination of GHS and program staff. Afterwards, a training-of-trainers was organized to train administrators at various levels. Those trainers would then be expected to assist and eventually lead the facilitation of future trainings. In practice, however, administrators were never responsible for submitting text messages themselves, and so felt poorly equipped to be teaching others on how to do such a thing. Eventually, the ToTs were discontinued, and the local District Health Information Officer (DHIO) — who had already been extensively trained as technical support staff for the system and who had gained much experience helping facility users to submit stock reports successfully — became responsible for facilitating training.

### *Lesson Learned*

Programs must determine the overall logistics knowledge of those being trained and plan trainings accordingly. Short refresher trainings should follow up the initial training after a few months in order to address the many questions that arrive in practice. Involving all the stakeholders in training for the sake of inclusion has its drawbacks. Not only does a large training session carry an additional expense, it can be inefficient for providing the key users with the training they need. In our experience, it has been sufficient to focus the majority of the training on the target users as well as a small number of backup users in case the target user is unavailable. A subset of the training should be set aside to orient managers and other relevant stakeholders, but this can be short and directed.

The ToT model has demonstrated a lot of success and has been widely utilized in logistics program initiatives. However, one thing that a ToT model cannot provide is the kind of comfort and expertise gained by users responsible for using and supporting a complex system for several months. While it is still important to engage with local authorities and trainers when conducting trainings, a vital resource that should also be leveraged are the "power users" from the pilot or previous deployments.

## SUPPORTING CONTINUOUS TRAINING

The discussion with training has so far focused on 'classroom' training. Too often, conversations on training only focus on initial or refresher classroom training and regular continuous training is overlooked. There are several reasons why continuous training should be planned and supported as an integral part of program operations.

First, training interspersed during regular work phases and located at the work environment addresses the common knowledge attrition that results due to the high turnover rates of personnel in low-resource settings. By holding an initial training and then following up with monthly support meetings, the vRMIS deployment in Mozambique was able to identify and train new workers and refresh end-users' skills on complex features. They were also able to demonstrate and support the system in real-world use cases, and address complex questions that arise when a system is actually in use. Finally, this minimized the need for dedicated training facilities as well as the burden of time and travel faced by attendees. The main drawback of such a hands-on approach to continuous training is that it can only be realistically supported with a small number of system users. In Malawi, central managers have

dealt with time constraints by using cStock's group messaging feature to reinforce the need to confirm receipts and other kinds of basic training feedback within an electronic forum.

### *Lesson Learned*

Refresher continuous training is an effective method to identify and train new workers, demonstrate the system, identify real-world challenges and solutions, and incorporate staff members whose skills are crucial for successful implementation of new systems. While the effort required in supporting continuous training necessarily limits how widely it can be applied, such an approach is viable and effective for a small number of users.

## EFFECTIVELY LEVERAGING EXISTING SUPPORT STRUCTURES AND EXPERTISE

Identifying the appropriate people to do ongoing user support, especially for logistics applications with a large number of end-users, is one of the most important tasks for a successful project. Since all the logistics projects here are implemented in partnership with the public health sector and the ministries of health, all projects had to find existing resources within the public sector that can support users as the projects grew and scaled. The Early Warning System in Ghana leverages the local DHIO in each district deployment to provide technical support as well as handle user and facility registration and deletion. DHIOs played a crucial role in the success of the pilot.

In designing a health-strengthening system, there are many actors that can play a supportive role. Often NGO staff play a critical role, particularly in the initial setup, since they can help provide additional capacity during the early stages of a new initiative. Training multiple users at one health center or hospital can also be helpful as these users are then able to reinforce each other's performance as well as provide continuous training for new hires. Identifying and training district-level supervisors and/or district administrators to play a support role is another option, and both provide a level of authority that can help support technology adoption. Finally, it may be useful to identify any technical staff or technology vendors supporting the district, hospital, or health center because they may have the capacity and knowledge to be effective and informed support personnel.

In Ghana, the DHIOs were an effective resource for multiple reasons. They were a focal person within a group of facilities who could be relied on to have access to each of the facilities and facility information when necessary. Their job function required a degree of proficiency with technology and computers that proved invaluable. Their familiarity with laptops and access to Internet connectivity allowed them to manage registration quickly and answer questions with authority. Finally, as members of the district administration, they were an authority figure within the facilities, so could play a role reinforcing not only the technical function of the system but also incentives for health workers to participate.

### *Lessons Learned*

Many factors can contribute towards a successful support model for new technology deployments. Ideally, support personnel should be figures of authority, familiar with the user community, accessible, and have some proficiency in ICT tools. We recognize this combination can be difficult to find, but more ministries are adding a role similar to the Ghana DHIO to support health information systems projects at the regional and district levels and may be leveraged to support ICT4SC projects as well.

# Scale-Up

One common misconception among both technical and non-technical staff alike is that building new technology is a time-bound activity. While this may be true for a tool that is used indefinitely in exactly the same way, often software will need to grow and evolve alongside programs, practice, and deployment size.

## PROGRAMS AND PRACTICE

In many of the case studies highlighted in this report, the projects started by tracking data on a small number of commodities manageable through SMS. Invariably, as the pilots demonstrated their feasibility and success, ministries of health or partners requested that the systems begin tracking additional commodities. In some cases, these requested including tracking products at additional levels of the health system or adding new donor-specific reporting requirements, which were not included in the original technology platform. In Malawi, some stakeholders expressed an interest in expanding the system designed specifically for logistics monitoring to also track service delivery indicators, a task which would have significantly raised the scope and complexity of the software design and program implementation. Similarly, as the paper-based logistics system for reporting, delivery, or inventory management evolves, the requirements for the mobile component may have to shift and change. In Mozambique, rapid diagnostic test kits were added to the logistics system that vrMIS supported. This meant data needed to be collected from the lab at each facility, and not just from the immunization program. This changed the specifications for the technology, but also changed the process by which data was collected and the people who needed to be involved. These types of changes can have serious implications on the requirements for the mobile component and the implementation of the technology.

### *Lesson Learned*

Project directors can anticipate and plan for program integration and allow for flexibility in order to facilitate a smooth transition from pilot phase to scale-up. This consideration includes defining the potential scope of a successful system: what it may grow to cover, and what it should leave to other systems. Program managers also need to work with stakeholders to be clear about what is feasible to do within an existing system. Very successful systems with a narrow scope have become less useful and overburdened as more functionality and features are added so the tradeoffs need to be well understood by everyone involved in implementation.

## ITERATING QUICKLY VS BUILDING FOR SCALE

A challenge many ICT4SC-related projects face is the tension between building technology that is deployed, tested and modified quickly versus a technology that can handle a high number of transactions as the system goes to scale. The underlying reason for this tension is that the two goals often – although not always – oppose one another. Developing something quickly for field testing and piloting often leads to a lightweight solution, whereas software built for scale requires investing in a strong backbone which can effectively queue, schedule, and batch operations. These contrasting approaches lead to different decisions throughout the design, development, and implementation

phases of a project.

Failure to scale can be discovered quickly when a system fails catastrophically, or it can manifest itself as a slow and gradual decrease in performance, which may initially be easy to ignore. In the ILSGateway project, initial priority was given to developing a system that could be pilot-tested quickly with a relatively simple set of use cases. Targeted reports, which would draw information from the data, were added over time. This approach was effective for demonstrating the potential impact of the system during a pilot phase with a limited number of districts and providing immediate value to the MOH. However, as the number of users and the amount of data being processed scaled, many of the web reports became steadily slower, until the point where some reports sometimes took several minutes to load. When the initial success led to a decision to scale the system to all 5,500 health facilities in Tanzania, it became necessary to invest resources in core infrastructure performance improvements. The software team moved to data warehousing to reduce the number of calculations needed and used distributed technologies for storage and processing to share the calculation load among multiple servers. A core architecture build-out was required to reduce response times to an acceptable level, and the associated effort was a significant portion of the overall software development work. This level of effort, for a system that was already considered 'working', came as a surprise to stakeholders, causing budget issues and delays that could have been better anticipated and communicated.

#### *Lesson Learned*

Not anticipating scale appropriately is a critical issue that many ICT projects face. Scale should be understood during the design phase. The trade-off between developing for scale and developing lightweight applications for field-testing must be communicated to all stakeholders and funders. Developing systems for scale is a difficult task, requiring serious investment in time, funds and resources. Project managers need to recognize the necessity of this investment, and plan and communicate the benefits and risks of not planning for scale upfront. Once functionality has been tested and verified, and before a system can go to scale, it needs to be capable of handling the load necessary to support expansion at scale, and this built-out can raise the cost of software development by an order of magnitude or more.

# The Early Warning System

## Ghana



### Description:

#### The Program

In 2009, the Focus Region Health Project (FRHP), implemented by JSI Research & Training Institute Inc., in collaboration with Ghana Health Services (GHS) and the USAID | DELIVER PROJECT, engaged with Dimagi to design and implement the Early Warning System. The goal of this system was to improve supply reporting from health facilities and detect stockouts, with the intention to help prevent stockouts by enabling districts and facilities to anticipate usage patterns and plan resupply orders using automated data analysis tools.

#### The Technology

Service providers use their own mobile phones to report stock levels of tracer commodities via SMS to a dedicated, toll-free short code on a weekly basis. Commodities were selected from a cross-section of priority programs including family planning, malaria, and HIV/AIDS. All levels of facilities are represented, from rural community outposts to urban teaching hospitals and the regional medical stores (RMS). Data is then processed and made available to all relevant parties via a website which allows users to view national data as well as drill down to specific regions, districts, or facilities of interest.

#### Achievements

An initial pilot was completed by FRHP with facilities from six districts between 2009 and 2010, as

well as an extension of the pilot that focused entirely on HIV/AIDS commodities in an additional 89 districts elsewhere in the country. Following the success of the pilot, FRHP and GHS are expanding full coverage to an additional 6 districts, while The USAID | DELIVER PROJECT is scaling the intervention across all ART sites in the country.

### Challenges and Vision

This system has demonstrated that accurate, real-time information on stock levels can be effectively and consistently captured over time through the use of personal mobile phones and a toll-free shortcode. Current challenges include engagement with the larger facilities, particularly the RMS, who need to manage a large number of commodities, as well as the analysis and interpretation of the rich data received in order to better inform decision-making. Looking ahead, many users have suggested that the next step would be to somehow integrate this information in order to trigger or expedite the formal paper-based requisition process.

# cStock

## Malawi



Name: Supply Chains for Community Case Management of Pneumonia and Other Common Disease of Childhood Project

Partners: JSI Research & Training Institute, Bill & Melinda Gates Foundation, Malawi Ministry of Health

Start Date: 2009

Mackson HSA Phone: ©VillageReach 2010, Malawi

### Description:

#### The Program

In Malawi, community health workers, also known as Health Surveillance Assistants (HSAs), provide Community Case Management (CCM). These HSAs carry and prescribe a defined list of essential medicines such as ORS, anti-malarials, antibiotics, and family planning commodities. The Improving Supply Chains for Community Case Management of Pneumonia and Other Common Diseases of Childhood project (SC4CCM), implemented by the JSI Research & Training Institute, Inc. (JSI R&T) funded by the Bill & Melinda Gates Foundation, has worked with the Malawi Ministry of Health in developing approaches to address the lack of data visibility in the health supply chain for HSAs, which contributes to poor product availability in hard to reach areas. With 94% of HSAs surveyed owning a mobile phone, SC4CCM has developed a mobile system to not only to improve data visibility, but also to streamline the HSA requisitioning process.

#### The Technology

The system, known as cStock, allows HSAs to use their personal phones to submit SMS with stock information, allowing community level data, previously unavailable, to be visible to decision makers at all levels of the system. cStock automatically calculates the resupply needs for an individual HSA based on reported stock levels and system-calculated consumption, and transmits this need via SMS to the corresponding health center, enabling staff to pre-pack orders in advance of the HSA arriving. A second message is sent by the health center staff who then informs the HSA when their products are ready

to be picked up. In addition, cStock alerts higher-level staff via SMS if supplies cannot be replenished, or if an HSA remains at low levels of stock despite being resupplied. Data is also available via a web-based dashboard that provides timely visibility into actual stock levels held by HSAs, enabling real time identification of problem areas and overall monitoring of supply chain performance by the district and central level administration.

### Achievements

To date, cStock has been deployed to over 1,500 HSAs in Malawi (representing involvement of 15 out of 30 national districts), with regional reporting rates over 95%, demonstrating that regular, scheduled reporting and supervision result in significantly higher reporting rates than those done in an ad-hoc manner.

### Challenges and Vision

Current challenges include the fact that while many HSAs have phones, many do not know how to send SMS, and so additional effort must be invested in training in order to learn that new skill set. Currently the HSA programs are managed regionally by different organizations. Some of these organizations give the HSAs a mobile phone with custom software installed to help them manage their clients. Looking forward, one possibility for improving usability and data is to integrate the cStock system into these mobile applications so commodities can be tracked directly against clients.

# vrMIS

## Mozambique

Project Name: Dedicated Logistics System (DLS) Program

Partners: VillageReach, Mozambique Ministry of Health

Start Date: 2002



Vaccine Outreach: Photo courtesy of Naashon Zalk/Full Frame 2005, Mozambique

### Description:

#### The Program

Since 2002, VillageReach has worked with the Ministry of Health of Mozambique to implement the Dedicated Logistics System (DLS), a vendor managed inventory, level-skipping model for vaccine distribution with the goal of improving access to vaccination services by addressing supply chain challenges. With a successful pilot showing DPT-Hep B3 vaccine coverage rates increased from 68.9% to 95.4% at a cost of 17% more cost-effective per child vaccinated and 21% less expensive per vaccine dose delivered, the system has progressed from an NGO project in one province to a government-led implementation with technical support from VillageReach in 4 provinces with 440 health centers reached monthly. An automated data collection and analysis tool, called vrMIS or the DLS Information System, is a critical component in the successful implementation and outcomes of the Dedicated Logistics System.

#### The Technology

An Internet /mobile-enabled, open source eLMIS application called vrMIS is used to store and report on data collected during vaccine distributions. Because 80% of the health centers do not have electricity and cell phone coverage is limited, the system moves information by taking advantage of the monthly circulation of the delivery trucks from the provincial level through each health center and back. Those delivering medical commodities also serve as data collectors, collecting data on stock on hand, cold chain performance, consumption, and services provided. The data is then entered in an

offline application that is uploaded to a cloud-based server. Several reports of the data are available online and offline to users anywhere in the world with login credentials.

## Achievements

A first version of vrMIS was implemented in 2004 and with continued interest and need, the system is now in its fourth iteration with a series of technological and process innovations. The technology has changed from an Access database in 2004, to an open-source, web and mobile enabled cloud-based application with offline and online functionality today. In 2011, the implementation was completed in four provinces reaching 440 health centers monthly. The information system enables users to track the nature and location of the problem. For example, it shows when there is a refrigerator problem and the location of that refrigerator. With the implementation of the DLS and vrMIS, key metrics such as vaccine stock outs and refrigerator problems have reduced to within target levels.

## Challenges and Vision

This system has demonstrated that accurate, real-time vaccine supply chain information extending to the service delivery point can be successfully collected and used for improved outcomes. Work continues to institutionalize the use of the system for decision-making, and VillageReach's technical support continues to focus on this crucial aspect. One of the learnings from the implementation was that despite easy, offline access to reports was readily available to users on an on-demand basis, users did not log in to the system to access reports, but waited for reports to be sent to them with preliminary analysis before examining the data. Additionally, despite extensive online functionality of the system to drill down indicators and find the sources of outliers and problems, users did not take advantage of the functionality.

VillageReach plans to implement on-site electronic data capture through an offline mode within the coming year. While the current paper-based data collection is highly valued and institutionalized, electronic data capture will result in reduced time spent on the data collection and entry and is expected to reduce errors and lag time. While vrMIS has been released publicly as open source, another major initiative in the current year is to enhance and integrate with other health commodities through the OpenLMIS initiative, making the technology more widely available. Finally, work will continue to ensure that the system supports and is coordinated with global work being done to define a standard set of vaccine supply chain indicators and reporting.

# ODK Scan

## Mozambique



### Description:

#### The Program

Mozambique's Ministry of Health (MISAU) began the Agentes Polivalentes Elementares (APEs) program to extend coverage of the national public health system to include underserved rural populations. APEs are Mozambique's Community Health Worker cadre. APEs have catchment areas of 500-2000 people and have routine tasks including developing strong ties to their community, health promotion and education, family planning counseling, and prevention and treatment of common ailments. Currently, APEs are given a kit of standard quantities of predetermined products for distribution on a regular basis, with consumption tallies collected on paper forms. Each APE receives two kits each month, in addition to rapid diagnostic tests for malaria.

The USAID | DELIVER Project and VillageReach jointly created a study using ODK Scan, a mobile phone application that digitizes paper data, to inform actual consumption and use the data to improve the availability of commodities.

#### The Technology

Each APE tallies the distribution of commodities on a paper form, which is collected on a monthly basis by the supervisor in his or her district. The supervisor is equipped with an Android phone that has the necessary applications for the project, ODK Scan and ODK Collect. The supervisors, who have received training on ODK Scan from the local VillageReach office, scan each form with an Android phone that

has the ODK Scan application on it. The phone digitizes the tallies of commodities distributed, similar to a Scantron form used for standardized testing or voting. The purpose of the scan is to improve the accuracy and speed of data collection over manual tallying of forms. The supervisor exports the form to ODK Collect and completes the digital data entry for fields that are not digitized, such as text and select fields. Finally, the ODK Collect form submits to ODK Aggregate, a cloud based database.

## Achievements

The study will examine six months of consumption data to determine the quantities of each commodity that is used, distributed, and received by each APE. This data will provide better information about the actual inventory needs and will inform improvements to the system, including the frequency of resupply, the APEs commodity needs, and the unplanned transfers that may happen between APEs in the case that emergency stock is required.

Based on preliminary findings, scanning, completing, and submitting each form takes approximately ten minutes of a supervisor's time and results in immediate data availability.

## Challenges and Vision

The study will conclude in June 2013 and until then there is limited data on data quality. In addition, there is no data on how the data is used in the decision making process. If the study results show that using ODK Scan is not a significant burden on staff and provides actionable data that is used in the decision making process, it can be easily scaled to additional districts, provinces, countries, and programs.

# ILS Gateway

## Tanzania



Project Name: ILS Gateway

Partners: Ministry of Health and Social Welfare, USAID | DELIVER Project

Start Date: 2008

Stakeholder Meeting: © Dimagi 2011, Tanzania

### Description:

#### The Program

As part of a larger effort to integrate and streamline logistics management in Tanzania, the USAID | DELIVER PROJECT and the Ministry of Health and Social Welfare (MOHSW) established the ILSGateway in 2008 in order to expand accessibility and visibility of logistics data to inform supply chain decision making through mobile technology.

#### The Technology

ILSGateway is an open source platform, built on RapidSMS, which allows health facility personnel to use personal mobile phones to send SMS to a toll-free short code ("15018") reporting data on stock levels of tracer commodities. ILSGateway does not replace the paper reporting and requisition process to Zonal Medical Stores, but instead provides visibility into monthly stock levels for a small set of tracer commodities. In addition to tracking and reporting on end of month stock on hand of these tracer commodities, ILSGateway was also designed to reinforce and monitor the Integrated Logistics System (ILS) which is used to order and distribute the majority of medicines and supplies for health facilities in Tanzania. Health facility staff members using ILSGateway receive reminders to submit their quarterly Report and Requisition (R&R) forms on time, report when shipments of medicines are received, report on losses and adjustments that happened to tracer commodities, and report when supervision visits happen allowing district, regional, and national stakeholders to track performance of the ILS. An SMS aggregator directs the messages to a web database, which analyzes the findings and makes them

available to users through a web portal at [www.ilsgateway.com](http://www.ilsgateway.com).

### Achievements

A pilot program of the ILSGateway was initiated in November 2010 in Mtwara, Tanzania. The pilot began with an initial commodity list of six reproductive health commodities products, and based on its success, has since been expanded to 22 tracer commodities, identified as high priority by the MOHSW, across a number of different health programs (malaria, essential medicines, and family planning). Pilot evaluation results showed the ILSGateway was increased the number of health facilities submitting their quarterly reports and orders on-time, and has also increased the attention paid to supply chain reporting by both health facility staff and district staff. The ILSGateway is currently being expanded nationally, and is already in use in more than 2,300 facilities across the country.

### Challenges and Vision

ILSGateway relies on health facility staff being trained to use the system with their own mobile phones. Significant workforce turnover at the health facility level has made training challenging. However, district and regional staff have been trained to provide training and support to the new staff at health facilities in their districts and regions. The initiative also originally tried to digitize the paper R&R forms at the district level by using scanners and Google Docs to transfer the electronic file to the Zonal Medical Stores involved in the pilot. Due to limited connectivity at the districts, this technology was not successful. Looking ahead, Tanzania is planning to integrate the ILSGateway with a national open-source LMIS system in order to minimize duplication, reduce errors, and improve data quality.

# mTrac

## Uganda

Project Name: Focus Region Health Project

Partners: UNICEF Uganda, Ministry of Health

Start Date: 2012



HSA with Bicycle: ©VillageReach 2010, Malawi

### Description:

#### The Program

mTrac is an SMS-based disease surveillance and medicine tracking system that provides real-time data for response while monitoring health service delivery performance. The initiative also integrates governance and accountability through citizen feedback, an anonymous hotline and public dialogue sessions. UNICEF Uganda and the Ministry of Health are currently rolling this out nationwide (2012-2014). mTrac is supplemented by UReport, which uses free SMS to gather opinions from young people in remote areas. As of July 2012, over 130,000 young Ugandans had signed up to receive weekly polls to their phones on community services and youth issues. In return, subscribers receive results and useful facts for action. The Government of Uganda also publishes results in newspapers, radio and television.

#### The Technology

mTrac is based on RapidSMS, a free and open source framework for dynamic data collection, logistics coordination and communication, leveraging basic short message service (SMS) mobile phone technology. The bulk of mTrac was built by a small team of Ugandan software programmers, under the supervision of UNICEF, over the course of approximately six months. Additionally, Dimagi contributed work over a few months on the logistics and alerts modules. UReport was developed in a very similar manner and UNICEF recently launched UReport in Burundi and Zambia.

## Achievements

Since May 2012, mTrac has seen a steady increase in health facility and village health teams (VHT) reporting rates on almost a weekly basis. The reporting rates vary significantly among different districts, and nationally are at around 50% for both health facilities and VHTs. Approximately 70% of Districts are reporting at rates higher than the national average for the paper-based HMIS system, yet a small but significant number of Districts suffer from very low reporting rates. Support supervision visits have identified a number of factors potentially causing this, including weak District management and lack of general motivation. The mTrac team is now working through multiple channels to increase reporting rates, including providing District level updates to chief administrative officers and local government, and involving development partners working with these DHTs.

ACT medicine data has shown a general decrease in under-stocked and stocked-out health facilities. In July 2012, 25.2% of reporting facilities indicated a total stock-out of ACTs. By September, stock-outs had decreased to 14.2%. It is important to note that this should not be attributed solely (or even primarily) to mTrac, as there are a number of other more significant factors that have contributed to this decrease. It is even more difficult to explicitly quantify to what extent mTrac has contributed. However, this data is being used by NMS and the MOH at the national level for better planning, and many DHTs have described how mTrac has enabled them to better shift supplies from overstocked to under-stocked facilities. VHT stock-outs have been even less severe, with an average of 2.29% per week suffering from an absence of medicine.

## Challenges and Vision

An absence of a national eHealth policy has meant that there is currently no guidance on issues such as patient privacy, user authentication, hosting and integration. This has caused significant challenges in developing and deploying new eHealth initiatives, and has specifically slowed progress around solutions that address patient level needs (as opposed to aggregate data that mTrac deals with). Additionally, it is one of the primary reasons for low levels of private sector investment in eHealth in Uganda. Additionally, technical capacity of the MOH to fully take over management of mTrac has been slower than anticipated. This includes shifting the mTrac server to the MOH data warehouse (which suffers from inconsistent power and shoddy back-ups) and transferring support maintenance contracts to local software companies that the MOH can directly hire.

SMS messages in Uganda that run through third party aggregators generally get reprioritized against person-to-person messages and advertisements run by the telecoms themselves. This can lead to long message queues and delays of up to a day. This has become a major issue as systems like mTrac scale nationally and become relied on during emergencies. UNICEF is currently lobbying bodies like the Uganda Communications Commission to provide a special classification for humanitarian services like these, and ensure they get priority access.

Interoperability is a critical component to ensuring long-term ownership by the MOH. Our first test was exchanging data with DHIS2. While there were minimal difficulties developing appropriate API's and sharing data, matching health facilities proved a significant challenge. While both mTrac and DHIS2 started with the same dataset, during the past couple of years many changes were made by various stakeholders to the health facility databases, including recording upgrades of facilities, updating GPS coordinates, correcting spelling mistakes and changing ownership. This led to a divergence of almost

50% of the total dataset of 5000 health facilities, and identified a need to urgently work with the MOH to develop a national facility registry web service to serve as the “single version of truth” between all eHealth applications. We are currently working with a number of stakeholders to develop this, including HISP and ThoughtWorks, using the FRED API standard.

# Appendix A: Technology Overview

vrMIS: vrMIS is an HTML5 application developed to manage distribution of vaccines from the provincial level to the service delivery point in Mozambique. vrMIS is available in both offline and online versions, making it well suited for low-resource environments. vrMIS is free and open-source, released under the Eclipse Public License.

CommTrack is a lightweight logistic-system strengthening platform that interfaces with any mobile phone through simple text messaging (SMS). CommTrack is an open source solution and has been designed through real-world projects in resource-poor settings where organizations have adopted it to work with their various electronic and paper-based logistics systems managing their global health projects. It enables rapid communication between supervisors and their personnel in the field and eliminates weeks and months of delays in logistics management that are common to purely paper-based systems. Called “cStock” in Malawi, the architecture includes a cloud-based server and website that allows for real-time monitoring of data and automatic generation of reports, reminders and alerts. By virtue of its design on open standard tools, it can inexpensively supplement existing paper or electronic logistics systems, but is not designed to replace them.

The CommTrack Module is currently being used in Tanzania (where it is called “ILSGateway”), Ghana (where it is called “Early Warning System”), Malawi (where it is called “cStock”), and Uganda (as part of a system called “mTrac”). The Ministry of Health in Tanzania, Malawi, and Ghana are considering the use of this technology at national scale.

MOTECH Suite is a set of Open Source technology components from a consortium of partners who have recognized that their complimentary software efforts can address the core needs of mHealth. MOTECH Suite is a software platform from Grameen Foundation, Dimagi, InSTEDD and other partners that harnesses the ubiquity of mobile phones to deliver and receive information from patients and caregivers. By building on top of MOTECH Suite, NGOs and other health system implementers can more easily deliver solutions with lead to positive health outcomes. MOTECH Suite functionality includes the ability to:

- Communicate information to patients via voice or SMS
- Customize messages based on a schedule of care prescribed for the patient—appointments, pill reminders, or vaccinations
- Collect data from patients or caregivers on a mobile application
- Receive reports of services delivered by caregivers
- Alert caregivers to the status of their patients
- Coordinate messaging between different parts of the healthcare ecosystem

ODK Scan: ODK Scan is a mobile smartphone application developed by the University of Washington’s Computer Science & Engineering Department in partnership with VillageReach. ODK Scan uses computer vision to capture certain data types (checkboxes and bubble tallies) from paper forms and automatically converts it to digital data. It has the power to transform paper-based data into a scalable

digital system that significantly lowers time and cost for data capture, produces more reliable data from the last mile, and provides quick access to data to enable critical decision making by stakeholders at all levels in healthcare delivery. All of the data processing and digitization is completed on the phone, thereby reducing the need for Internet connectivity or cellular connections at the time of data capture. The use of computer vision algorithms to process the data reduces the amount of manual data entry necessary.

As part of the Open Data Kit (ODK) suite of tools, it is integrated with other tools, including ODK Collect and Aggregate, allowing users to complete the digitization of all data manually with Collect and submit to a cloud based database with Aggregate, making the complete digitized data immediately available and actionable.

OpenLMIS: OpenLMIS is a highly scalable, enterprise-level logistics management information system designed to support logistics operations as commonly handled in a broad range of developing countries, encompassing requisitions, orders, shipments, receipts, rationing and validation, backorders, product substitutions, inter-facility transfers, forecasting, and integration with central warehouse inventory systems. OpenLMIS is currently working in collaboration with two eLMIS projects in Africa, and expects these countries to be the initial deployments of OpenLMIS in 2013.

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