Feasibility study to enable Freedom Fone with voice-based Emergency Data Exchange (FF4EDXL)

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Project Report, Version 0.8
December 10, 2011

Published by LIRNEasia in the Public Domain

Project Title: Feasibility study to enable Freedom Fone with voice-based Emergency Data Exchange
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1 Synthesis

The “feasibility study to enable Freedom Fone with voice-based Emergency Data Exchange (FF4EDXL) set out to investigate the challenges of integrating the Freedom Fone (FF) Interactive Voice Response (IVR) system with the 'Sahana' disaster management system. The project adopted standardized interoperable emergency content standards; namely, the Emergency Data Exchange Language (EDXL) Situational Reporting (SITREP) and Common Alerting Protocol (CAP), in the efforts to interlink the two software products.

The beneficiary of this project was the Lanka Jathika Sarvodaya Shramadana Sangamaya (abbreviated as Sarvodaya). They are Sri Lanka's largest community-based organization that also engages in humanitarian assistance. Sarvodaya responds to all national and local level disasters. The business study, conducted at the early stages of the project, concluded that Sarvodaya use telephone calls, in almost all cases, to exchange daily, weekly, and monthly situational reports. Their main activities are providing health, shelter, food, water, and sanitation type assistance to Internally Displaced Persons (IDPs).

As a stand alone solution, FF is easy to install and operationalize in a very short time because it comes bundled with the Ubuntu Operating System, Freeswitch Global System for Mobile (GSM) gateway, MySQL relational database, Apache Hyper Text Transfer Protocol (HTTP) server, and PHP-based Web Graphic User Interface (GUI). There are some limitations with the fully bundled solution such as when trying to install and operationalize FF to coexist with the Sahana disaster management system. The difficulties arose with sharing common HTTP resources and the 2N Universal Mobile Telecommunication Ssystem (UMTS) modem. What may seem trivial to an experienced expert information technology systems administrator was not for average software developers and grass roots level Sarvodaya Hazard Information Hub Operators (HIHO).

Given that Sarvodaya Community Emergency Response Team (CERT) members use voice telephony for their disaster communication, the Technology Acceptance Modem (TAM) results concluded that they found FF to be easy to use, useful, and had a positive attitude towards integrating it in to their activities. FF was the first experience for most CERT members interacting with an IVR. However, the observation statistics reasoned that only 8.75% of the users found FF to be difficult (or complex) to use and 84.31% completed their FF activities in a single or couple of attempts.

In the Sri Lankan context, with the need to accommodate three languages: Sinhala, Tamil, and English as well as lesser computer literates, the simple telephone call controlled FF stands as a workable solution for Sarvodaya members. The sustenance of the system will depend on how Sarvodaya decides to integrate FF in to their daily activities (i.e. utilities beyond disaster management). A couple of suggestions that came from the users were to utilize it for project reporting and project information sharing. Then is it always operational and always ready to use.

The project experimented with three disaster communication functions: 1) Alerting (or situational awareness) 2) Situational Reporting and 3) Surveys. The HIHO and CERT members were given training on FF and Sahana software systems. Thereafter, they took part in a series of silent-tests and controlled-exercises. The alerting process had HIHO generate a CAP message then post a localized voiced version in the FF voice menus for CERT members to access through their mobile phones. The situational reporting activities had CERT members leave a voice message, in FF, relaying a hypothetical incident using their mobile phones. Those local language incident voice messages were

translated to English and transcribed in to Sahana in the form of text. Sahana would then be used to analyze the categorical information to derive the response resources.

There were inefficiencies at the Hazard Information Hub (HIH) that were mainly a result of the HIHO having to switch between multiple software systems to complete the work flows. Each action cycle: alerting and situational reporting, for the controlled-exercises, were expected to take nor more than 15. However, the actual Mean Time To Completion (MTTC) was 30.50 minutes for each action cycle. These inefficiencies can be improved with a stronger integration between FF and Sahana as well as streamlining the processes to control the work flows. Evidence points to the need for a single application presented to the user; i.e. the FF IVR should be built in to Sahana. A better streamlined and integrated system would reduce the burden on the training requirements for multiple systems as well.

Literature surveys and consultations with the University of Colombo School of Computing Natural Language Processing Lab established that Sinhala and Tamil Text-To-Speech (TTS) and Speech-To-Text (STT) were still unreliable for adaptation. Such transformation software engines may improve the HIH alerting and situational reporting efficiencies. However, voice quality, at times, was unsatisfactory for even human operators to decipher the information. This would be another challenge for implementing reliable TTS and SST software. The Mean Opinion Score (MOS) of 3.52 and Percent Difficulty (or Difficulty Score) of 29.44% were below expectation, especially when considered for mission critical emergency communication systems.

The project was able to accomplish the intended activities over the six month period. The lessons to date are promising for integrating voice for emergency communication; especially to bridge the last-mile with incident management hubs. Moreover, it is effective than other ways to enable ICTs for low computer literate non English working language community-based disaster management organizations in developing countries. The research findings were shared with the Sahana Foundation and Freedom Fone decision-makers and was able to influenced them to work towards integrating the two disparate systems. That would position, the integrated voice-enabled disaster communication system, for a wider-scale adaptation; especially, with community-based emergency management and response organizations that would otherwise be less inclined to adopt an expert disaster management system like Sahana.

2 Research Problem

Research question - “What are the design strategies for facilitating an interoperable emergency data exchange platform for voice enabled alerting and situational reporting?”

Focused group interviews with Sarvodaya Provincial, District, and Divisional Coordinators as well as meetings with CERT members in Colombo (CO), Matara (MH), Nuwara-eliya (NW), and Ratnapura Districts (RN), revealed the complexities of coordinating large-scale national crises: flood (2011), landslide (2011), war (2009), and tsunami (2004) in Sri Lanka. Moreover, they emphasized that local disasters, caused by torrential monsoon rains, are equally impacting when damaged bridges and inundated roads frequently disrupt their daily routines. The change in weather patterns are also increasing hazards events and a database of local events could provide them with the insight to prepare for these periodic events.

Zainudeen and Ratnadiwakara (2010[1]) research infers people in developing countries, like Sri Lanka, to

1 Zainudeen, Ayesha and Ratnadiwakara, Dimuthu, The Use of Mobiles Beyond Voice: Identifying the Conditions for Use at the BOP (December 8, 2010). Communication Policy Research South (CPRsouth), Xi'an, China, December 6-8, 2010.

be accustomed to voice-based telephony services opposed to text-based applications. Therefor, it is possible to position FF interface as a tool to aid in emergency information communication that benefits the local disaster management communities in Sri Lanka.

Absence of interactive voice applications for exchanging information and complex text based systems are forcing local emergency coordinators to remain with paper-based systems. Typically, Information is, first, received through fax print or a phone call message that is transcribed on to paper. Then those communiques are, once again, entered in to computers to produce ad-hoc aggregate reports. Such multi-iterate duplicate data entry methods are inefficient, unaccountable, and contort information. An end-to-end electronic system with data digitized at the frontlines would improve efficiencies, accountability, and data integrity. Crisis information organized in electronic form has proven to be efficient and effective in coordinating any scale of disasters[2].

An important aspect is that the technology interventions for community-based applications must be localized for Sinhala and Tamil users in Sri Lanka. An early technology challenge, identified and is required for automation, was the deficit of STT and TTS transformation software libraries for Sinhala and Tamil. HazInfo technical report (2008) emphasized that CAP profile for Sri Lanka requires messages to be delivered in Sinhala and Tamil to effectively communicate the threats to 99% of the Sri Lankan population. Upstream communication of SITREP messages would also be in the same two languages.

Natural language translation or machine translation for voice-text transformations, both ways, for local languages, are still unstable and are being gradually refined by the local academia[3]. A project challenge was developing easy to use software and streamlined procedures that can supplement the automation shortcomings.

3 Objectives

The objective of this phase of the research was to study whether data received in the form of voice can adapt to interoperable emergency content standards. Thereafter, device a strategy to integrate FF with Sahana. For this research, EDXL CAP and SITREP were chosen as the basis for assessing the feasibility for integrating FF and Sahana for standardized data exchange between the two systems. Figure 1 shows the intended architecture of the integration. The study will specifically focus on community-based disaster management with the need for multilingual capabilities.

At this stage of the research, the actual integration of FF with Sahana will not be completed. Instead, the outcomes of this research will be to better understand the system requirements that will lead to design recommendations for a complete integration of FF with Sahana for standardized emergency information interchange. Based on those findings, apply for other funding opportunities to solve the prevailing gaps. We will also attempt to utilize Random Hacks of Kindness, Google Summer of Code and Google Code-In initiatives to attract volunteer software developers to contribute to future software developments.

Available at SSRN: http://ssrn.com/abstract=1724517

2 Prustalis, Mark and De Silva, Chamindra (2010). The Sahana Free and Open Source Disaster Management System in Haiti, ICT for Disaster Risk Reduction, United Nations Asian and Pacific Training Centre for Information and Communication Technology for Development (UN-APCICT/ESCAP), ICTD Case Study 2.

3 Weerasinghe, Ruvan, Wasala, Asanka, Welgama, Viraj. and Gamage, Kumudu. (2007). Festival-si: A Sinhala Text-to-Speech System, Language Technology Research Laboratory, University of Colombo School of Computing, Colombo, Sri Lanka

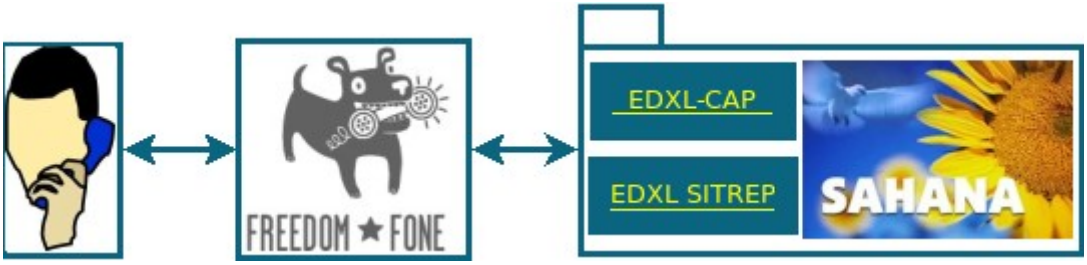

Figure 1: Integration of telephony, Freedom Fone IVR, and Sahana DMS for EDXL-CAP/SITREP standardized emergency information exchange

The project sought to achieve the following specific objectives -

1. Study the risk information communication needs for disaster coordination between "Samana
2. Thetha" (also known as the Sarvodaya Community Disaster Management Center -SCDMC) and the Sarvodaya District/Divisional Coordinators and CERT members
3. Map those requirements to EDXL-CAP and EDXL-SITREP enabled Sahana modules as well as FF functions
4. Implement the FF IVR system that addresses the requirements for exchanging standardized messages between Samana Thetha and the District/Divisional Coordinators and CERT members
5. Assess the implementation challenges and design changes required for FF to comply with Sarvodaya needs, EDXL-CAP alerting standard, and EDXL-SITREP situational reporting standard for exchanging multilingual emergency information

4 Methodology

The sections below, briefly outlines the methodology and the outcomes. The reader is encouraged to refer to the Technical Annex[4] (TA): "*Evaluation Toolkit and Results*" document for an in-depth understanding of the evaluation methodology, results, and outcomes.

A business analysis was conducted through a series of interviews and user interactions to first, determine Sarvodaya's disaster information communication needs. The project selected Colombo, Matara, Nuwara-Eliya, and Ratnapura Districts for the study. Between ten and fifteen CERT members from each District were involved in the project. These members had responded to nationally significant disasters in the past. They were given a questionnaire (TA, section 11, p 38-40) to supply information on the ways and means by which they had engaged in emergency communication and response activities.

All the CERT members were trained to use the FF system for receiving and submitting information. Basic steps involved navigating through the menus, activating functions with the phone keypad, and recording messages. A team of three voluntary HIHOs underwent a training and certification course. They were introduced to the HIH infrastructure, software components, standard operating procedures, and support/maintenance aspects (see section 6.2.1). Thereafter, the HIHOs were exposed to a series of silent-tests in preparation for the controlled-exercises.

A series of controlled-exercises were carried out at the HIH and in the four Districts. The exercises were designed to evaluate the complexities (interaction techniques and reliability), usability (human action cycles and gulf of execution/evaluation), and utility (perceived ease of use, perceived usefulness, and attitude towards using) of the implementation. Feedback on the complexity, usability, and utility

4 Waidyanatha. (2011). "Evaluation Toolkit and Results (Technical Annex)", under subheading – Reports, published in the project page: http://lirneasia.net/projects/2010-12-research-program/ff4edxl/

indicators were obtained through focus-group discussions, interviews, assessments, and observations from the various workshops and exercises (TA, section 6, p 13-17).

Interaction techniques evaluated the CERT members' ability to navigate through the FF menu trees to execute the relevant actions. It involved observing the sequence of steps and iterations executed by the CERT members to listen to an alert or record a situational report. The complexity of interaction sequence measured the length of the sequence, validation actions, and time take to attain the desired state (TA, section 6.1.1, p13).

The reliability factor (TA, section 6.1.2, p13-15) took in to account the Mean-Time-To-Completion (MTTC) and data quality (information completeness). Both are critical as timeliness can save lives and complete information will remove any ambiguities that may lead to inappropriate actions. The MTTC estimated the time for a certain actor (HIHO or CERT member) to complete a given action. The data quality specifically applied the Mean Opinion Score (MOS), Difficulty Percent (DP), and Categorical Characteristic Ration (CCR).

Human action cycle model, used to analyze the efficiency of the User Interfaces (UIs), set out to evaluate the steps taken by the HIHO when they were interacting with the various software components. The analysis helped predict the future outcomes. The users went through the actions of formulating the goals, intents, and actions. Thereafter, executed the actions using software. Finally, engaged in evaluating the state of the outcomes to determine whether the expectations were met (TA, section 6.2.1, p16).

Gulf of execution differentiates between the the HIHO's intentions and the actions that are permited by the ICT systems. Gulf of evaluation refers to the difference between the HIHO's understanding of the state of the system and the actual state (TA, section 6.2.2, p16-17).

Utility plays a role in the system adaptability. Specifically, in terms of the benefits that it would provide to Sarvodaya's disaster management activities. Evaluation framework surfaced the user perceived value of the FF4EDXL proposed system and procedures. Parts of the TAM was applied to evaluate the perceived usefulness, perceived ease of use, and attitude towards using the FF and Sahana software (TA, section 6.3, p17).

5 Project Activities

Table 1: description and timelines of project activities

Main activity	**Description of subtasks**	**Begin-End dates**
Preliminaries - Activities before launching the research project		
Signing-off on MoU	A Memorandum of Understanding (MOU) was signed between the research implementation partner: LIRNEasia and the funding partner: The Kubatana Trust of Zimbabwe. The first payment of the grant was received at the time of signing the MoU. Subsequent payments were made there after.	2011-05-28 2011-06-24
Recruiting research	Two assistant cum analyst programmer were recruited in the capacity of research interns. The internships were advertised through LIRNEasia's	2011-05-24

assistants	email lists, which accompanied the Terms of Reference (TOR). During the proposal phase the plan was to recruit one intern. Since the project was unable to identify a good candidate, the project recruited two interns to share the work. They were both contracted for the duration of the project. In addition to the interns a Sarvodaya project manager was used on a task by task basis to assist with coordination and implementation of field level activities.	2011-06-04
Procurement of equipment	A 2N Office Route was ordered from Czechoslovakia. The dilemma was getting the unit to Sri Lanka. It was decided to hand carry it rather than courier it. The first attempt to get a LIRNEasia colleague to bring it in to Sri Lanka from Finland failed due to DHL failing to deliver on time as a result of seasonal holidays in Europe. Thereafter, it was shipped to UK to another LIRNEasia colleague until it was hand carried by a Sarvodaya member from Geneva. The unit had to be re-shipped to Geneva. A branded computer: HP Pro (CPU only) was purchased through the technology company eWis. The project decided to use an available computer monitor but purchased a 4 port KVM Switch to couple the several servers including the HP Pro to a single monitor. There were delays in delivering the HP Pro as eWis claimed there were logistical problems with clearing the PC from customs. The FF system GUIs had to be exposed over the Internet through a real IP. This was to allow for district level emergency management. First we needed a RJ45 cross cable to connect the CPU with the 2N Modem. The HP Pro 6200 on board Ethernet card was not recognized by the Ubuntu OS. There were no drivers available on the public domain. Therefore, the project had to buy an additional Ethernet card to attach to the HP Pro CPU to connect to the modem. Since the HP Pro on-board Ethernet card was dysfunctional the project had to purchase a USB-RJ45 converter to connect the CPU to the Internet.	2011-05-30 2011-07-16
System Delivery - implement the FF technology and develop the interfaces to Sahana		
User requirements	The research team studied the the EDXL-SITREP and EDXL-CAP specifications. The team also gathered users' requirements through interviews and focused group discussions. These requirements were then mapped to EDXL-SITREP and EDXL-CAP elements. These specifications related to the requirements gathered are mentioned in section 6.1.1. Through a two day workshop the research team engaged in discussions with Sarvodaya Provincial/District Coordinators, and other senior	2011-07-01 2011-09-09

	Sarvodaya members to gather the requirements. The workshop report is referenced in section 6.3. Along with a training on FF, an exercise was conducted in each of the four districts that involved participants submitting their past disaster information communication methods and experiences. The project used FF to gather collect the response data. Then categorized and analyzed them	
Software Specifications	After understanding Sarvoday's disaster communication needs, the process flows, and constraints, the team prepared the SRS document for SITREP and CAP module. The CAP module had already been developed for text-messaging but had to be revised voice-messaging. The completed SRS outputs are discussed in section 6.1.2. Prototypes of both CAP Broker for alerting and SITREP for incident management were developed. The project team made the necessary modification to Sahana. The FF implementation was demonstrated to Provincial/District Coordinators and the CERT members during workshops in the four pilot districts. The workshop report is refernced in section 6.3.	2011-07-06 2011-11-23
User Interactions	The project conducted a comprehensive training and certification program for the HIHO. Seven members were identified and recruited to be trained. Only three of the seven completed the training and proved an aptitude to engage in the controlled-exercises. In addition to learning how to issue alerts and process incident reports, they were given training with basic knowledge on administering the HIH and executing other related operating procedures. The training and certification guide is referenced in section 6.2.1. A set of training aid and quick reference guides with standard operating procedures were developed for the users. Those documents were used during the Sarvodaya CERT training sessions the four districts. The quick guides are referenced in section 6.2.2.	2011-09-01 2011-10-30
Evaluation – run controlled exercises		
Release Beta	The integration and developments went through several iterations with the researchers trying several implementation strategies. The beta integration is what the project strives for. It was completed prior to the controlled-exercises.	2011-08-01 2011-11-30
Mock drills	Prior to the main controlled-exercises, the team conduct a series of silent-tests. These were to: 1) provide the HIHO with opportunity to rehearse their activities and 2) for the software developers and	2011-10-15 2011-11-09

	implementors to stream-line the tools and procedures The controlled-exercises were stretch through two weeks to accommodate the availability of District personnel. Four interdependent Observers took part in reviewing the HIH operations during the exercises and submit a formal report on the outcomes. The controlled-exercise scenarios for alerting and situational reporting were established on the inputs received through the requirements study.	
Final Report	The report was separated in to two documents 1) this document "Project Report and 2) Evaluation Toolkit and Results. The second carries a detailed discussion of the methodology, results with outcomes, and an appendix of the actual raw data.	2011-09-15 2011-12-09
Dissemination – share project findings		
Publications	The research findings were first presented to the LIRNEasia researchers at a colloquium and then to the Sahana members during the monthly community call. The first peer-reviewed paper was presented IET-PATW 2011 at the University of Moratuwa in Sri Lanka. Another paper was accepted to the ITS 2012 conference and will be presented in February 2012. Other papers have been submitted and are being reviewed. See section 6.4 for a listing of the dissemination activities. A supplemental proposal has been submitted to the Humanitarian Innovation Fund and Internews to support the dissemination activities.	2011-11-17 work-in-progress

6 Project Outputs

6.1 Software design documents

6.1.1 User Requirements Specifications (URS)

To understand Sarvodaya's emergency communication business practices, the FF4EDXL project team conducted interviews and a survey (TA, section 2). A workshop was conducted with Sarvodaya Provincial/District Coordinators and other Sarvodaya Executives. During this event the participants were introduced to FF4EDXL concepts. Then used that as a basis to engage them in focused group discussions to determine the ways and means by which they submit and receive information as well as the types of content that is exchanged for communicating the incident management information. The research team also analyzed some of the paper-based reports and information that was used in past disasters to communicate the situational information. The outcomes of the business study is documented in the URS[5].

5 "Business Study of Sarvodaya Situational Reporting Information Needs", under subheading - Software Specifications, published in the project page: http://lirneasia.net/projects/2010-12-research-program/ff4edxl/

6.1.2 Software Requirements Specifications (SRS)

There are two SRS documents: 1) Situational reporting 2) alerting.

1) Purpose of the situational-reporting-SRS[6] was to document the understanding of EDXL-SITREP, Sarvodaya's information needs for incident management, and then derive design requirements to integrate Sahana and FF for exchanging EDXL-SITREP information for voice-based situational reporting.
2) Purpose of voice-alerting-SRS[7] was to document Sarvodaya's alerting information needs. Thereafter, derive the design requirements to exchange EDXL-CAP messages between Sahana and FF for delivery of voice based alerts to Sarvodaya CERT members.

6.2 User manuals and standard operating procedures

6.2.1 Sarvodaya HIHO training and certification guide

A *comprehensive training and certification program*[8] was designed for the Sarvodaya HIH. The intent of this activity was to develop a set of volunteers; namely HIHO, for maintaining the disaster information management software, hardware, and infrastructure.

6.2.2 Quick reference guides

There are three *quick reference guides*:

1) Creating and issuing CAP messages with Sahana and FF[9]
2) Receiving alerts and reporting field observation with FF[10]
3) Processing FF received FORs and completing the Sahana SITREP[11]

Quick guide 2) is specifically for CERT and quick guides 1) and 3) are for the HIHO.

6.3 Training and awareness workshops

- Awareness and requirements workshop. 28-29 July, 2011, Lanka Jathika Sarovdaya Shramadana Sangamaya Head Office, Moratuwa, Sri Lanka. Report available on the web: http://lirneasia.net/2011/08/ff4edxl-planning-workshop-20110728/

- Freedom Fone training workshop. 05-09 September, 2011, District Coordinator office, Colombo, Matara, Nuwara-eliya, and Ratnapura in Sri Lanka. Report available on the web:

6 "Software Specifications: Sahana Eden EDXL-SITREP Reporting Module", under subheading - Software Specifications, published in the project page: http://lirneasia.net/projects/2010-12-research-program/ff4edxl/

7 "Software Specifications: Sahana Agasti EDXL-CAP Alerting Broker", under subheading - Software Specifications, published in the project page: http://lirneasia.net/projects/2010-12-research-program/ff4edxl/

8 "HIH Training & Certification Guide", under subheading – Training aids, published in the project page: http://lirneasia.net/projects/2010-12-research-program/ff4edxl/

9 "HIH Operator guide to issuing CAP messages with Sahana Agasti Alerting Broker and posting voice-alerts in Freedom Fone", under subheading – Operational guides, published in the project page: http://lirneasia.net/projects/2010-12-research-program/ff4edxl/

10 "Community Emergency Response Team guide to Freedom Fone alerting and reporting", under subheading – Operational guides, published in the project page: http://lirneasia.net/projects/2010-12-research-program/ff4edxl/

11 "HIH Operator guide to transferring Freedom Fone field observation reports to Sahana-Eden SITREP module ", under subheading – Operational guides, published in the project page: http://lirneasia.net/projects/2010-12-research-program/ff4edxl/

http://lirneasia.net/2011/09/ff4edxl-training-sept-201/

- HIHO training workshops, 01 September – 28 October, 2011, Sarvodaya Community Disaster Management Center, Moratuwa, Sri Lanka. Report, on the outcomes of the training regime assessed through silent-test, available on the web: http://lirneasia.net/2011/11/crowdsource-hiho-ff4edxl/

6.4 Dissemination

- International Conference on Computer and Information Science, Kuala Lumpur, Malaysia; 12-14 June 2012 (http://www.utp.edu.my/iccis2012/). Peer-reviewed paper: Mean Opinion Score Performance in Classifying Voice-enabled Emergency Communication Systems (submitted 2011-12-30).
- Information Systems for Crisis Response and Management, Vancouver, Canada; 22-25 April 2012 (http://www.iscram2012.org/). Peer-reviewed paper: Complexity and Usability of Voice-enabled Alerting and Situational Reporting Decoupled Systems (submitted 2011-12-12).
- International Telecommunications Society, New Delhi, India; 22-24 February 2012 (http://www.its2012india.com/). Peer-reviewed paper: Challenges of implementing Standardized Emergency Data Exchange with Interactive Voice Response in Sri Lanka (accepted, manuscript submitted 2012-01-12).
- Institute of Engineering and Technology, Annual Technical Conference: Present Around The World, University of Moratuwa, Sri Lanka; 19 December 2011 (http://www.ietpatw2011.com). Peer-reviewed paper: Automation Complexities in Integrating Voice and Text for Emergency Communications in Sri Lanka (accepted/presented).
- Sahana Community Call (web). 11 & 13 December 2011 (http://tinyurl.com/7mdgvo7). Presented the findings at the monthly Sahana community meeting, through a WebEx call conference, with attendees from the International Federation of Red Cross and Red Crescent Societies and Sahana community members.
- LIRNEasia colloquium, Colombo, Sri Lanka. 17 November 2011 (http://tinyurl.com/74q525v). Presented to the researchers at LIRNEasia. Other participants were from Sarvodaya and The Kubatana Trust of Zimbabwe.

7 Project Outcomes

In the sections below, the content will cite the "*Evaluation Tool and Results"*, TA[4] to point to the respective evidence.

7.1 Emergency managers in Sri Lanka prefer voice over text

A reason the field level Sarvodaya CERT members are unconformable in using text-based technologies is because of the unavailability of localized applications. Sarvodaya business is conducted in Sinhala and Tamil. Other LIRNEasia studies point to evidence that most Asians prefer voice communications over text (Zainudeen and Ratnadiwakara, 2010[1]). FF is not restricted by a single language. One may leave-a-message in any language. Only the administrative web based GUI components. Therefore,

simple phone call makes it easy for CERT members to submit and receive disaster information.

For most of the CERT members, FF was their first exposure to an IVR systems. Only very few of them expressed difficulties and had to make more than two attempts with completing their controlled-exercise interactive voice activities (TA, sections 7.1.1 and 7.1.2). Their usual experience with a mobile phone was dialing a number to make a phone call or typing an occasional SMS. The functions of an IVR are no different from their regular or daily mobile experience.

On average it took a CERT member, less than, 2.5 minutes to complete an FF alerting or reporting cycle. About 1.3 minutes of that cycle was listening to the IVR instructions and navigating through the menus (TA, section 7.1.3). The CERT members requested that those descriptive instructions be reduced, which they said otherwise confused them with realizing the IVR transitional state.

One example - to commit a FOR voice recording, the CERT had to press the # key on the phone keypad. This action was mentioned during the instructions but they had forgotten this by the time they finished recording the FOR and were terminating the call. Therefore, the report was not committed to FF and had to repeat the process.

The lengthy IVR instructions are an additional minute of calling time they had to pay for. Expenses can be reversed with a toll free number or the system calling back. Then that becomes an expense the HIH has to bare. It may cost a single CERT member about 10 Rupees and is an affordable goodwill contribution to the cause but collectively would become an immense expense of Sarvodaya was to absorb that cost.

The CERT members, in their response to the TAM questionnaire, expressed that the FF system was easy to use and they found it useful in their disaster communication work (TA, section 7.4.2). Most importantly, they responded with a good and positive attitude towards the application. Their perceived attitude also revealed that FF was a beneficial and a wise idea to implement for Sarvodaya (TA, section 7.4.3).

7.2 Uninterrupted communications

A critical question that is asked in emergency communication system research is **“did the system work on the day of the exercise?”**. In the HazInfo project (HazInfo Technical Report[12], 2008, page 18, section 3.1, paragraph 3), we had documented several reasons for the technology to fail on the day of the exercise. Some of them range from disruption to cellular services due to unpaid bills, accidentally deleting the mobile phone software, so on and so forth.

Similarly, on the day of a silent-test in preparation for a series of project activities that required the use of the FF technology, the team noticed that the license to the 2N UMTS modem had abruptly terminated, which prohibited the use of the device[13]. If not for the preparation tests, this disruption would have not been noticed. It took more than 48 hours to receive the new license and reactivate the system, in the nick of time for the planned drills.

FF recommends 2N Office Route UMTS modem in their solution package. “2N persists in supplying OfficeRoute units with limited licenses to customers who have paid in full prior to dispatch of

12 Evaluating las-mile hazard dissemination: a research project. (2008). Final Technical Report found on the web: http://www.lirneasia.net/wp-content/uploads/2008/05/hazinfo-technical-report.pdf

13 Blog on the license related problem: http://lirneasia.net/2011/09/ff4edxl-license-dependencies-ews/

equipment” (Brenda Burrell, 04-September-2011, extract from an email to 2N). Hence, this realization from the project experience instigated the need for 2N to develop better procedures that ensures 2N customers using FF do not run in to the same problem, as such behavior could have serious consequences for crisis response deployments.

A lorry that ran in to a main grid power transformer discontinued power to the HIH and neighborhood. The power surge from the impact blew the HIH circuit breakers in to pieces. Hence, the generator was unable to supply power to the HIH either. Given that the FF hosted server and the UMTS communications gateway to FF was connected to a set of batteries (i.e. Uninterrupted Power Service units), FF was able to continue its voice and SMS services.

In the event the battery power was to diminish beyond the required capacity to run the server and UMTS modem, then those two units can be easily relocated to resume services. In contrast, the WiMax Internet connection that HIH uses to connect to the Internet would be difficult to relocate on short notice because hoisting and aligning the point-to-point microwave antenna requires special technical skills, which usually the service provider has to supply. In that regard the 2N modem is versatile and the FF system portable.

The exercises in Colombo District took longer for the HIHO to complete, relative to the one in MH District. Th main reason was the computer they were using for the Colombo exercises was not properly configured and tested prior to the exercises; i.e. “the technology failed on the day of the exercise”. A lesson for the implementers is that don't always assume if it works for A it will work for B; there is always Murphy's Law that applies.

7.3 Affect the on the human action cycle

During all exercises the HIHO were constantly referring to the quick reference guide to determine the next steps. Such steps should be streamlined with software controls. Default values and naming conventions were another cause to constantly refer to the guide. Help content should be provided in the software with quick reference pop-ups or suggested values.

Implementing the FF4EDXL ICT system would require complete integration of FF and Sahana as a single software with built-in audio recording capabilities. Thereby, interactions are with a single software application and not three. Multiple decoupled systems affects the human action cycle (TA, section 7.3.1). HIHO deviating from the expected tasks execution sequence was a result of using several software applications. Had they been integrated in to a single application, then software controls would have better streamlined those actions.

Sahana expert system procedures were most time consuming (Waidyanatha 2011, section 7.2.1). Domain specific data entry, for unskilled non English speakers, is much harder than recording a simple localized voice message and organizing them in FF. Moreover, Sarvodaya CERT and HIHO are predominantly volunteers (i.e. not skilled disaster management experts). Hence, emergency information exchange between them would follow a crowd sourcing paradigm. However, completing emergency information that adhere to content standards is not self-intuitive for such volunteers.

7.4 Low quality voice data leads to inefficiencies

Almost every call had some kind of noise interfering with the voice content. Some were background noise while the others were caused by the communication system electronics. As a result, those HIHO transcribing the voice-based information to text could not decipher 29.44% of the information (TA,

section 7.2.2.2). An option is to call back the information sender to verify those missing information. However, that is an extra step that one would like to avoid when managing a crisis.

A MOS cut-point of 4.0 would improve the sensitivity making the positive test of a voice recording to be rather strict. In crises management situations, it is necessary that ambiguity is minimized to avoid any false predictions and inappropriate actions. The project analyzed the overall MOS of FF system to be 3.52 (TA, section 7.2.2.1), which is below the proposed MOS 4.0 threshold (or cut-point). The qualitative evidence of HIHO struggling to transform the information is a clear indication that the proposed x=4.0 cut-point is optimistic for developing reliable and effective IVR based emergency communication systems; especially, for low skilled community-based emergency managers in the rural setting.

7.5 Other technical difficulties

7.5.1 Data center

The HIHO and other software services in FF were found to permanently delete records from the database. This is a bad practice since there is accountability associated with disaster information. For example, if someone asks how did a particular record get created in Eden-SitRep, the system should be able to trace that to the FF message FOR. Records should never be purged from the database. Instead they should be deactivated, thereby, giving the option reactivate or restore them in the event of a mishap.

The system integrators had difficulties getting the FF PHP/Apache and Eden-SitRep Python/Web2Py (WSIG) web applications to coexist and work side by side on a single server. Only one of them could be active at any given time. The researchers had to manually enable and disable one or the other during the controlled-exercises.

The instability of the software, in its present state, resulted in several disruptions to the project activities. Debugging and fixing them were too time consuming. Therefore, in several occasions, the researchers had to reinstall the entire system. Such instabilities must be rectified before a crisis management software system, as the proposed by FF4EDXL, is offered for a wider-scale implementation.

7.5.2 In the Field

Unlike computer or mobile applications that display the transition state on the screen, IVRs do not provide a visual of the transition states to the user. Therefore, determining the application's transition history was not intuitive. Moreover, the CERT members had forgotten how to reverse their actions to traverse back to the previous menu. Instead, they terminated the call to make another one. An implementation policy may be to ensure that the menu tree does not branch more than three nodes; i.e. first is language selection, second is application, third is the function (e.g. Sinhala → Reporting → Leave a message).

There were frustrations caused by cheap unbranded mobile phones not interacting well with FF. The keypad entries, to navigate through the menu, were not recognized by the system. As a result, ignorant of the technical fault, those CERT members were repeating the call. Another theory could be that the telco was not forwarding the Dual Tone Multi Frequency (DTMF) signaling. Given that there were other users connecting through the same provider, the DTMF problem can be ruled out.

8 Overall Assessment and Recommendations

FF can be positioned as a user interface to send and receive emergency information. The value of that information is appreciated when in categorical text form. Then that categorical information can be analyzed for decision support. Project findings are such that converting the audio to data and maintaining the information with multiple applications (i.e. FF and Sahana) is a laborious process. Therefore, a more robust integration between FF and Sahana is essential.

The advantage of FF is that it can carry localized descriptive messages. Relatively, a SMS text is limited by the number of characters and handsets are not always localized. Other means for exchanging descriptive messages over a mobile phone is through the Internet. However, utilization of the Internet by grass-roots level CERT members is perceived cumbersome. The relatively older mobile phone users are not comfortable with text based applications.

8.1 Positioning FF

8.1.1 Alerting and Situational Awareness

Low cut-off rate with long warning horizons are better for high risk-averse decision process. Therefore the alerting process within the warning horizon must be minimized. A well integrated and configured FF and Sahana should not take longer than 5-7 minutes for a trained operator to create and deliver a voice-alert. Then the system can be recommended for slow-onset (more than 60 minutes) and rapid-onset (between 30-60 minutes) hazard events.

The Canadian alerting authorities, in British Columbia, use an IVR to push early warnings to their emergency first-responders. The system is capable of delivering 100s of voice calls in a matter of minutes. However, they use expensive and sophisticated IVR equipment that ride on prioritized telecommunications channels. With a 30 minute tsunami impact warning horizon, such a system would take can be effective.

With FF in its present state, developed for low cost installations, is best positioned for alerting during post disaster situations, such as activating first-responders for post disaster response activities (i.e. not for life saving mass warnings). This was the scenario that was field tested with Sarvodaya CERT members in this project (i.e. for activating CERT members).

During the peak time of a disaster (i.e. around the mean impact time of a hazard event) telecommunications networks experience congestion due to high caller volumes. Therefore, FF system would not be efficient during those time. While governments (such as the Canadian solution) are capable of installing expensive and sophisticated early warning solutions, FF would be affordable and effective for community-based disaster management organizations (e.g. Sarvodaya and Red Cross Societies).

8.1.2 Situational reporting

FF is ideal for SITREP. Incident reporting is time critical but not as demanding as alerting. The simple phone calls and leaving of messages are easy to use and useful for low computer literate CERT members. Moreover, it does not require English competency as information can be localized. Since Sarvodaya practice has been with communicating SITREP through phone calls, FF does not change

their behavior instead complements their standard operating procedures.

A key aspect, in the Sarvodaya context, is that FF includes accountability; whereby, messages received from CERT members and recorded in the FF system guarantees an accountable communication of those reported incidents. Regular phone calls that were answered or unanswered by a human can get lost or fail to replay in the chaos of a crisis.

One element that was not tested in this project was the downstream communication of situational reports. Thus, once a FOR is reported, upstream, to the HIH and it is processed to derive the 3R, that 3R should be made available on FF for CERT members to access. This process completes the communication loop; whereby, the 3R hosted on FF, acts as the feedback and response to the respective FOR. Future developments should implement the feedback element of the reporting cycle.

The proposed work flow for SITREP is:

1) CERT member calls FF to leave a message (i.e. a FOR) on a particular incident
2) Message is processed and a SITREP is created in Sahana
3) Sahana SITREP record unique identifier is delivered to the CERT member via SMS
4) HIH (or incident command center) analyze the SITREP to derive the 3R
5) 3R information is update in FF
6) Respective CERT members are alerted of the new (or updated) 3R with its unique identifier
7) CERT member calls FF, then enters the 3R unique identifier to listen to that information

Sahana community agree on FF's potential for being a useful interface for CERT members to communicate. Therefore, it was recommended that FF is immediately integrated for extending its functions for exchanging situational reports with Sahana and possibly other applicable functions.

8.2 Integration strategies

The FF4EDXL study revealed that efficiencies and human action cycles are compromised when HIHO have to switch between multiple applications for completing their actions. Therefore, the HIHO should be presented with a single software that can administer the FF, Audacity (for recording and listening to audio), and Sahana functions.

There are certain integration challenges and features that are required:

1) Sahana Eden is a Python/Web2Py application and FF is a PHP/Apache application
2) FF must be unbundled such that the Operating System (i.e. Linux Debian – Ubuntu), Freeswitch (GSM gateway), http server, and GSM modem can be installed and configure separately.
3) As Sahana disaster management system will be the front end to the users, FF will function in the capacity of a back-end service where Sahana will interface with FF through a set of application programming interfaces (APIs).
4) The FF APIs should allow for dynamic real-time interfacing with all functions: structuring menus, uploading audio files to the menu tree nodes, accessing “leave-a-message” audio files, sharing the GSM modem resources, and other administrative functions.
5) Allow for passive and active delivery of voice messages; i.e. passive being user calls to access the message and active being FF calls the user to deliver the message

9 Acknowledgement

The research team would like to thank Sarvodaya in providing access to the HIH and facilitating the

exercises with staff and volunteers in the respective Districts. Volunteer-HIHO at the Sarvodaya HIH for collaborating. Special appreciation for the technical support provided by the Sahana Eden and Freedom Fone members. This project could not have been possible without the grant from The Kubatana Trust of Zimbabwe.

10 APPENDIX A – Glossary of Acronyms and Terms

2N-OFR	2N office route (IVR modem)
CAP	Common Alerting Protocol
CERT	Community Emergency Response Teams
EDXL	Emergency Data Exchange Language
FF	Freedom Fone
FOR	Field Observation Report
HCI	Human Computer Interaction
HIH	Hazard Information Hub
HIHO	HIH Operators
ICT	Information and Communication Technology
RRR	Response Resource Report
Sahan	Sahana Disaster Management System
SCDMC	Sarvodaya Community Disaster Preparedness Center
SITREP	Situational Reporting
SMS	Short Messaging Service
SOP	Standard Operating Procedures
STT	Speech To Text
TTS	Text To Speech
WiMax	Worldwide Interoperability for Microwave Access