Last Mile Initiative
Community Health Data Collection
Sustainability & Pilot Plan

1. Introduction

The Last Mile Initiative Community Health Data Collection project was designed to allow community volunteers in Rwanda to go door-to-door and gather important health information from the citizens via mobile phone. The original scope of the project was to develop the application and perform a pilot test of it in two districts in Rwanda. Due to unforeseen political and funding issues that pilot was not performed and the development process was altered to accommodate the lack of hardware available to test with.

2. Development

One success of the work done on LMI has been that the public health professionals working in conjunction with the Twubakane project benefited from the process of us reviewing the data collection forms and the health indicators the forms are based on. Unfortunately for our development this caused a great deal of dynamic flow to the indicators and forms which in turn, required us to redo the database and forms.

2.1 OpenMRS

It was decided during the development process that the freely available OpenMRS[1] (Open Medical Records System) was a perfect fit for this project. OpenMRS provide a stable, flexible platform to work with when collecting health data. The open-source system has been under development for many years and has a very robust community which continually improves it. The community is very engaged and helpful, providing a good source for support not only in development, but in usage of the system as well.

2.2 Indicators

When the project started the Twubakane project had close to 30 health indicators in which the data collection forms were based on. By the close of our work that has been narrowed to 15 indicators. While this is good streamlining for their purposes it does point out the complications inherent to such a system.

Health indicators are always dynamic as diseases take hold in certain regions or populations and international focus shifts. It is important to understand and design for some shift in the indicators over longer periods of time. However, rapid changes would be detrimental to the data collection process as well as the availability of developer time in changing the database schema and front-end forms. The rate of change that happened during our work was unexpected.

2.3 Example: Adding an Indicator

If, for example a new indicator was added the database would have to be altered to include the new indicator. This would involve adding the new indicator to the schema however, since we are using OpenMRS the change would be fairly trivial. In fact, a non-programmer

1. http://openmrs.org/wiki/OpenMRS

could add the new indicator via the administrative tools provided with OpenMRS.

Adding the new indicator to the database is only half of what is needed, the forms which allow the community volunteer to enter the data are static and would need to be done by hand. While this can be something a non-developer can learn how to do it would help to have someone who is fairly comfortable doing so. However, translating that form to Kinyrwandan (or another language if taken to another country) would, of course, require some expertise.

2.4 Rapid Development

One aspect which we felt we could increase the amount of time and knowledge needed to make changes to the system was in the development of the forms themselves (the screens displayed on the phone). OpenMRS being a Java-based application relies quite heavily on Java for all aspects of the system. We wanted to have a much easier environment for making the forms so we wrote an abstraction layer to the system which allows for easier form creation. This layer, created in PHP, is open-source and has been given to the OpenMRS community on behalf of the Last Mile Initiative project. The code for this layer can be found on the Launchpad site set up for all of our work.

2.5 Scalability

Due to the selection of OpenMRS, which utilizes the MySQL database, all running on Linux, scalability is not a big concern for this system. The system should be able to handle, conservatively estimating, over 6000 transactions per hour. It is doubtful that even if the system were to be rolled out to the whole country that those numbers would even be realized.

Having said that, as with most countries in the region which Rwanda is in, having the server in a location which provides stable and strong bandwidth is a concern which is related to scalability and is one which would benefit from revisiting from time to time were the system in use. Please refer to the Pilot section of this document for more on server support issues.

3.0 Transparency

Transparency and openness has been a foundation of this project since its inception. One original goal was to try to tap into any existing open source communities working in Africa, or more specifically in the region around Rwanda to help with the development. Although we made contact with a couple different groups (further below) since the development stage was stunted a bit due to the issues around a second partner for hardware costs these efforts have slowed down. This is not to say that they are dead though as the work we have done has been shared with the community and we hope it will gain some traction.

This is the key to why being as open and collaborative as possible is good for sustainability - it allows for a project to continue to grow even if there are other factors working against it. In areas such as Rwanda this can be quite refreshing. When we first approached some of the main stakeholders in this project we were asked pointedly if our work would be freely available or would they have to hire "another specialist from Europe" to work on it once we were gone. That one moment shows off the importance of an open source license in remote and poor areas of the world. It can be expensive and difficult to bring someone in to modify or fix code. If that has to be done simply because the license will not allow the users to see the code it can be very frustrating to those on the ground.

In order to ensure the transparency of this project we have taken a few important steps to make our work as accessible as possible.

3.1 Licensing
All of the work we have done on this project has been licensed under the GPL[2] (General Public License) which is a fully open source license. This is very important for sustainability as it allows anyone in the world to freely acquire, modify, and even redistribute the code - as long as it is under the same license and includes the original copyright holders information.

In addition to our work's license, the OpenMRS codebase is also licensed under the GPL making the two fully compatible.

3.2 Community
It has been important for us since the inception of this project to make sure that we have been utilizing any communities already in existence around technologies we are taking advantage of as well as attempt to form communities around our technologies. While the absence of a pilot has hampered the creation of communities around our work, we have been active in the OpenMRS as well as the OpenROSA communities. Any work we have done has been announced to the appropriate community and made freely available to them. At the time of writing this document there has already been a great deal of interest in the Rapid Development library which was created for this project. This could lead to an expansion of the library in the future and a sign that it will continue on even if this project comes to an end. This is one of the best aspects of being transparent and collaborative with this work, it has the possibility of living on and helping many more people in the end.

By far, the most useful information and interest in this project is coming from the two project listed above. While we did communicate with other groups (including AVOIR[3], the USAID sponsored open source community in Africa), we found most groups had waned in activity at this time. This tends to be the case with open source groups and a lesson that can be learned for our desire to create community for this project. If there is a central problem to be solved, and enough people who desire to see it solved, a community is far easier to build. This is especially true if there are enough points of entry (or tools to make it easier).

3.3 Launchpad
One tool we have utilized in the development stage has been Launchpad[4]. Launchpad is a multi-functional, web-based tool for development. In addition to code source version control system, bug tracking system, and easy translation editing tools, it provides areas for planning and interactions with users (though we have not taken advantage of the last two). The system was created by Canonical who are the main sponsors of the Ubuntu linux project so it is geared toward the creation of open source work. This is important as it gives us one place to point people to for getting the code - even as we work on it.

3.4 Wiki
In addition to Launchpad we have set up a wiki[5] which contains every piece of information we have written or acquired about this project. This continues the theme of transparency instilled in this project which we considered as one goal of the project itself. Were the pilot to be picked up and launched, the continuation of transparency would be very easy with these tools and licensing. A wiki allows anyone to get a registration and edit or add documents to it. This is true of our wiki and we have also put all information on the wiki

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2. http://www.fsf.org/licensing/licenses/gpl.html
3. http://avoir.uwc.ac.za/avoir/
4. http://www.launchpad.net
5. http://open.intrahealth.org/wiki/index.php/Last_Mile_Initiative

under a GNU Free Documentation License[6] which is very similar to the GPL.

The wiki instance we have running is a Mediawiki[7] server which is the same wiki software used (and created by) the Wikipedia project. It is by far the most recognizable wiki and many people already know the editing options because of its popularity.

4. Hardware

This particular project has a strong reliance on numerous, inexpensive hardware. For a country like Rwanda was important to look for hardware which is readily available in-country but still was capable of displaying readable information and accept data input in a manner which was efficient for the volunteers. While there was much discussion about hardware during this project, no single model was ever identified.

This is quite important for this project for development. At this time our development focused on least-common denominator hardware and thus is a web-based front-end. However, as explored below, the platform selection can allow for far more interesting interaction. What must be clear for any future implementation is whether *available* hardware is more important than the development concerns. At this time Rwanda is very limited in the models of phones available. As we were working closely with Qualcomm we tended to focus on the phones available through Rwandatel (the CDMA driven network), however if MTN (the GSM carrier) were looked at the models available would be vastly superior.

4.1 Costs

Mobile phone costs in Rwanda tend to run similar to their exact counterparts in Europe, keeping in mind that they are utilizing much older models than Europe currently has available. Pricing for phones ranges from as low as $40(US) to $500(US) with the $500 model being a smart-phone with a full keyboard (though this model is normally not readily available).

Considering just the original pilot plan for working with two different health clinics in Rwanda we would have been working with between 20 and 60 volunteers if it had been fully rolled out. While that would have covered quite a few villages (3 to 6 volunteers per village) it still would have been very small in comparison to the number of clinics and villages throughout the country. The costs for phones to accomplish that would be quite high.

4.2 Available Platforms

The most prominent phone brand in all of Rwanda is Nokia. Nokias, for the most part, run on the Symbian operating system. This system is the leading installed embedded operating system for phones worldwide (46% of all phones use Symbian). Symbian's application layer is an implementation of Java ME (J2ME). The distinct problem however is that the older model, smaller phones often do not have a similar application layer which, in our case, meant that we would not have been assured of having Java available had we chosen it.

Having said that, for sustainability's sake as well as to combat poor coverage in certain areas, we would recommend further development to focus on Java and phone which utilize it in the application layer.

Of particular note is the OpenROSA[8] project. OpenROSA is an open-source effort to reduce

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6. http://www.gnu.org/copyleft/fdl.html
7. http://www.mediawiki.org/wiki/MediaWiki

duplication of effort in the area of mobile data collection. More specifically it is a data collection application toolkit for J2ME with its first implementation having a strong focus on OpenMRS usage. Intrahealth has contributed to discussions on the development of OpenROSA with the Last Mile Initiative as the prime example of the needs we had for the toolkit.

4.3 Lifecycle

One consideration when thinking of hardware is the life-cycle of a mobile phone. Small, somewhat fragile devices such as phones are bound to encounter some problems and are typically easier to replace than repair. This can have a fairly large impact on the sustainability of the project.

Replacement costs for lost or broken phones must be worked into the costs of rolling out to any area. One rule of thumb might be to suggest that for every three operational phones there should be funds available to purchase one replacement. The choice of three to one being based on the fact that for each small village there would be up to three volunteers working at one particular time.

5. Mobile Network

During the development cycle of this project most of our focus was on Rwandatel due to our relationship with Qualcomm who are the makers of the CDMA network technology which Rwandatel uses. Most of the information below is based on this focus and could be quite different if MTN, or even both networks were considered for roll-out.

5.1 Carriers

The two main carriers in Rwanda are Rwandatel and MTN. While we focused mostly on Rwandatel, it is important for sustainability to keep an eye on both especially when considering the growth of the networks in the more rural areas of the country.

Rwandatel - Rwandatel's history is one which is divided almost equally between being state-owned and private. It is clear that the government does not want to own the business as it has sold it off quickly after resuing it from certain failure. Currently a majority stake of the company is owned by a Lybian investment firm but there are constant rumors of its sale to many different companies, most European. Rwandatel is also the country's wired phone and internet provider in the country which brings with it some great benefit. In terms of this project this was most useful in that Rwandatel had offered to host any servers for the project. Since they are the main internet provider in the country this is about as good as can be asked for in terms of bandwidth and stability.

MTN - It is safe to say that MTN is the more stable of the two companies. It is a South African based company which provides mobile coverage in many countries throughout Africa. In fact, in most countries in which it has a presence, it tends to be the leading provider.

5.2 Coverage

Coverage in Rwanda is quite good for both mobile networks. However, the areas in which the higher-end technologies that provide higher bandwidth are generally only located in Kigali and the areas just outside Kigali. There are exceptions to this though which, for Rwandatel, can be seen on the Rwandatel Mobile Coverage Map (2007) on the LMI wiki[9]. Despite the smaller areas outside of Kigali, the higher bandwidth technologies are not readily available despite the mobile coverage as a whole being quite good.

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8. http://www.openrosa.org/
9. http://open.intrahealth.org/wiki/upload/RURA_coverage_Regional_boundaries.xls

We do not have a similar map for MTN and the situation may be quite different for them. Furthermore, both networks continue to grow and are upgraded frequently. This situation may be completely different in a few years.

It is important to note that both *EVDO* on the CDMA network and *3G* on GSM network are technologies which have a very small presence but are scheduled to be rolled out over the next few years in Rwanda. Having these two high-bandwidth technologies could be very important for developing high-end and very useful applications as the better the bandwidth, the more interesting exchange of data can occur.

5.3 Partnerships

The approach we took with this project relied heavily on the mobile network companies. In our case, we approached Rwandatel and had conversations about their role in the project. The two most important parts for the growth of this project were airtime and hosting. Airtime, which is detailed below, while cheaper than many countries, could be expensive were the client to stay as it is and work mostly with browsing technologies. However, a partnership with the mobile company in which they donate or discount the airtime used in the project would save a great deal of money. One particular question raised by Rwandatel was whether or not the volunteers would be using these phones for their personal usage when not working on the project. They were not in favor of this idea although we had looked at it as one incentive for the volunteers to actually do the work. Estimating the time it would take for the workers to do the work and getting just that amount of airtime was one idea explored to answer this question. Rwandatel was also ready to offer us hosting services which were referred to previously. Again, in a country where hosting can be very unstable, we determined that Rwandatel would provide the most stable offering.

5.4 Costs

For mobile network access the costs certainly do depend on any partnerships which could be formed with the two main companies working in Rwanda. However, to get an idea of what kind of costs would be associated with normal usage, both companies work at roughly the same price breakdown:

Time Period	Pre-pay	Pay-as-you-go
Peak	$.16/minute	$.18/minute
Off-peak	$.12/minute	$.16/minute

If we were to spread this out across multiple phones throughout the country it would get expensive and could possibly go beyond what the mobile carriers are willing to donate. However, the numbers which we were estimating for an initial pilot did not seem to pose a problem for Rwandatel in terms of donating the airtime, especially when coupled with the important nature of the work for the welfare of the country.

6. Pilot

The pilot for the Community Health Data Collection system was originally planned for two health centers in Rwanda. The total costs associated with running the pilot was $150,000(US) which was planned to be paid for by Qualcomm. Early on in the process Qualcomm changed the total amount they could give to $75,000(US). In accordance the plans for the pilot were cut in half and included only one health center which had only a few villages associated with it. While this would still have given us a good idea as to the usefulness of the system to the volunteers who are already gathering the data via the paper

forms, it would have been difficult to guage the connectivity issues as the health center in consideration was fairly near Kigali and thus had decent EVDO coverage.

After many months of working with Qualcomm on determining the best hardware and specifications for the system they decided it was best for them to pull out of the project. Mostly this came down to changes in Rwanda from the Ministry of Health in relation to the many pilot projects scheduled across the country. Rightly, Qualcomm felt that the risks were too great if there was to no longer be heavy support from the Ministry of Health.

Nonetheless, the following information details some of the ideas and plans which were being drafted to run the pilot program which was to have started in December 2008.

6.1 Ministry of Health

The Ministry of Health is a vital partner for any health-related service or project in Rwanda. It is safe to say that any project should have the full backing of the Ministry before launching. There are some very good people in the Ministry and quite a few who understand technology well. At this time, however, the ministry has chosen to suspend all pilot programs in country. This was done for a couple reasons: First, there were far too many pilots launching or running at the same time. Too many for the Ministry staff to keep up with. Second, the Ministry decided that they were going to scrap all of the work that was being done on a country-wide HMIS (Health Management Information System) so that they could start fresh, with a new partner, and get it done correctly. Any programs which were to feed data into this HMIS were then put on hold.

As this project is a pilot and we had hoped to work with the HMIS, it is difficult to say when the time might be right for attempting to launch a pilot. Certainly not in the original timeframe. Nonetheless, when dealing with the Ministry it can ber very useful to get the approval from the Permanent Secretary. Once done all other issues tend to be more easily resolved. This can also be a huge thing to leverage when dealing with other local organizations like the mobile phone carriers.

6.2 Volunteers

The Volunteers are truly the heart of the whole process. The handling of the volunteers is all coordinated from the Twubakane project working on the decentralization of health care in Rwanda. The volunteers are people from each village who are elected in small ceremonies to be the health representatives for the village. There is a bit of prestige in the position and the volunteers do much more than they are recognized for doing. This is to our great benefit as the volunteers who are chosen tend to be very motivated .

In our pilot these would be the people using the system on a daily basis. Initially they would need to be trained in the health center in which they report (unless travel expenses were used to get them elsewhere). As part of the existing organization for these volunteers, there are also volunteer coordinators in the health centers who would be ideal in a pilot to coordinate lost or stolen phone replacement, passing on problems or issues, and making sure that the data being entered by his/her volunteers is accurate. The volunteer coordinators should be quite useful in any future pilot.

6.3 Training

The training for using the system would best be performed in the health centers from which the volunteers work from. Typically they are not far from the villages in which the volunteers live and most have some room or space in which the training could be done. The training itself would be fairly straight-forward as the volunteers are all already familiar with the paper forms which contain all of the same questions. The key portions of the training would be instructing them on getting to the forms, navigating through the forms, and

inputting the information itself. Further training could be done on the web front-end so that volunteers and coordinators understand how to check on the data once it is in the system in order to correct any input errors or to see any health trends that might need immediate attention.

6.4 Support Structure

For the most part, the reliance on the volunteer coordinators is vital in the support structure. They can ensure that lost or stolen phones are replaced, make sure that incorrect data entry problems are corrected, and generally be a lifeline back to staff in Kigali or the US. However, as these staff work with the Twubakane project a task sharing/payment plan would need to be figured out before the work could begin to avoid confusion on who pays for which tasks and which people.

6.5 Hardware Costs

The plan for hardware in the pilot was to have one mobile phone for each volunteer (three volunteers per village) a laptop computer with a mobile network PC Card for the community volunteer coordinator, and a main server in Kigali.

For more information on hardware please refer to Section 4.

The phones would range from $30(US) to $500(US), the laptop would range from $600(US) to $1700(US), and the server would range from $2000(US) to $3500(US) depending on what is available in-country at the time.

6.6 Personnel

The personnel would consist of the Volunteer (the numbers would range depending on how many villages reported to the health center at the time of launch), the Volunteer Coordinator, and time from an Measurement and Evaluations expert, a local developer/ system administrator, and one local project manager. The last three people could be shared with the Twubakane project which would bring their costs down considerably.

7. Conclusions

It is clear that a system such as this can be a great success if a number of factors are present. However, these factors must all align well to accomplish the task of making the data collection a more efficient process for the community health workers. The factors at play in this project are: Mobile phone coverage in-country, willing donations from the mobile phone carriers, enough mobile hardware to accomodate all of the volunteers, a strong financial partner to cover the hardware and pilot costs, strong support from the Ministry of Health (or similar institution).

With all of these things present, and a schedule which allows for flexible development and training, there could be some positive results of utilizing the mobile networks which are growing so rapidly across Africa. There are a few questions which have to be raised at the same time however. First is the question on whether a small laptop with a mobile network card would not be more efficient in this case. Second is the necessity of having the hardware come from the *currently* available phones in-country when they may not be good enough for the task at hand given the poor selections.

Without being able to test the system and test some of the questions presented here it is hard to have definitive answers. However, what has happened is still a step forward for thinking about efficiency in data collection in such a poor resourced area.

We can certainly be particularly proud of the efforts we have contributed to OpenMRS and proud of the reactions we are receiving from their community to our work. We can also be proud of the fact that this work is already useful in the design for a new, very similar project which will be launching in Senegal very soon.

These are very interesting times in Africa with mobile networking and are likely to be times that redefine many regions on the continent because of these technologies. If we did nothing more than ask questions for others to think about, we have contributed greatly to this revolution of information.