

Deploying Innovative Mobile-based Telemedicine Systems using Open Source tools in Resource-poor Areas of the Philippines

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Abstract: There have been several eHealth and Tele-Health projects in resource challenged settings in the Philippines in the past five years. These projects have made use of the available Information Technology and communications tools to provide tele-medicine services to Filipinos in the rural areas of the country. Today, there are new technologies that improve on, and address the shortcomings and limitations of the previous systems. The Sana Mobile Telemedicine system is an innovative mobile healthcare information system that provides an end-to-end infrastructure of medical diagnosis and treatment. The system is highly customizable, with an easy to use Android-based mobile phone interface, built on top of several Open Source technologies. It utilizes a collaborative multi-discipline approach in its development and implementation. The Philippine implementation is a multi-organization collaboration among the following: Center For Community Transformation, and Negros Women's for Tomorrow Foundation (non-government organizations), Integrated Open Source Solutions (a software development company), and Asia Pacific College (a school). The Sana Mobile Telemedicine system was successfully piloted within CCT and NWTF. A Sana Mobile Hypertension procedure was created and customized to local requirements. The average time for gaining familiarity with the Android mobile interface was one day. Healthcare workers found the interface straightforward and easy to use. Doctors were able to view detailed patient information and send their diagnosis back to the healthcare worker through the system. CCT and NWTF are now planning to integrate the Sana Mobile Telemedicine system within their organizations to provide tele-medicine services to their members.

Introduction

The healthcare situation in the rural areas of the Philippines has remained unchanged over the past five years. There is a continued lack of doctors and hospitals to serve the 50 million Filipinos living in the rural areas of the

country [1]. There have been previous projects that attempted to address this situation using available Information Communication Technologies, the primary technology being the use of Short Message Service (SMS) based systems for the transmitting of information [2]. The shortcoming of SMS based systems is the very limited amount of information (160 characters per message) that can be sent through the system.

Since then, there have been advances in technology such as Android based cell phones. These phones allow intuitive, user-friendly applications to be built, that can capture detailed patient information and store the data on the phone. These records are then transmitted to a central Electronic Medical Record system, through various methods of transmission.

With these new technologies now available, doctors can now receive detailed information to make a more accurate diagnosis, and can service many more patients since the technology extends their reach remotely.

System Outline

The Sana Mobile Telemedicine System is a standard-focused open-source system that allows for the creation of highly customizable workflows that are loaded onto the phone (Android application), connects to a back-end electronic Medical Record System (OpenMRS), and allows for reliable operation on unreliable networks through its synchronization, packetization and multi-modal transfer abilities [3].

The Sana Mobile Telemedicine system has the following features [4]:

- It interfaces with point-of-care diagnostic tools through the attachment of portable medical devices to the mobile phone.
- It allows guidelines, checklists, medical procedures and protocols to be saved on the phone, bringing evidence based Medicine into the hands of a health worker or nurse at a clinic.
- It streamlines triage and referral system which includes initial assessment, initiation of diagnostic procedures, appropriate physical examination, and documentation.
- It facilitates coordination of care, care standardization and quality monitoring through the use of Electronic Medical Records.

Components of Sana

There are four components of Sana. These are: the Sana Android Phone client, the Mobile Dispatch Server, the SMS Server, and the Electronic Medical Record System [5].



Fig. 1 Components of Sana

Phone Client – Android Phone

The Sana phone client is an application written for the Android phone. This phone client allows multiple procedures to be stored onto the phone. Examples of procedures are: Hypertension questionnaire, Shortness of Breath Evaluation. The Health care worker Opens the Sana phone clients, selects a procedure and follows the workflow hard coded into the procedure when interviewing the patient. The Sana application guides the Health Care worker through the step-by-step questionnaire [6].

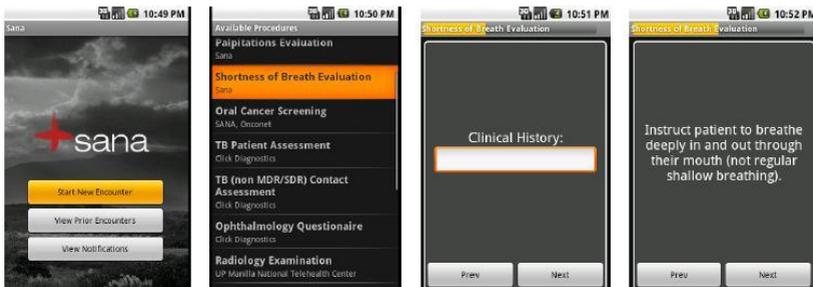


Fig. 2 Sana Phone Client phone interface, List of Procedures, Selected procedure

Once the health care worker completes the form for a patient, information is stored on the phone and then uploaded to the Electronic Medical Record System through multi-modal transfers: data is transferred using multiple interfaces, including GPRS, 3G, WiFi, SMS and USB cable depending on the size and quality of data [3].

Mobile Dispatch Server

The Sana Mobile Dispatch Server gives the Sana system the capabilities of synchronization, and packetization. These are two very important capabilities as the system is meant to be used in remote areas where there might be little or no mobile telephone network connection. The Mobile Dispatch Server also sends notifications from the Electronic Medical Record System, back to the phone via SMS, through the SMS server. The Mobile Dispatch Server is the bridge that connects the Android phone client to the OpenMRS, Electronic Medical Record System [5].

Electronic Medical Record System - OpenMRS

OpenMRS is an Open Source Electronic Medical Record System that is based on the idea of a concept dictionary, and has the following features, among others [7]:

- Supports open standards for medical data exchange including HL7
- Central concept dictionary: Definitions of all data (both questions and answers) are defined in a centralized dictionary, allowing for robust, coded data
- Patient workflows: An embedded patient workflow service allows patient to be put into programs and tracked through various states.
- Support for complex data: Radiology images, sound files, etc. can be stored as “complex” observations

Results and Discussion

Multi-Organization partnership

The pilot implementation of the Sana Mobile Telemedicine System in the Philippines is a multi-organization partnership that is grouped into three areas: The Implementation and Operations Partners, the Social Partners, and the Medical Partners [8].

Implementation & Operations Partners: **Asia Pacific College (APC)** – Academic Partner to provide research and development resources for the Sana project. **Integrated Open Source Solutions (IOSS)** – I.T. Solutions provider to manage the project, and provide maintenance and support. **CS**

Foundation, Inc. – Funding source to pay for the project pilot. Social Partners : **Center for Community Transformation (CCT)** – Manila based Non-government Organization with a nationwide membership of over one hundred thousand. **Negros Women For Tomorrow Foundation (NWF)** – Bacolod based NGO that helps women achieve self-sufficiency and self-reliance. Medical Partners: The Doctors that participated in the pilot implementations were the in-house doctors of each of the NGO’s.

Actual Pilot Implementation

At the start of the project, the hypertension procedure was agreed upon by the two organizations as the procedure that would be used for the pilot. IOSS was able to customize the hypertension procedure according to the requirements of the two partner NGO’s. The hypertension procedure was piloted with the members of each of the two NGO’s, and the results of the pilot were discussed after the pilot was completed. Based on interviews of the participants in the project, the Community Health Workers adapted quickly to the Mobile Application (within one or two days). Major complaints were with regards to delays in transmission and receipt of data due to lack of a cell phone signal in some pilot areas [9].

A key component to the success of the pilot was the iterative process used in refining the Hypertension Procedure based on constant feedback from the users. Each organization is now preparing for full implementations of Sana and integration as part of their strategy for delivery of medical services to their members.

Table 1- Costs of Implementation based on the deployment of Ten Android Phones for one year, within each organization (CCT, NWF)

Hardware Costs	Unit Cost (Euro)	Quantity	Total Cost
Android Smart Phone (ten units)	107	10	1,072
USB GSM Modem (one unit)	18	1	18
SMS Server (one unit)	268	1	268
Monthly Recurring Costs			
Virtual Private Server	200	12	2400
Monthly SMS cost	16	12	193
I.T. Maintenance Support	536	12	6,430
Software License Cost			
Open Source Software	0		0
Total Costs			10,381

Conclusion

Based on the Five (5) Elements of Telemedicine [10], the Sana Mobile Telemedicine project is able to address each element.

The use of an Open Source Software development platform allows various specialized groups to collaborate and build on top of each group's expertise. This is so well characterized in the Sana Mobile Telemedicine project, which makes use of several Open Source technologies to come up with an effective, working, low-cost solution to provide Remote Medical Diagnosis in low resource areas not only in the Philippines, but for the rest of the world.

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