

Final Technical Report:

Community Based Child Injury

Surveillance System - Rapid Data Collection Using Short

Messaging Service (Proj Ref No: 0302A1_L41)

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Synthesis

Setting up responsive community-based health information systems is a constant challenge for any national system integrating information technology in health care. The Community Based Child Injury Surveillance System project's aim was initially to create a data collection system using short messaging service over cellphones. After preliminary investigations, however, the researchers shifted strategies and created a computer-based information system that served the needs of the health center facility primarily, and of the national public health system secondarily.

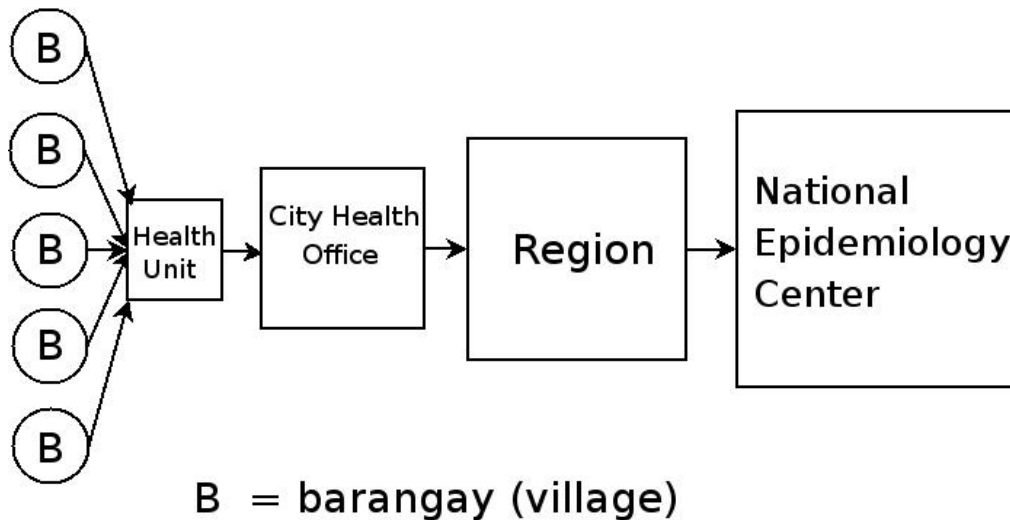
The project was renamed CHITS (Community Health Information and Tracking System) and was redesigned to circumvent issues associated with the original strategy such as constraints in economics (cost of sending messages) and existing national and local health policies (only government health centers can submit official health data). By employing a combination of methods, (community immersion, systems analysis, joint rapid application development, onsite technical assistance and grassroots-oriented training), CHITS was piloted in two of thirteen health centers in Pasay City. It had two major components: [1] an extensible and customizable software engine for health facilities, and [2] a training program for health data collectors (health center staff and community health workers). It has attracted the attention of the Department of Health; its tuberculosis module has been presented to TB control program managers in the private health sector and is being considered for adoption. In the near future, there are plans of citywide implementation of the CHITS in two cities of Pasay and Marikina, two of the most progressive cities in the country that are multi-awarded and have been recipients of local and international citations; inquiries from three other municipalities have been made. The generic software engine of CHITS is now being used by a blood bank information system and a national surgical registry. CHITS offers lessons in systems development that addresses end-user and organizational requirements as well as creates value at the level of data collection. It is proof that open source is a viable alternative to software development in health.

1 Research Problem: A Flawed Health Information System

Pasay is one of the major cities in Metro Manila situated near Manila Bay. Its population of about 435,000, 40% of which are urban poor, live in 201 barangays, or villages. Local government-subsidized health services can be accessed in 13 local health centers. Each health center has a specific number of barangays assigned to them; public health midwives, assigned to particular villages, follow up their constituents. The Pasay City Health Department's health information system, reflective of the

national picture, is manual and paper-based. It starts with data collected at the local health center and proceed to consolidation at higher levels (figure 1) until it reaches the National Epidemiology Center [NEC] of the Department of Health [DOH].

Figure 1. Flow of data from village to National Epidemiology Center



Child injury in Pasay City is grossly underreported. The national government has no specific program for child injury control; injury is not a reportable disease¹. Initially, the proponents aimed to create a cellular phone-based text message data collection system to report child injuries. Because of the availability of cell phones, it was deemed viable to have community health volunteers report injuries using this ubiquitous technology.

1.1 Situational Analysis

Immersion activities and systems analysis revealed that the project as proposed would not realistically address the needs of end-users and decision-makers on the ground.

1.1.1 Incomplete Devolution of Health Care Services

The delivery of health care in the Philippines was devolved to local government under Republic Act 7160². To further improve management of health systems the Health Sector Reform Agenda was the policy adopted by the Department of Health [DOH]³ in 1998. The DOH, however, requires submission of local data on specific national health targets. Despite these two national policies little attention was given to equipping local governments to manage their own local health information system. Problems of data collection, information processing, data quality and reliability at all levels of the health system,

¹ Marcelo, PF, Consunji, RC, Arcadio, RL. 2003. Child Injury in Pasay City. Safekids Worldwide and University of the Philippines Manila, unpublished

²The Local Government Code of the Philippines (Republic Act 7160). Also at <http://www.chanrobles.com/localgov.htm>

³Health Sector Reform Agenda. URL: <http://www.doh.gov.ph/>.

particularly at the grassroots, were made more apparent with the decentralization.

1.1.2 The Tyranny of Vertical National Programs

The Field Health Surveillance and Information System [FHSIS] of the DOH was implemented in 1989 to generate measures of performance at the local level on national vertical health programs such as Maternal Care, Tuberculosis Control, Family Planning, and the Expanded Program on Immunization. Each program, however, had its own set of logbooks and reporting protocols. At the health center level, each vertical program has a specific logbook, called the Target Client List [TCL], as data collection tool; individual patient records are analyzed and classified according to program in specific TCL. Depending on the number of vertical programs, the number of logbooks to be filled by health center staff will vary. But the time-consuming task of filling out the logbooks with repeating information consumes essentially half a day - time that can otherwise be devoted to delivering care. Aside from the daily log into the TCL, the health center staff has to create weekly, monthly, quarterly and annual reports derived from the vertical program logbooks. Program managers at different levels of the public health system would receive aggregated data for analysis in paper format from lower level organizational units. Only information collected through the FHSIS is considered official data collected by the NEC of the DOH.

This kind of health information system is ripe with problems of data collection, information processing, data quality [i.e. duplication, accuracy and timeliness] and reliability, and these problems are presumably magnified as data goes up through different levels of the health system.

Child injury in Pasay City is grossly underreported. The national government has no specific program for child injury control; injury is not a reportable disease [Marcelo, P. et al. 2004 unpublished]. While this project is seen as part of a larger child injury control campaign, the preoccupation of the health center staff, a major stakeholder in this project, with data processing requirements of existing vertical programs minimizes the value of this pilot project on child injury information system management. Proponents felt that the project would add more and not address the health information system issues of the local health department.

1.1.3 Health Workers are Not Worker Ants

In the health centers studied and from interviews with health workers (including those from outside Pasay City), utilization of data at the level that they are collected is more of the exception than the rule. Like worker ants collecting food, health workers at the community level dutifully and laboriously collect data and write them down in the logbooks. The authors subsequently observe that this practice promotes 'data manufacturing' and loss of data integrity, since no subsequent and intrinsic validation is done by using the data for decision making at that level. The collection of huge amounts of health data without feedback to the collectors seems to be the practice not only in the Philippines but in other settings as well⁴. This situation can only be obviated through adoption of capacity enhancing measures and building up an appropriate outlook towards data quality among health workers.

1.1.4 Health Worker Export

⁴ [Tolentino, H, Marcelo A, Maramba I, 2003, Mekong Basin Disease Surveillance Project. Technical report to the WHO and the Rockefeller Foundation].

Health worker migration to foreign shores (labor export) potentially compromises the quality of health service delivery including data processing and decision-making. As the authors conducted interviews with physicians running the different health centers in Pasay, more than half have begun preparations for working as nurses abroad. This left the authors with very little choice over which health centers to select as pilot areas. It was apparent that an out-of-the-box solution was required. An article in the WHO Weekly Epidemiological Record describes the similar practice of using national vertical programs in other countries⁵ [WER].

1.2 Shifting Course

1.2.2 Targeting the more strategic stakeholder

The original idea was to improve collection at the community level by allowing community health volunteers (called barangay health workers or BHWs in the Philippines) to submit child injury data through short messaging service over cellular networks. This was based on the assumption that BHWs were organic to the communities where majority of child injuries occur. The hypothesis was that once the data is in electronic form, consolidation would then be essentially an automated process and would result in more accurate and timely reports that are useful to the community and to the public health experts. A prototype of this SMS application was quickly created and beta tested with mixed results. Constraints are identified:

1. Despite the pervasiveness of cellphones in the Philippine society, BHWs belonged to the lower socio-economic income brackets and could not afford spending their own money for text messages sent through cellphones. This would create significant gaps in the data collection and is a significant issue in program sustainability.
2. Although the SMS application was able to accept submissions and insert to a database, there were valid questions on sustainability as to who will pay for the messages later on when the project's funding has ended.
3. Among those with cellphones, the BHWs had varying skills in crafting and remembering the standard syntax for reporting (e.g., INJ JOSE RIZAL, 4,M, 11-04-2004,1345,at home, fell from stairs). But this was assessed to be minor and could be later addressed through capacity building.
4. The project initially proposed child injury data collection by *community health volunteers* emanating from the *homes* in the barangay. National and Pasay City health policies are based on local health center data collected by official health center staff; community volunteers are not employees of the local government. Thus data from BHWs cannot be accepted for formal analysis.
5. The fact that official data are first generated at the local health center makes the local health center staff as the more logical and strategic stakeholders to focus on for this project.

⁵Anonymous. An integrated approach to communicable disease surveillance. WHO Weekly Epidemiological Record, Jan 7 2000, 75:1, page 1.

1.2.2 Fundamental components missing

Preliminary investigations from the community revealed that more fundamental components of a community health information system were still lacking. One, in terms of policy, only the local health unit was officially mandated to collect, consolidate and publish public health data. This would mean that any child injury data reported by the community volunteer health volunteer via cellphone, external to the local health unit system, would be unofficial and useless. Two, there was no effective information system in the local health center that ultimately would allow them to manage their resources effectively. For example, vaccines were being given but without a reliable way to monitor if the service delivered is reaching its intended beneficiaries. Basic information systems, like the patient registry of patients was still carried out manually.

There are many reasons identified for this problematic health information system. First, the manual (using pencil and paper) and tedious nature of data collection as well as multi-user, multi-level consolidation, results in data that are generally viewed as arithmetically incorrect. Thus even the data collectors themselves do not take the resulting reports seriously. In the end, evidence-based decisions could not be made since the manual system could not provide a clear picture of how the health system is performing at the community level. This poor performance of data management is consequentially passed on up to the national level. Second, there is an observed lack of capacity among data collectors on quality data management. Midwives assigned to collect health data do so as a matter of obedience and not because they understand the value of the data for their own community. In focused discussions, some midwives confessed to fabricating data just so they can meet the deadlines for reporting. Knowing that the data they themselves have submitted is inaccurate, it is understandable that they find no value to the reports generated by this manual information system. This in turn only serves to reinforce their habit of submitting incorrect data the next time; and the vicious cycle continues. In effect, despite the numerous data accumulated daily, there is no confidence among the health workers that these may be used reliably to generate information for decision-making.

So although the project started out as a child injury reporting system, it evolved into a local health center-based information system for service delivery realizing that this is the core foundation from which all other community health services will be based (including, but not exclusively, child injury).

Thus, this study shifted to the creation of a health unit-based information system that was useful at the community level but which also served the needs of the national public health managers.

2 Fulfillment of Objectives

2.1 General objective

2.1.1 To determine the feasibility of establishing a community-based child injury surveillance system using mobile phone technology and people-centric strategies

Due to the reasons stated in the previous two sections, this objective was shifted to the development of a computer-based information system for public health centers using people-centric strategies.

2.2 Specific objectives

2.2.1 Design and develop SMS-based data collection system using open source tools (modified)

The project shifted to the design and development of an extensible and customizable computer-based information system for the local health unit level using open source tools. This is in recognition that the local health center is the most strategic location for organizing the health data of the community. To date, the engine comprising the core of the computer-based health information system is finished and is already being used in two health centers. The health centers continue to modify their system to suit their local needs. Four other local government units have expressed interest in the system and have requested for training and installation. One local government (Marikina City -- a WHO and DOH-awarded Healthy City) has signed a memorandum of agreement for capability building; the current one, Pasay City, a convergence site for World Bank-recommended and USAID-supported Health Sector Reform Agenda, is in the process of renewing its MOA with the University.

2.2.2 Design and develop professional training program for community health workers (achieved)

The training programs have been designed and delivered for the health professionals of the health center, and community volunteer workers. For the former, it has helped in transitioning the health center staff from the manual to the computerized system. To date, six training sessions have been conducted (two for community health volunteers [during the first part of the project], and two for each of the health center staff). One-on-one end user training has also been conducted since the system was first deployed on the fourth month.

Training materials for the administrator of the computer-based health information system were also developed. [See attachment]

As of this report, a Data Club among health workers is being planned as a means of closing the loop for the data collectors of the computerized health information system. This Data Club is aimed at extracting useful information from the computerized system.

2.2.3 Engage community in child injury prevention activities (achieved)

Due to the shift in strategy from community-based health information system to health center-based service delivery information system, this objective of engaging the community in child injury prevention activities has not been achieved by this project. This is because most of the interventions on the latter part of the project were at the health center level where opportunities for community-based prevention activities are less. However, this project should also be seen in larger context of the College of Medicine's child injury prevention campaign. Other units of the College and student activities engaged communities towards this endeavor. Activities included community volunteer health worker training on injury control, home hazard survey and community discussion, multi-sectoral school pedestrian safety inventory and community discussion planning.

Community health volunteers were also oriented on how they can interface with the health center information system. The community health volunteers are tasked to remind patients in their catchment area for their follow-up in the health center for immunization, maternal care, family planning or anti-tuberculosis treatment. This information, previously unavailable with the manual system, can be generated by the computerized system. In time, the health center-based computerized

system still will be able to engage the community in preventive health activities including the area of child injury.

2.2.4 Promote use of open source for use in health applications (added and ongoing)

One of the fundamental principles of the project was the development of an application that would be freely available to other developers and users. The open source phenomenon is just beginning to gain ground in the Philippines and the research team feels that making software for health open source would result to better applications and systems. The complete source code of the software has been uploaded to www.sourceforge.net⁶ (project name: game-engine), a web-based repository of open source software.

To date, the following applications are using the GAME engine for their own development:

1. Blood Bank Information Management Package (BLIMP) by the University of the Philippines-Philippine General Hospital
2. The National Surgical Registry of the Philippine College of Surgeons

3 Project Processes: The Chosen Approach

About 70-80% of information systems projects worldwide end up as failures⁷ [Heeks]. Facing the possibility of implementing a project that looks feasible and innovative on paper but will never be used, the authors decided to address health information needs of the local health center and expanded the project scope to include not only the development of a child injury surveillance system but also the other existing health programs. Likewise, the project aimed at converting the existing paper-based information system into one that is rationalized and unified through horizontal integration. For this project, two health centers in the Pasay City local government unit were selected: (1) the Malibay Health Center, a very busy health center or with a heavy patient load [80-120 patients seen every day], and (2) the Lagrosa Health Center, with light to moderate patient load [30-50 patients/day].

3.1 Preliminary systems investigation through immersion and ethnographic investigation

The project team anticipated difficulty in ascertaining the actual information culture at the health center from interviews alone. Together with incremental software development (see below), the project director, trainers and key software development staff spent 6 weeks of working with the health center staff to acculturate themselves with the health center information culture. It also allowed the building of relationships and an environment of mutual trust, in which a lot more information was extracted from the health center workers, not just in terms of information system processes, but also in terms of attitudes and culturally bound practices. An insight into the aspirations of health center staff allowed the project team to carefully craft a multi-level curriculum for capacity building geared towards empowerment and building of self-esteem. Lunch time (group) and individualized encounters of project team members with the health center staff also provided a non-threatening environment and

⁶<http://www.sourceforge.org/game-engine/>

⁷Heeks R. Failure, Success and Improvisation of Information Systems Projects in Developing Countries. Institute for Development Policy and Management. URL: http://www.man.ac.uk/idpm/idpm_dp.htm#devinf_wp. January 2002.

teachable moments for health center staff to absorb nuggets of informatics knowledge and principles.

One of the hardest lessons came early in the project when the project leader began immersing himself with the work environment of the community health volunteer workers and the health center staff. From that perspective, it was clearly seen that foundational components were not in place to support a text-messaging system for child injury reporting. First, there was no policy that recognized reports from community health volunteer workers as official data. This is because most of the interventions on the latter part of the project were at the health center level where opportunities for community-based prevention activities are less. Second, the health centers themselves do not have an electronic registry of patients and of services rendered. It would be difficult to relate child injury data to more basic data like demography. Third, data management principles were not being followed within the health centers such as completeness, timeliness, accuracy, legibility, and usefulness. This culture of poor data management would only serve to make any information system cumbersome, whether paper-based or cellphone-based.

In effect, all of these issues were detected by immersing within the work environment of the end users. And the realizations from this immersion convinced the researchers to shift their strategy from a cellphone-based system to that of a health center-based computerized system.

3.2 Joint systems development

3.2.1 Rapid Application Development of Computer-based Information System for the Health Center

This component involved the standard systems development lifecycle: project initiation, systems analysis, systems design, software development, testing, and maintenance. It commenced on the first day of the project (after the shift) and is now in its maintenance phase. Some modifications applied to this process were:

1. Rapid application development onsite with quick response to end-user comments. The system was designed together with the staff of health center. This process worked because it provided ownership of the application among the staff themselves thus strengthening their stake on the project.
2. Modular design of software allowed addition of features without affecting other modules or the core application. This process worked because it encapsulated modules from each other as much as possible. This allowed the system to be useful but at the same time flexible enough to accommodate future modules later on.
3. Early response to the reportorial needs of the staff enable them to immediately see the benefits of automation. It was crucial to let the staff see the immediate benefits of computerization. For them, the most visible impact is the rapid retrieval of information and the automated consolidation of reports. Showing them these benefits early on was important to convince them that the initial difficulties in migrating from manual to computerized systems are worth the effort.

From the systems investigation phase, the investigators gleaned enough information to decide

on the design and implementation of a computerized patient transaction system at the health center level that will be responsive to the need of the center but will also be flexible enough to be customized as needed by the staff. The software should be open source and will be released under the General Public License (GPL) to allow as many developers to contribute to the source code. The application will be modular so that features may be added to the application on a case-to-case basis depending on the capability of the local staff to use the new module.

3.2.1.1. Spiral Model and Modular Software Development

Initial interviews at the City Health Office revealed an attempt to create a few electronic systems for surveillance. In one of these attempts, the system was not deployed fully because there was no training and orientation of end-users and the computers were pulled out after the data encoding was completed. To avoid the same mishap from happening, the authors incorporated capacity building into the project and adopted the spiral software development model [Clements], a tedious and iterative, but participatory model, and introduced an object-oriented approach to the development of modular software components using a modular software architecture (see below). Each software component (data model, work flow and user interface) goes through several iterations of model validation and user testing. After 5 to 6 iterations (database model validation, user interface testing and work flow optimization), a parallel run is conducted to find out how the component behaves in actual use, in comparison to the paper-based system.

In this setting, the gold standard (and competition) is the paper-based system. If the health center staff, would eventually and willingly leave their paper-based system, the project team would take it to mean that the new electronic system will have generated enough momentum to push the move from paper to digital format. As of this writing, the system has been implemented at the Lagrosa Health Center, and the health center staff has stopped using the paper forms for clinical consults. Implementation at the Malibay Health Center started September 15th, 2004 and is currently at the early stages of implementation.

3.2.1.2. Software as an Agent of Change

Change management was approached from a variety of angles. One of the creative ways this was carried out was through the principle of using software as an agent of change (proactive). This concept is a complete reversal of the traditional situation where change is managed because software introduces changes (reactive).

Using this method, the project team introduced, in a controlled manner, critical points of change in various aspects of health center operations where end users are presented with opportunities for enlightenment about certain issues. As an example, the amount of involvement of Barangay Health Workers has been traditionally minimal in health center operations. With the software introducing points of change in 1] electronic data collection and 2] proactive patient management (a known gap) that will eventually strengthen health center coverage of its constituents, but would require more BHW contribution to the effort, the health center staff eventually acknowledged that the health center information system would need BHW involvement to strengthen its programs.

3.2.1.3. The GAME Engine and CHITS

Out of the need for a modular approach was born the GAME Engine [sourceforge], short for Generic

Architecture for a Modular Enterprise, which allows the reuse of software code in other software development projects¹. This software architecture was developed for use by a number of projects being carried out by the Medical Informatics Unit. Since the project was reoriented towards developing a full information system, the benefits of rapid applications development that the GAME engine provides is a welcome development in the face of local IT manpower constraints. The use of the GAME Engine entails using the application's data model as the foundation for creation of software modules. Essentially, two types of data models are used: the GAME Engine internal data model and the health center (CHITS) data model.

Using the GAME Engine, software development is currently being done on a modular basis, avoiding global and potentially catastrophic and time-consuming changes to monolithic code and database structure, and strictly enforces both module independence and dependence, and system security and authentication. This approach also enables implementation of completed modules without waiting for the rest of the application to be completed.

The Child Injury Surveillance System, now renamed Community Health Information Tracking Systems, or CHITS, is currently composed of close to 40 software components together with lookup data libraries. It includes ICD10 Diagnosis Coding with its own search engine, and the majority of modules were developed within a span of 3 months of intense software development activity. The Child Injury Surveillance Module is now part of the bigger application and is appropriately integrated into the big picture at the community level. This change in the project specification also effectively increases the contribution of the Medical Informatics Unit and the University of the Philippines in the overall funding picture. The original SMS portion of the project has been expanded to include clinical reminders, which serves several modules. The module, Clinical Reminders, enables health center staff to send SMS messages generated from system templates to patients for follow-up and medication intake reminders. This appears to have greatest impact in three modules: Child Care for vaccination follow-ups, Maternal Care for prenatal follow-ups and anti-tetanus vaccinations and the National TB Program for the DOTS treatment protocol.

The original proposal called for an SMS-based data collection system. This is still under intense study because of feasibility and sustainability issues.

The GAME Engine modules are both functionally designed to be self-contained and reusable with very minimal modifications. Since the GAME Engine is web-based, hardware requirements are not too exacting and modules are uploaded as files and automatically incorporated into the system. The modules (and also their upgrades) are distributed in compressed format (GZIP) so that they can be easily passed around in 3.5 floppies. The CHITS application currently runs in an intranet environment with a Pentium 4 class server and 3 scaled down Pentium 4 workstations. Although it runs in an Intranet environment, it has also been designed with stubs to incorporate source code for running in a distributed network (to link health centers together) to enable data interchange between health centers using ordinary dial-up connections and XML-based web services using Simple Object Access Protocol (SOAP).

3.2.1.4. Use of Open Source Software

The software development tools used in this project belong the open source genre⁸ [OPENSOURCE]. Software developers and advocates of tools in this category espouse making source code available together with the application itself. In the health care domain, this paradigm promotes

⁸The Open Source web site. URL: <http://www.opensource.org/>.

transparency and peer review of health information systems. It also allows for equitable use of scarce and potentially costly information processing resources, including software in health information systems.

To help reduce implementation cost and maintenance, the Linux Operating System⁹ (Debian [DEBIAN] distribution) running the KDE desktop was selected. Since Linux is known for its stability and security and there are fewer computer viruses for this platform¹⁰ [Granneman], this would potentially reduce technical support calls and system downtime. The engine uses MySQL, a very popular open source database and implements tables using InnoDB for transactions and referential integrity. The software is actually written in PHP¹¹ [PHP] and makes extensive use of previously published open source code libraries like JPGRAPH¹² [JPGRAPH] for object-oriented graph display and FPDF¹³ [FPDF], a PDF-generation engine for creating the summary reports.

To put the software in the public domain, particularly the GAME Engine, the Medical Informatics Unit set up a Sourceforge web site, a popular repository of open source software. This was done to open up the source code to and invite interested developers worldwide to participate in the software development project aside from being able to use it themselves. In anticipation of multilingual (global) and multi-dialect (local) use, the authors incorporated a multi-lingualization engine used in a previous open source disease surveillance system project, which was developed for the Mekong Basin Disease Surveillance Project¹⁴ [MBDS].

3.2.1.5. Horizontal Integration of Vertical Programs

The CHITS project presents an opportunity to solve the disintegration of vertical programs' paper-based information systems at the community level (health center). Health information systems are deemed complete when they perform the three critical activities (collection, integration and presentation) within one level to enable the end-users to see the whole spectrum of data transformation. The vertical programs, after analysis by the project team, revealed thoughtful and logical implementation on paper with their individual data models mimicking the electronic one, purely and possibly from numerous iterations during implementation. However, their individual data models disregarded the existence of the other vertical programs and created information system islands. The approach taken here was to integrate the different data models into one and present a unified interface and report generation tools to the end-user.

3.2.1.6. Real Time Output Display

To address issues in data quality, the end users were given strategies in integrating software outputs into their decision-making. The software also enables them to see graphs and reports as data is generated in real time. From various discussions over time, the health center staff involved in software development began to see the value of having instantaneous access to health information and even proposed new performance measures to enable them to deliver quality service. Upon further realizing that the computer can aide in numerous calculations, the health center staff began proposing

⁹ The Debian Linux Distribution web site. URL: <http://www.debian.org/>.

¹⁰Granneman S. Linux vs. Windows Viruses. The Register.
http://www.theregister.co.uk/2003/10/06/linux_vs_windows_viruses/

¹¹The PHP Official web site. URL: <http://www.php.net/>.

¹²The JPGraph Official web site. URL: <http://www.aditus.nu/jpgraph/>.

¹³The FPDF Official web site. URL: <http://www.fpdf.org/>.

¹⁴Mekong Basin Disease Surveillance Project. URL: <http://www.mbdnet.org/>.

innovations to help them deal with repetitive, redundant or time-consuming tasks through automation. Among these suggestions include date projections for TB therapy for projecting sputum exam dates and setting appointments so the staff will know patients who are supposed to follow up for certain appointment codes everyday. Through this innovation, the health center staff can also determine follow up behavior of specific patients.

3.2.1.7. Decentralization

To avoid creating a physician-centric health information system, the authors created a system that enables all staff members in the health center (from admissions to laboratory) to contribute to building up the database and maintaining the information system in a distributed manner. In the first pilot health center, a nurse readily serves as a system administrator and creates accounts and assigns permissions for the rest of the staff. He also teaches the staff how to log in and use the different modules of the system (effectively duplicating what the health center physician can do). The Filipino custom called bayanihan involves sharing the workload in a given task such that village folk can move a whole bamboo and nipa house by carrying the house together (Figure 4). The bayanihan concept of doing work in consolidating patient data slowly became evident as systematic data entry utilizing the different interfaces for the different modules.

3.3 Capacity Building: Two Carrots and a Stick

Capability building is inherent to improving systems. The free health information system (as carrot #1, and described below) together with formal (certificate) and informal training (carrot #2) provide a compelling combination of empowering tools to enable the health center to have buy-in and eventually a competency-based stake in the project. The capacity building activities come in two forms: formal and informal.

Formal capacity building includes certificate and competency-based training courses for different levels (from Community Volunteer Health Worker to health center staff). The training courses involve building up health information systems management capabilities in the respective domains of the health workers, whether it is at the barangay health center or at the city health office. Informal capacity building includes nuggets of health informatics knowledge distributed as the need arises, during lunchtime conversations and briefings.

3.3.1 Introduction to Health Information Systems for Community Health Volunteers (2 weeks preparation, 1 day implementation)

This involved initial focused group discussions to assess training needs and level of education, and was followed by research on various structured learning exercises (SLEs) on how to instill new knowledge about health information systems and skills on how to collect data of good quality. A very simple one-page handout with easy to remember acronyms and slogans based on a World health Organization guidebook¹⁵ was given to participants [see attachment]. The first training sessions were offered during the second month of the project.

¹⁵Improving Data Quality:A Guide for Developing Countries.English 2003, WPRO Nonserial Publication, 80 pages.

3.3.2 Introduction to Health Information System for Health Center Staff (2 weeks preparation, 1 day implementation for each of the two health centers involved the project)

This is the same as the previous item but with an additional orientation on computer systems and health personnel migration issues. This was followed by regular one-on-one assistance onsite by members of the research team to address technical issues. Request for changes were also attended to during these one-on-one support visits. These were offered beginning on the fifth month (site 1) and the seventh month (site 2) of the project.

3.3.3 Basic Computer Literacy through Computer Games (2 weeks implementation)

A period when the health center staff members (site 2) were asked to play the games in the computer to familiarize themselves with the components of the computer and to allay their fears of technology. This strategy served several purposes:

1. Gradual exposure to hardware and software through non-stressful applications
2. Non-threatening introduction to the electronic environment that is enjoyable and fun
3. Testing of the network and the operating system with regards to reliability and robustness

This particular strategy was implemented on the seventh month of the project for health center 2.

3.4 Project dissemination and promotion/ advocacy of open source and data quality (since 2nd month of project)

Members of the research team have been invited to talk about the project and other software developed by the unit and they have taken each opportunity to inform the audience about this project and about the open source method of application development.

1. Tolentino H: "Public Health Informatics: Appropriate Technologies for Developing Countries", Asia Pacific Medical Informatics Association Annual Conference, 6-9 April 2004, Kuala Lumpur, Malaysia
2. Marcelo A: "Community-based Health Information Tracking System (CHITS), a health information management tool for health centers", 13th AMIC Annual Conference "ICT and Media Inputs and Developments: Impact of New and Old Media on development in Asia", 1-3 July 2004, Bangkok, Thailand.
3. Maramba: "Why Health Applications Must Be Open Source" , Philippine Open Source Conference, Manila, 19 August 2004, EDSA Shangrila Hotel, Manila
4. Marcelo A: "The Critical Role of Open Source in the Philippine National Health Information Infrastructure", Philippine Open Source Conference, 19 August 2004, EDSA Shangrila Hotel, Manila
5. Marcelo A: "Design and Implementation of the Integrated Surgical Information System", Inter-departmental Grand Rounds, UP College of Medicine, 5 October 2004,

Ermita, Manila

6. Marcelo A, Maramba: "Orientation on the Philippine National Health Information Infrastructure", to the Secretary of Health Dr. Manuel M. Dayrit, 4 October 2004, Sta Cruz, Manila

7. Tolentino, Marcelo A, Maramba: "Design and Implementation of an Open Source Prototype Telephony and Web-based Critical Event Reporting System for Continuous Quality Improvement Program in Anesthesiology", Medinfo 2004 Conference, 7-11 September 2004, San Francisco, USA

8. Marcelo A, Tolentino: "A Community-based Chld Injury Surveillance System: A Rapid Data Collection System Using Short Messaging System (SMS)", poster presentation, 7th World Conference on Injury Prevention and Safety Promotion (Safety2004), 6-9 June 2004, , Vienna, Austria

9. Marcelo A: Presentation of the computer-based health center information system to the Marikina City Health Office, 18 September 2004, Marikina City

10. Marcelo A: Open source philosophy for health development. Alternative learning classes for University of the Philippines Manila undergraduate students

11. Marcelo A et al: Evaluation of the Decentralized Field Health Service Information System in Selected Infectious Disease Surveillance and Control Project Sites. Commissioned study submitted to USAID November 30, 2004.

12. Marcelo A: Business opportunities in health informatics. Applied Computer Systems Program, College of St. Benilde, De la salle University, November 13, 2004.

13. Marcelo A: Open source for health: in "Open Source, Open Minds:A New Look at the Open Source Paradigm". UP Alternative Classroom Learning experience, Rizal Hall, UP Manila, November 18,2004.

3.5 Discussions and development of ethical guidelines for electronic health information

The project proponents on the area of data protection and privacy have started initial discussions. This is due to the fact that there is increasingly sensitive information being collected in the computerized system and therefore, there must be guidelines on the proper management of electronic health data that has to be integrated into the training of the end users. For this, the paper of one proponent, Maramba, will be used extensively as reference.¹⁶

¹⁶Maramba. Data Protection in the United Kingdom and the Philippines. University of Warwick, 2000

3.6. Best Practices

3.6.1 Personal Realizations

Personal realizations about data quality often came out of lunchtime conversations. For example, reporting of prenatal home visits appeared to be manufactured based on need. It is also interesting to note that the end-users themselves verbally express that it will be very hard to cheat when everything is computerized as (1) the system keeps record of who did data entry for a specific module and (2) they do not have access to the raw data in the database.

An interesting outcome is that during one vaccination day (the third parallel testing for the Child Care Module), the mean consult time for each patient was 29 minutes per patient per consult, 1 minute less than the health ministry standard of 30 minutes per patient per consult (a criteria for being included in a quality circle by the Ministry of Health). Given that the end users have not even become proficient with the mouse and the keyboard, and considering that the system is being loaded with new patients, this appears to be a very positive outcome. Succeeding trial runs also enabled them to see the effect of understaffing on consult times (less staff available, longer consult times).

In the course of their exposure to the CHITS application, the staff gained a certain level of confidence to propose innovations to the application, as the project team noted (1) increasing numbers of inputs and suggestions for system improvements (including health center process innovations), and (2) requests for new useful features. Their proposed innovations included among others, the passing of SMS credits from patients (who will be sent clinical reminders) to the health center SMS server1.

Personal realizations, which the Medical Informatics Unit was able to elicit, are not totally confined to health center information processing issues alone. Sometimes, more personal ones at the level of personal meaning, mission and vision come up and give the authors insight into motivating factors that can potentially affect project outcome and sustainability. The project team delved into this realm to determine the match between the end-users mental model (inclusive of personal and organizational factors) of their environment and the applications conceptual model [Heeks]. Although Heeks argues that things will not change if the information system were to exactly match the environment, the authors put forth the argument that the software itself can be an agent of change using implicit, camouflaged processes. This strategy, however, still needs to be refined and validated in other deployments of CHITS.

3.7.2 Develop partnerships

As the authors were developing the module for the National TB Program, one of the vertical programs implemented at the health center level, the Philippine Coalition Against TB (PhilCAT), learned and signified its interest the CHITS application. Tuberculosis control needs a responsive computerized health information system, one that is not currently found the country. The Rotary Club chapter of Paranaque, a neighboring city, also signified its intention to adopt CHITS (particularly the National TB Program module) for implementation in health centers in a neighboring city (south of Manila) for its anti-TB project. They intend to cover training and hardware installation expenses. The local government health office of another progressive city east of Manila, Marikina, also signified their intention to implement CHITS citiwide.

These developments bring to the fore one of the significant issues below that of training, technical support and maintenance.

The Advanced Science and Technology Institute (ASTI) of the Department of Science and Technology (a government agency)¹⁷ [ASTI] developed a device that incorporates a GSM modem in computer PCI form factor. When the technical developers of the device learned of the full implementation of CHITS, ASTI decided to lend the device for testing in the pilot health center to enable the authors to test it for sending clinical reminders by SMS.

Between July and August, two demonstration sessions were conducted for the city health offices of two other neighboring cities (Paranaque and Marikina). In October and November, demonstrations to the Department of Health National Epidemiology Center and Infectious Disease Surveillance and Control Project (IDSCP) were also made. Demonstrations during this period also included personnel from the Centers for Disease Control and Prevention and World Health Organization who made random visits of the Lagrosa Health Center. More partnerships are emerging and a template memorandum of agreement has been developed [see Annexes] to speed up the process of partnerships with local government units.

3.7.3 Scratch an Itch: the Last Mile for TB Information

In a radical departure from health center tradition, the developers created an interface for Barangay Health Workers (community health workers), who act as treatment partners for TB patients in the community, to be able to enter drug intake data using the health center workstations. To support this activity, the authors developed a two-level certification course for health information management specifically for BHWs. The Level 1 training deals with data quality concepts and roles in the bigger organization. Level 2 training deals with personal record management so that when data is to be merged, there will be some level of standardization that will enable data integration with the CHITS application. Their participation in the health center information system potentially qualifies them for a level 3 certification, working with various health center modules requiring data coming from the community (surveillance and others). What the project team aim to develop using this strategy is a sense of professionalization among the health center staff that their increase in knowledge and skills be recognized as a formal step in career development.

3.7.4 Modeling primary care informatics

The CHITS database offers numerous opportunities for community based health research providing an alternative venue for clinical research. This also provides the Medical Informatics Unit with an opportunity to link community based information systems (primary care) with hospital based information systems (tertiary care) by making patient information digital and portable. One scenario the project team foresees is a patient coming from the health center bringing his personal health information record in a diskette to the hospital when he goes there for a tertiary care referral. This is similar to one of the models described by Rigby, where patients hold on to a copy of their record¹⁸ [Rigby]. The hospital information system, using the same engine and compatible software, reads the XML-based patient information off the disk into their databases. With this potential data integration

¹⁷Advance Science and Technology Institute, Department of Science and Technology. URL: <http://asti.dost.gov.ph/>.

¹⁸Rigby. Integrated record keeping as an essential aspect of a primary care led health service. *BMJ* 1998;317:579-582 (29 August)

within reach, the information system boundaries between levels of health care delivery will be blurred. The developers have already incorporated code for unique patient ID generation to prepare for secure health information exchange among health centers.

3.8 Other issues

3.8.1 Privacy and Confidentiality

Since electronic records offer efficiency and seamless integration, it can also enable efficient and seamless access for breaching patient privacy and confidentiality with the same level of efficiency and speed. This is the reason the application is set up as an intranet (not connected to the Internet) with appropriate security measures incorporated in the system (e.g., password authentication).

3.8.2 Technical Issues

The use of the mouse and keyboard initially appeared to be a daunting obstacle to efficient use of the system. A creative approach using computer games was employed to enable health center staff to gain proficiency in using these input devices while having fun during their free time. The use of Linux as the operating system with the KDE desktop apparently did not deter the staff from using the system. As a control, the Medical Informatics Unit left one computer running Windows XP, and the authors observed no apparent show of bias towards any operating system. Hardware issues that can potentially add to end-user frustration include loose power outlets, and loose network cable connectors. Improperly installed Linux workstations can also add to end-user frustration as observed in a few instances when one (out of 3) workstation consistently failed to launch the graphical user interface (KDE desktop) and show the unfriendly root prompt.

3.8.3 Organizational Issues

The transition from paper-based system to electronic records provided the health center staff with an opportunity to re-examine their procedures. The seamless and integrated access to records encouraged the health center staff to use the system and learn about it more. Since the best training methodology could not be determined earlier, the authors proceeded to carry out modular testing and training together. The subsequent parallel runs eventually resulted in less technical queries from the staff to the Medical Informatics Unit, an indication of deepening understanding of how the system works. This decision to go modular in training the staff proved to be the best choice in the end.

3.8.4 Training, Technical Support and Maintenance

The observation that end users can become effective trainers themselves potentially offers an empowering solution to training staff from other health centers. Monetary remuneration that can be obtained from training others also provides the authors with a sustainable way of propagating the necessary skills and creating a community of users who know how to manage the system. This potential development can relieve the Medical Informatics Unit of the burden of technical support by empowering a user community to help one another in open source fashion.

The system implementation was also carried out in piece-meal fashion before deployment in the other high-volume health center (Malibay). This is to ensure that most physical network and hardware issues have been identified, most bugs have been unearthed and most system functionality is already available. The modular training approach also still needs to be refined, as the authors employ the write-as-we-go method for training module development.

4 Project outputs and dissemination

The following are considered outputs of the project:

4.1 Information sharing:

4.1.1 Presentations of computer-based system to other interested local health centers

There are requests from other local government units for a demonstration of the computer-based system (Tangub City, Misamis Oriental; Oroquieta City, Misamis Oriental; and San Fernando, La Union). A memorandum of agreement has been signed with one wishing to deploy CHITS in their city health office (Marikina).

4.1.2 Presentation of computer-based system to the Secretary of Health

Last October 4th, 2004, the Secretary of Health Manuel M. Dayrit has shown interest in supporting the initiative for the development of the Philippine National Health Information Infrastructure (PNHII). The CHITS Research team is one of the convenors of the PNHII. The CHITS computer-based system will be a demonstration project of the PNHII.

4.1.3 Presentation of computer-based system to various agencies

The 13th Annual AMIC conference in Bangkok last July allowed the research team to present their initial findings to other teams and share experiences and ideas.

4.2 Knowledge creation

4.2.1 Software for the Computer-based Information System for Health Centers:

A set of PHP scripts and MySQL dumps already available at the Sourceforge.net website. Search term is 'game-engine'. The software may be downloaded and installed in other servers for free. There is documentation embedded within the application.

4.2.2 Curriculum for introducing the concept of health information systems

A training design that introduces the concept of health information systems and the value of collecting data of good quality has been carried out and achieved its objectives. Participants' evaluations of the sessions have been overwhelmingly positive. An extra challenge to the course designers was the fact that the language of the courses had to be tailored to match that of the participants.

4.2.3 Administrators' Manual

These are documents that provide instructions to persons who will administer the computer-based system within each site/health center.

4.3 Training

4.3.1 Training program: Introduction to Health Information Systems for Community Health Workers

Attended by community health volunteers to get an orientation of how important health information is for the community

4.3.2 Training program: Introduction to Health Information Systems for Health Center Staff

Attended by staff of the health center to make them understand the value of an accurate and timely health information

4.3.3 Lecture-demo: Medical students and Students of the Masters in Family and Community Medicine of the UP College of Medicine

Graduate students from the UP College of Medicine had their lecture on health information systems conducted onsite at health center 1. To date, 115 medical students rotating at the Pasay Health Centers have seen and most used the CHITS.

4.3.4 Lecture-demo of the system to visitors from WHO and CDC

Dr. Tippavan Nagachinta from the Division of International Health, Centers for Disease Prevention and Control, and another WHO personnel was able to view the software in action.

4.3.5 Lecture-demo of the system to the Marikina City Health office

This has resulted in the signing of a memorandum of agreement to install the system in Marikina City (another local government unit) and conduct training there.

4.3.6 Lecture-demo of the system to the National Epidemiology Center

The staff of the National Epidemiology Center (NEC) and the Infectious Disease Surveillance and Control Project from the Department of Health viewed the computer-based system and is considering funding an evaluation of the system.

4.4 *Research capacity with respect to*

4.4.1 Research skills

The research staff was able to learn new techniques in software development (incremental, object-oriented, modular). In particular, the project reinforced the initial hypothesis of the researchers that success in software systems is tightly entwined with ownership of the system by end users. An effective way is to involve the end users in the development of the modules of the system.

The research staff was able to obtain new perspectives in evaluating ICT developments such as qualitative research techniques. Although the staff was not able to perform such an analysis themselves, they studied these techniques in preparation for the eventual evaluation of the project.

4.4.2 Research management capacity

The research staff was able to employ basic project management techniques in this project. Although the project was deterred midstream by the shift in leadership, it was not remiss in the area of implementation and was able to catch up in the area of documentation.

4.4.3 Capacity to link research to utilization of research results

Definitely, the techniques used by the project leaders, such as evolutionary software development, and purposeful immersion will be permanent strategies of the unit in its future designs and implementations. Already these techniques, as well as the GAME engine, are being used in a national surgical registry and a blood bank information system.

4.5 *Impact on marginalized and disadvantaged groups [see Impact 7.1]*

4.6 *Gender issues [see Impact 7.3]*

5 Capacity building

The project has been able to build up the research institution by:

1. Exposing the staff to the methods and procedures of large international granting agencies;

2. Affirming open source as a fundamental philosophy in software development for health;
3. Providing infrastructure (workstations) for developing the software;
4. And, providing exposure and hands on experience on internationally accepted financial reporting and accounting.

6 Project management

6.1 Administration

Because of the transition on project management from Dr. Tolentino to Dr. Marcelo midway into implementation, delays were experienced in reporting. Endorsements had to be made and Dr. Marcelo had to feel his way into the details of the project causing some delay in producing the required reports. However, all other components of the project like trainings and software development proceeded as usual in the two pilot sites and milestones were delivered on time.

6.2 Scientific management

A significant shift in strategy was made early in the project implementation because of the realizations about the need to shift focus from community health workers to the the health center staff (see section on Research Findings).

6.3 Technical

An evaluation of the project is lacking. There needs to be an assessment as to whether it was successful or if revisions may be necessary before implementing the system in other sites.

7 Impact

7.1 Recognition of marginalized communities

The clear impact of the computer-based system from the development perspective is the documentation of a citizen's health status and needs. This essentially puts that citizen into the radar screen of health services and forces the health system to respond to his/her needs in a comprehensive manner. In a country currently in fiscal crisis, it is easy for the marginalized to fall off the cracks if the health information system does not effectively detect them and monitor their needs. A computer-based system is a first important step towards documenting and acknowledging the needs of these marginalized poor and in allocating resources for them.

7.2 *Midwives can learn how to use computers*

One of the initial fears of some of the researchers was the ability of midwives to learn how to use a computer. This coming from the fact that most of them are in their forties and have not used a computer all their life. There was also a common belief that midwives do not have the educational background or ability to learn how to use computers. This project has shown that with adequate preparation and innovative strategies, midwives can learn to use web-based applications and gain aptitude fairly quickly. The key was integrating the technology into their workflow.

7.3 *Gender specific data now available*

In the previous manual paper-based system, gender specific data was only available for notifiable diseases but not for services (e.g., Expanded Program on Immunization, National Tuberculosis Program, Malaria, Leprosy, etc). With the computerized system, gender and age-specific data were now available for epidemiological analysis.

7.4 *Health applications are better if open source*

Open source as a development paradigm for health application may now become the norm in the Philippines because of the leadership shown by this project. This will result in several benefits:

- * Better quality through transparency. The algorithms and formulas are exposed and therefore errors are detected early before actual patients experience dangerous outcomes.
- * Collaborative development. This allows more people to work on the application and develop more features in less time.
- * Lower costs. Since the tools used for development are free themselves, costs may now be redirected to other areas like peopleware developers/training of end users) where resources are most needed.

8 Overall Assessment

The project, as revised, has shown to be extremely strategic in the development of the field of health informatics in the Philippines. The project has accorded to the research organization a deep understanding of the value of accurate and timely documentation of health in upholding the rights of the marginalized. Where there is no documentation of need, there will be no resources allocated. What began as simply a technology project has gone beyond just software development but also into community organization, immersion, and human rights advocacy.

In the area of funding, most of the expenses of the project went into software development and project management. Secondary items were the hardware and network infrastructure investments. This

is understandable since by its very nature information technology projects are expensive. But notable is the fact that from hereon, software development using open source software will be cheaper. And since the license of CHITS is GPL, then it means subsequent modifications by third parties will be cost-free to cities like Pasay and Marikina, thereby multiplying the benefits of the initial investments of Panasia.

9 Project sustainability

9.1 *Process sustainability*

There is a nagging question on the sustainability of the project with regard to process. This is because most of the learnings were gleaned by the researchers themselves, and much less by the beneficiaries. An obvious sustainability questions will be: can the two pilot sites be able to implement the same system in other health centers?

Offhand, the answer will be no. Mainly the negative is due to the multi-component nature of information systems and that the health officers in the pilot sites do not have strong grounding in the other components of information systems like networking, hardware, and software.

Activities that are planned to make the process sustainable are the following:

1. Integration of CHITS as a demonstration system in the Master of Science in Health Informatics which is being offered by the research leaders at the University of the Philippines Manila. Hopefully, the master students would be able to obtain the same lessons (and much more) and contribute to the fund of knowledge and techniques in support of a national health information system.
2. Development of new capability building packages that involves the local chief executive (mayors and governors). These packages ensure that the leaders who hold the levers of money and policy understand how reliable health information systems are beneficial to their governance.
3. Integration of the CHITS to the Philippine National Health Information Infrastructure. The PNHII is a public-private initiative of the researchers as a way of involving other partners into the work of building a robust information infrastructure for the national health information system. It has obtained a go-signal from the Secretary of the Department of Health and a draft memorandum of agreement is attached to this document.
4. Resourcing from the local government unit (Pasay City) to continue support to CHITS in the two health centers. This would include sending government personnel to training on CHITS administration and management.

9.2 *Input Resource sustainability*

9.2.1 Human resource input

There is currently a dearth of experts in the area of health informatics in the Philippines. The research unit is one of the leading agencies working on this area. Will CHITS work without the

intervention of the researchers? Probably not but again, the researchers are planning on building a corps of leaders in the area of health informatics who can contribute to the sustainability of health information systems at all levels of the bureaucracy. The dearth is then a temporary state, which will be addressed straight on by other projects already underway.

In addition, the local government (Pasay City) has been informed that funding from Panasia has been discontinued and they have signified interest in supporting the system (hardware upgrades, paper, printer ink, etc) from their own resources. For Marikina City, the local government shall expend all costs.

Because of the open source nature of the project, there is much less burden on the local governments in supporting the system and they can instead focus on the development of their human resources (programmers, network administrators, systems administrators) which are valuable in other areas of governance and not just health.

9.2.2 Capital equipment

Significant investments were made on hardware and networking. This is because the network-based computer application required standard PC workstation specifications. All procured equipment were standards based and are easily available from any computer shop in the country.

This investment was 'loss-leading' since it was quite substantial in cost. But it was deemed important to be able to show the decision makers on the benefit of the technology by proving the concept through execution. In Pasay, there is a beginning interest to install the system in other centers, but a noted slowness in the movement of the key leaders. In Marikina however, all hardware costs are being shouldered by the city government and in fact rightfully preceded the capability-building sessions. It appears buy-in of the local government is key to sustainability in the area of hardware and networking.

9.2.3 Salaries and professional services

Less than half of the budget went into salaries and professional services. This may appear expensive at first glance but considering that the output of the project was an extensible open source software engine and reusable training materials, the benefit exceeds the cost expended on human resource development.

9.2.4 International travel

The international travel component was important since these provided the research team exposure to an international audience of medical informatics experts. The environment also exposed them to potential opportunities for partnerships and collaborations. The event in Malaysia allowed the research team members to showcase the benefits of open source in health applications in general and CHITS in particular.

Additionally, the participation of the stakeholders from Pasay in the presentations into the 13th AMIC in Bangkok proved to them that the project that is gradually developing in their health centers are of international interest.

10 Recommendations

To come full circle, a full evaluation of the project (preferably external) and its components must be made. Efforts must be made to make this evaluation happen.

Once the evaluation is in, promotion of the project output may now be made to interested local government units. Now that bandwidth costs have gone down considerably, there is an increased demand from local government units to systematize their operations, and this includes delivery of health services. The project is a big step towards addressing this need on a wider scale, possible even national.

Establish other systems based on the 'game engine' as a proof of concept of its extensibility. At the core of the computer-based system is the generic architecture for modular enterprise. It is possible to use this system for other purposes like real property tax monitoring, community tax issuance, etc. It has the potential to integrate the information needs of a local government unit.

The project must participate with the Philippine National Health Information Infrastructure (PNHII) as a demonstration project. As mentioned previously, the PNHII is a consortium of public and private agencies that will create a cohesive infrastructure for health information management in the Philippines. Because of the experience of the CHITS project with real-life problems in health centers, it can provide leadership in the area of health center-based information systems within the PNHII framework.

11 Conclusion

Developing a community based health information system is a challenging task, closely approximating the level of difficulty found in the development of hospital and clinical information systems. By paying close attention to health center events and culture and by employing purposeful immersion in the end-user's way of life, the authors were able to gain immense insight into their needs and requirements and apply these insights into software code, a process we can call evolutionary software development¹⁹.

The authors were originally leaning towards a technology-centric implementation of an information system. With deeper analysis and understanding of the needs and requirements of end users, the authors were able to put technology in its place to serve the genuine needs of community health workers.

The majority if not all of the technology used in this project come from the Internet and are used to run the Internet. Being mature and stable open source technologies, with huge user populations, leveraging these technologies offer extreme value at the lowest cost and have been tested under extremely grueling conditions. With the use of GSM SMS in the Philippines as a very popular messaging system with wide user penetration in the general population, the two key technologies make for a formidable combination with popular support in this project.

¹⁹Clements P [editor]. Constructing Superior Software, Software Quality Institute Series. MacMillan Publishing, USA, 2000. Page 59.

Computers are magnificent tools for the realization of our dreams, but no machine can replace the human spark of spirit, compassion, love, and understanding. - Louis Gerstner, CEO, IBM

Annex 1: Financial report

Annex 2: Paper submitted to 13th AMIC Annual Conference in Bangkok, July 2004

Annex 3: Administrator's Manual (second draft – December 27, 2004) for the Community Health Information Tracking System (CHITS)

Annex 4: Sample handout to community health volunteers and health center staff (with translation)

Annex 5: PowerPoint presentation to the Philippine Open Source Conference

Annex 6: Approved Memorandum of Agreement with Marikina City

Annex 7: Proposed renewed memorandum of agreement with Pasay City