Last-Mile Hazard Warning System in Sri Lanka: Lessons Leaned from the Pilot Project

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Learning Initiatives on Reforms for Network Economies

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Outline

- **Vision, Goals, and Objectives**

- **Overview of HazInfo Project:**
  Research Design, Hypothesis, research questions, Information Communication Technologies, Concept of Operations

- **Methodology for Evaluating the Last-Mile Hazard Warning System:**
  CAP content standard to evaluate the communicability of Alerts, Reliability of the ICTs and First-Responders (processes), Effectiveness of the ICTs in the Last-Mile

- **Results from Simulations w.r.t Specific Research Objectives:**
  Reliability of the ICT as a warning technology, Effectiveness of the ICT a warning technology, Contribution of training regime, Contribution of village organizational development, Gender specific response to hazard mitigation action, Degree of integration of IC the daily life of villages

- **Conclusions:**
  Hypothesis, General Overview

- **Recommendations**

VISION, GOALS, & OBJECTIVES

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Vision

Expand upon the results of the Last Mile Hazard Warning System pilot phase;

Advocate is Sarvodaya Community Disaster Management Center (SCDMC).

Disaster risk reduction techniques in 15,000+ Sarvodaya villages

Enhanced community level knowledge on Disaster Risk Management

Business Model to partially sustain the operational cost of the LM-HWS in Sri Lanka (at least 30%)

Goals

- Develop a governance structure whereby the non-profit NGO, Sarvodaya, would provide oversight, training, a hazard information hub (HIH)
- HIH will monitor hazard threats and be responsible for the dissemination of alert messages to local communities within the Sarvodaya network of communities
- Utilize a combinations of different ICTs to assess their suitability in the last mile of a national disaster warning system for Sri Lanka
- Test the assessment tools used to calculate the suitability of ICTs deployed in varied conditions
- Set the stage for community-driven initiatives at the last mile of the hazard information dissemination system (HazInfo) by identifying and developing the critical capacity in the community.
- Extend the research findings to other developing countries.

Specific Research Objectives

The primary objective was to evaluate the suitability of various ICTs as the basis of a LM-HWS in Sri Lanka.

Six factors considered to assess the technologies:

Reliability of the ICTs

Effectiveness of the ICTs

Effectiveness of the training regime

Level of organizational development

Gender specific response

Integration of ICTs into everyday life

OVERVIEW

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HazInfo Project Research Design

	Trained				*Non - Trained*			
Sarvodaya Villages Stages 1,2,3	Urawatta **Galle**	Nirthavur **Kalmunai**	Tirukkadalar **Trincomalee**	Moratuwella **Colombo**	Madiya East **Matara**	Thambiliville **Kalmunai**	Oluvill **Kalmunai**	Maggona **Kalutara**
	Kirinda/ Modarapelessa **Hambantota**	Wattegama South **Matara**	Palamunnai **Batticaloa**	**CONTROL VILLAGE** Abeysinghe Pura **Ampara**	Thondamanar **Jaffna**	Shithakudi Puram **Kalmunai**	Munnai **Jaffna**	**CONTROL VILLAGE** Modara **Colombo**
Sarvodaya Villages Stages 4	Modaragama **Hambantota**	Diyalagoda **Kalutara**	Reriyakallar **Batticaloa**	Panama North **Ampara**	Maangadu **Batticaloa**	Samodagama **Hambantota**	Indivinna **Hambantota**	Brahmanawatte **Galle**
	Kalmunai ii **Kalmunai**	Samudragama **Trincomalee**	Velhengoda **Galle**	**CONTROL VILLAGE** Mirissa South **Matara**	Veramulla **Galle**	Kottegoda **Matara**	Thalalla South **Matara**	**CONTROL VILLAGE** Thalpitiya **Kalutara**

Research Hypothesis

1. Stage 4 & 5 Sarvodaya villages that are more organized, i.e., have a formal structure that enables coordination and direction of activities will respond more effectively to hazard warnings than less organized stage 1, 2 & 3 villages.

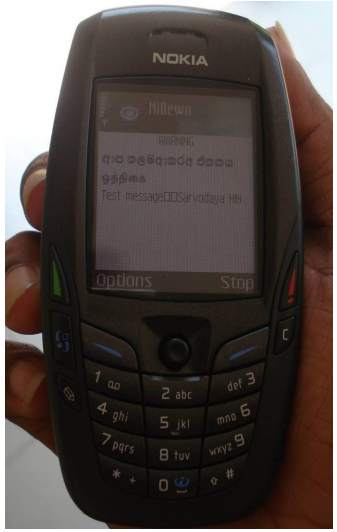
2. Villages that are provided training in recognizing and responding to hazards along with deployment of ICTs will respond more effectively to hazard warnings than villages that received no training.

3. Villages that have ICTs deployed for dissemination of hazard information will respond more effectively to hazard warnings than villages that have to rely on their existing channels of information for warnings.

4. ICTs that in addition to their hazard function, can also be leveraged in other areas to enrich the lives of the villages will potentially have lower downtime than ICTs that are poorly integrated into the day to day life of the beneficiaries.

5 ICTs Tested for Reliability and Effectiveness in the Last-Mile

CDMA Fixed Phone



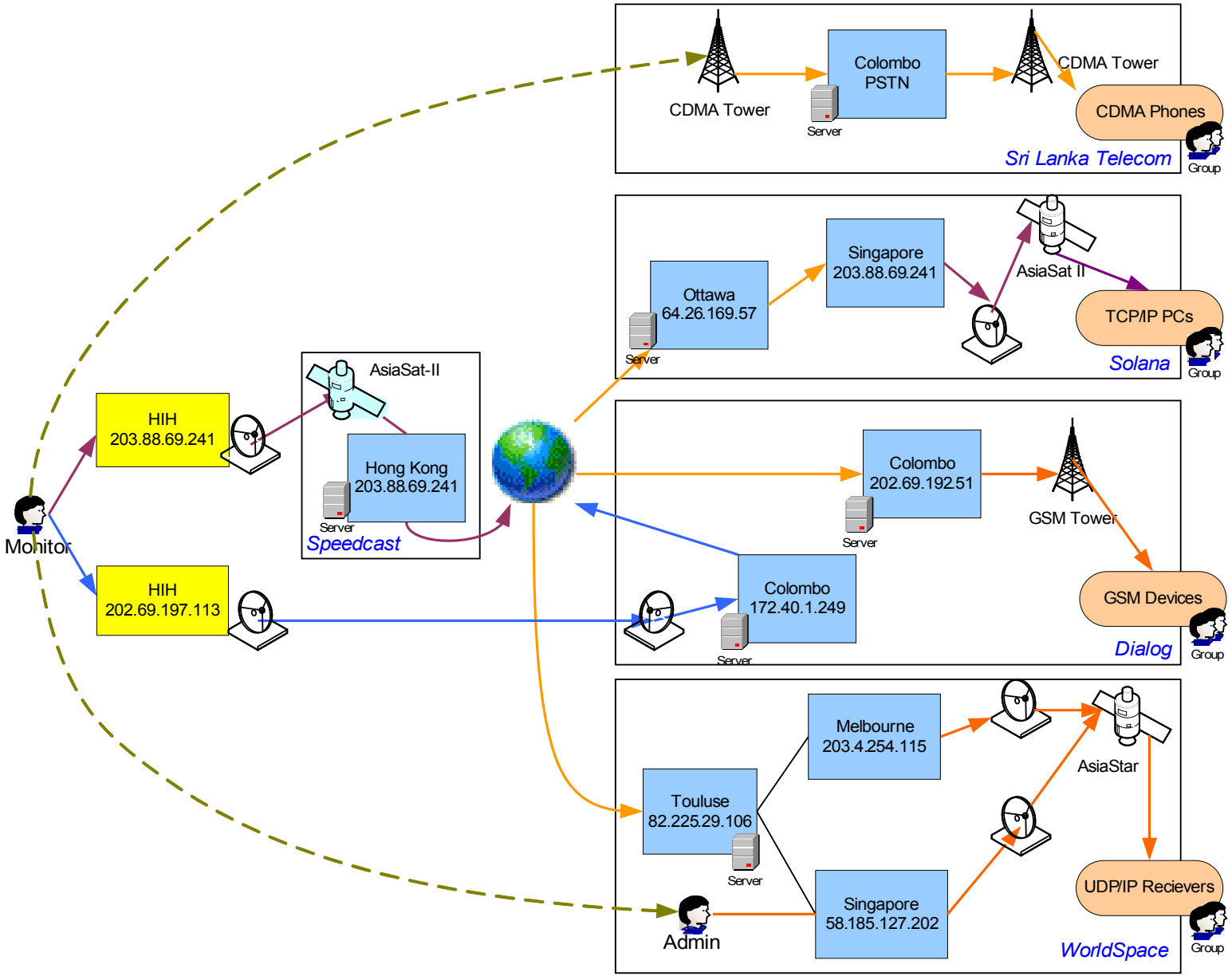
GSM Mobile Phone

Remote Alarm Device

Addressable Radios for Emergency Alerts

Very Small Aperture Terminals

Multiple Paths, Multiple Technologies and Multiple Gateways



METHADOLOGY

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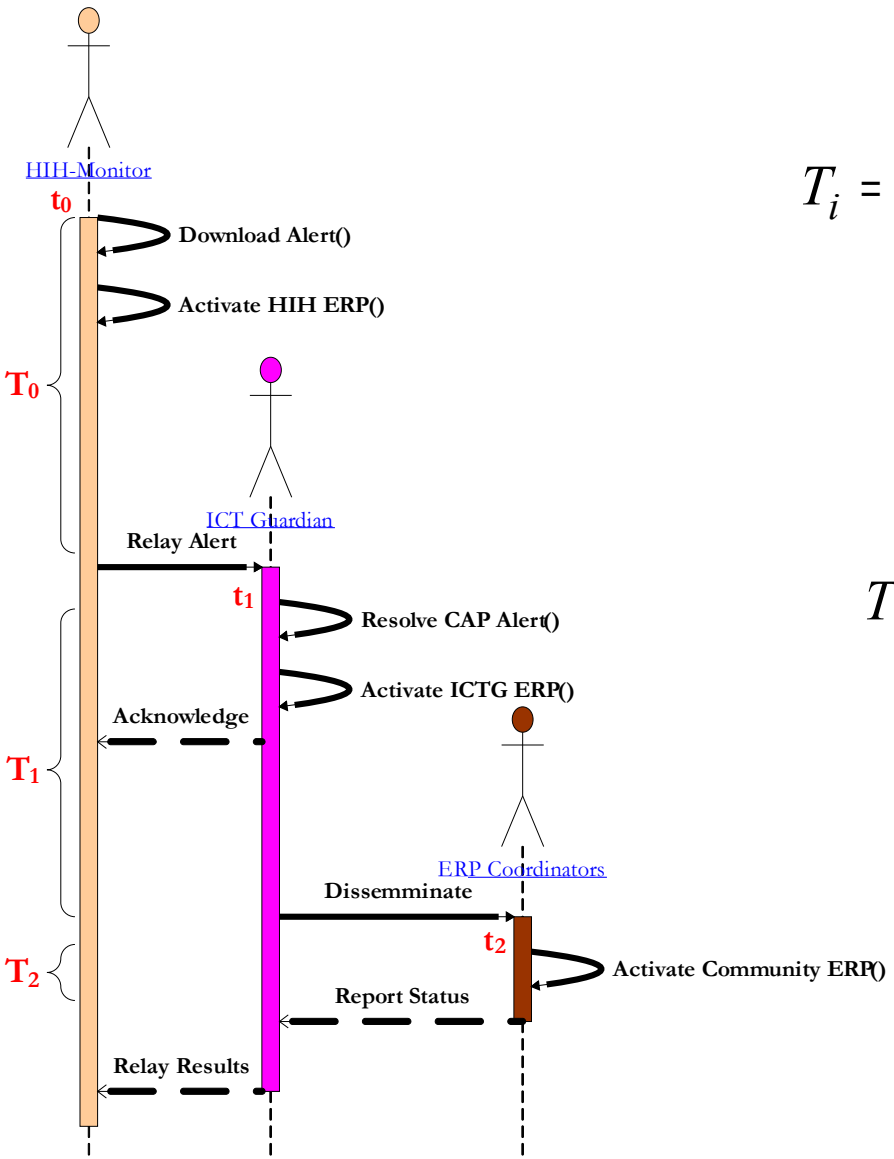
Formula for calculating the Reliability LM-HWS Processes



t_i : time process $i = \{0, 1, 2\}$ is initiated

t_i' : time process $i = \{0, 1, 2\}$ is terminated

$T_i = t_i' - t_i$: time interval taken to complete process i

$E(T_i)$: expected value of time interval

d : minimum distance between epicenter and impact zone

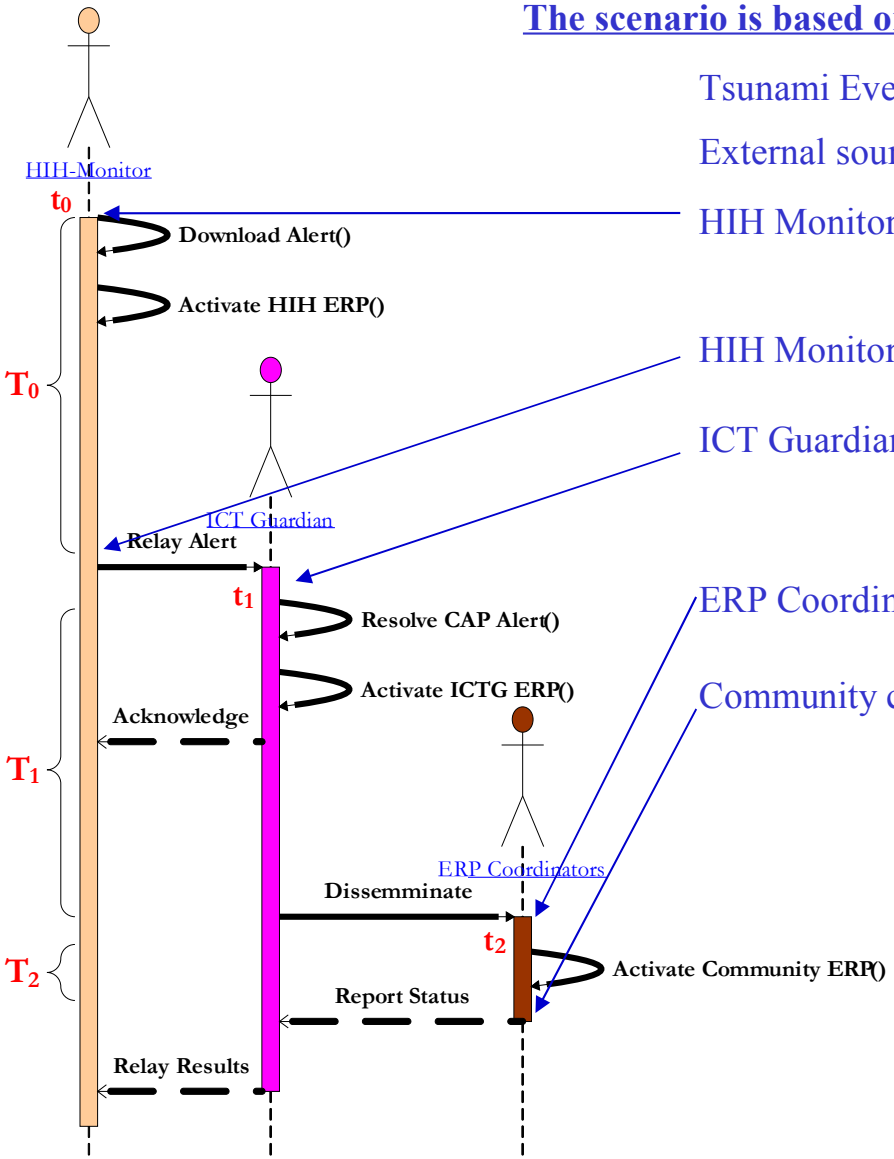
s : speed at which hazard is traveling

$T = d/s$: minimal allowable time interval to impact

R_i : Reliability of process i

$$R_i = \begin{cases} 1 & \text{when } T_i \leq E(T_i) \\ 1 - \left(\dfrac{T_i - E(T_i)}{T} \right) & \text{when } T_i > E(T_i) \\ 0 & \text{when } i < j : t_i' > E(t_j) \end{cases}$$

Example of Calculating the Reliabilities



The scenario is based on the Brahamanawatta (Galle District) simulation data

Tsunami Event occurred at 10:15am and will impact at 11:45

External source issued email bulletin at 10:25am

HIH Monitor receives email at **10:35am**

HIH Monitor issues CAP alert at **10:46am**

ICT Guardian receives CAP alert over AREA-B at 11:02am

ERP Coordinator receives alert information at 11:08am

Community completes evacuation at 11:08am

Calculate the Reliability of HIH Monitor activities

Assumption: since this is the first set of trials and the LM-HWS has no data to calculate an 'expected time we set $E(T_0) = 0$ (i.e. best case scenario)

$$R_0 = 1 - \left(\frac{11}{90}\right) = 0.8777$$

Sigmoid Scaling Function for Language Diversity

Value	Fuzzy Rule
1.00	Sinhala, Tamil, & English
0.95	Sinhala & Tamil
0.85	Sinhala & English
0.70	Sinhala Only
0.50	Tamil Only
0.20	English Only
0	Otherwise

The rules for Table were defined from the Ethnicity Statistics[1] obtained from the Census Bureau of Sri Lanka; approximately 82% are Sinhalese, 9.5% are Tamil (Sri Lanka and Indian Tamil), and the rest, 8.5% are Other (Sri Lanka Moor, Burgher, Malay, Sri Lanka Chetty, Bharatha, etc. "Other" ethnic groups are literate in English and in a major portion of them can speak and read either Sinhala or Tamil. Ideally, the CAP messages should be disseminated in all three languages or at least in Sinhala and Tamil.

[1] Statistics used in the explanation was obtained from -- http://www.statistics.gov.lk/census2001/population/district/t001c.htm ; the values used for Rural and Urban as a collective.

Sigmoid Scaling Function for Full CAP Compliance

Value	Fuzzy Rules
1.00	**All sub elements that are contained in the <alert>** element, which includes all the qualifier and sub elements
0.95	Mandatory defined in the Profile for Sri Lanka, which are the sub elements of the qualifier **<alert> qualifier** and <Info> elements -- **<urgency>, <severity>, <certainty>, <description>**
0.85	Mandatory sub elements of the **<alert> qualifier** element and the sub element **<description>**
0.70	**<description>** only
0.50	**Mandatory sub elements of the <alert>** element only
0	Otherwise

A CAP message is defined to have a high effectiveness value of 1 if the message contains the mandatory CAP elements as described in the section titled CAP Profile for Sri Lanka. The lower end value 0 is when the message is an empty CAP message; i.e. dead air or text elements with null values. The compulsory Elements of the CAP Profile include elements in the <Alert> "qualifier" elements: <Incident>, <Identifier>, <Sender>, <Sent>, <Status>, <msgType>, <Scope>, and the "sub" elements: <Info>, <Resource>, and <Area>

Sigmoid Scaling Function for -- Mix of Audio and Text Communication Medium

Value	Fuzzy Rule
1.00	Audio and Text
0.95	Audio only
0.85	Text only
0	Otherwise

Video not considers

The project found audio to be more effective than text. Table weights the ICT as a function of the capability to disseminate audio and/or text messages. For example the RAD has a build in FM radios the user can tune into. AREA use MP3 audio to broadcast voice. All the devices have text alerting capabilities.

Sigmoid Scaling Function for Acknowledgement of Message Receipt

Value	Fuzzy Rules
1.00	< 1.0 minutes
0.95	< 5.0 minutes
0.85	< 10.0 minutes
0.70	< 20.0 minutes
0.50	< 40.0 minutes
0.25	< 90.0 minutes
0	otherwise

Acknowledgement is vital for the Community-First-Responders to inform the Senders for "accountability"

In the context of Alerting the acknowledgement must be initiated by a human.

The Message Receipt an Acknowledgement is a Probability function based the time taken between Alerting functions: Download, Acknowledge, EOI, Approval, Issue.

The device would score 1.0 if the acknowledgement was reported in less than 1.0 minutes; score 0.95 if it took less than 5.0minutes; score 0.85 if it took less than 10.0 minutes; score 0.70 if it took less than 20.0 minutes; score 0.50 if it took less than 45.0 minutes; score 0.25 if it took less than 90.0 minutes. This defines a sigmoid shaped liken scaling function; where the score is higher if the time taken to report acknowledgement was all most instantaneous.

Sigmoid Scaling Function for wakeup function to draw attention

Value	Fuzzy Rules
1.00	Siren, Light, & Vibration
0.95	Siren & Light
0.85	Siren Only
0.70	Light & Vibration
0.50	Light or Vibration exclusively
0	otherwise

Designed to draw the attention of the targeted Community-First-Responders

attention-getters: sounding-sirens, flashing-lights, or mechanical-vibrations. Basically the Wakeup feature should actuate the aural, visual, and sensual sensors

The ICT device scores 1.0 if it has all three attention getters; scores 0.95 if it has a Siren and Light because this combination does not require the device to be attached to the Community-First-Responder in any way; scores 0.85 if it sounds a siren only; scores 0.70 if it sounds a siren and vibrates; scores 0.50 is it activates a flashing-light and vibrates; scores 0.25 activates only one a flashing-light or vibrates; scores 0 otherwise. For a person fast a sleep simply a flashing light alone will not get the attention of the sleeping person and needs an “Alarm” sound to wake them up.

Sigmoid Scaling Function for Geographic coverage and signal strength

Value	Fuzzy Rules
1.00	5 bars
0.95	4 bars
0.85	3 bars
0.70	2 bars
0.50	1 bar
0	otherwise

Geo Coverage of a Wireless Signal is usually measured as a function of the power of the signal in decibels (dB) then referenced to 1 mill watt (dBm).

The signal strength was measure at the message Community-First-Responders home or the location where equipment was installed.

A GSM Mobile Phone can function on -104 to -47 dBm range; Satellites operate on -127 to -60 dBm range. Hence, a simple function is dividing the dBm range by 5 discrete signal strength indicator bars.

A device is given a score 1.0 if it has 5 bars indicating at any given measuring point; score 0.95 if device indicates 4 bars; score 0.85 if device indicates 3 bars; score 0.70 if device indicates 2 bars; score 0.50 if device indicates 1 bar and 0 otherwise.

Sigmoid Scaling Function for Bi-directionality for Alerting

Value	Fuzzy Rules
1.00	Upstream and Downstream with no restrictions
0.95	Downstream and partial Upstream
0.85	Downstream only
0.70	Upstream only
0	otherwise

Bi-Directionality = upstream and/or downstream

upstream communication is mainly for Last-Mile Communities to inquire-of and report situations affecting their local communities Relay alerts to neighboring communities.

The MP, FP, and VSAT allow both upstream and downstream communication without any restriction.

The RAD has limited the upstream communication such that the user can “call back” only when an alert is received.

The AREA does not allow any upstream communication.

Device is given a score on a scale of 0 to 1 such that if it has no restrictions then it scores a 1.0 and a lower score for all other combinations giving prominence to (i.e. higher score) for upstream communication over downstream communication.

Common Alerting Protocol Content Standard to Evaluate the ICTs

CAP Profile for Sri Lanka

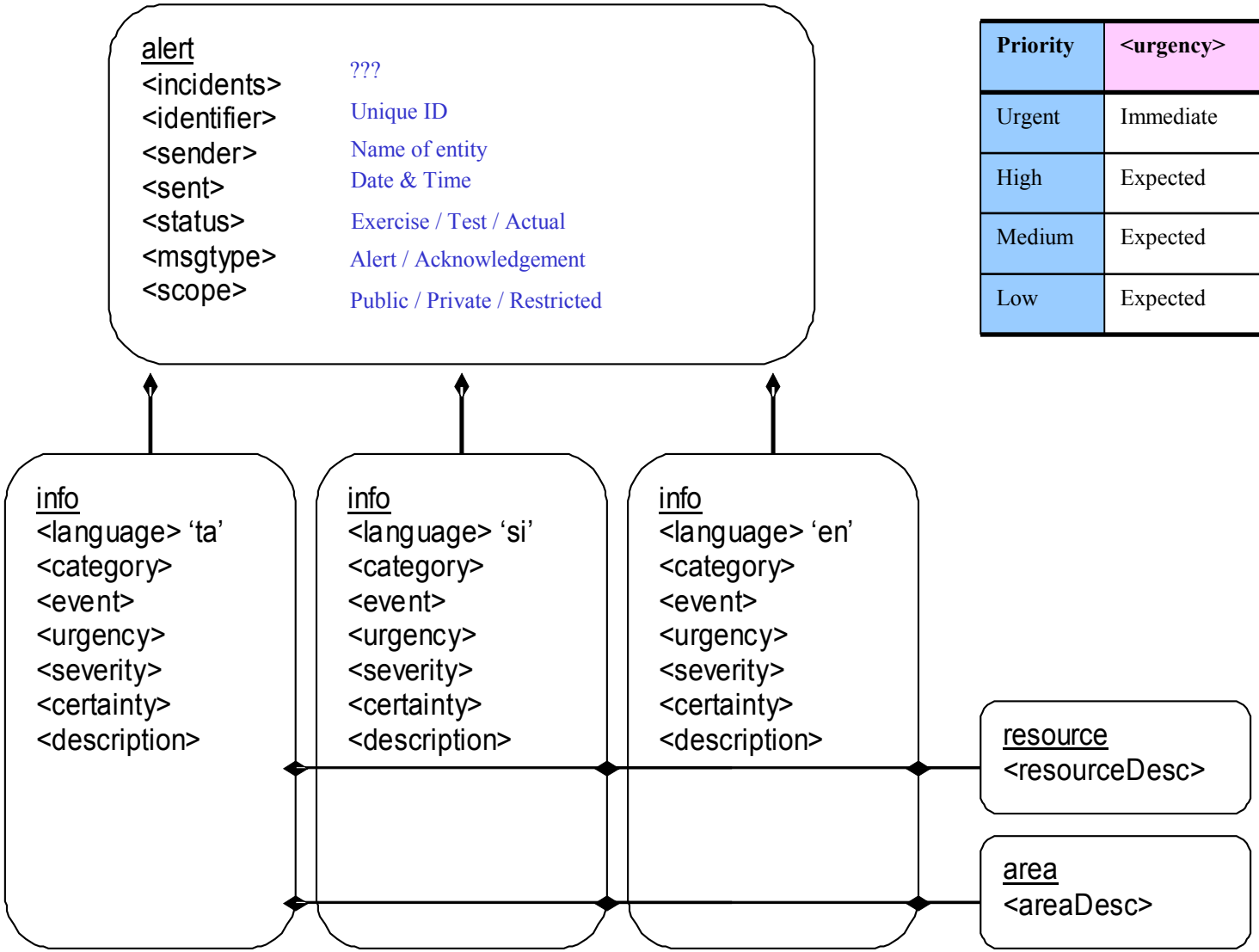


Table to determine priority of the event

Priority	<urgency>	<severity>	<certainty>
Urgent	Immediate	Extreme	Observed
High	Expected	Severe	Observed
Medium	Expected	Moderate	Observed
Low	Expected	Unknown	Likely

Example of Input Message to the last-Mile Hazard Warning System

TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST
Last-Mile HazInfo Simulation. No Repeat No Real Event is Effect

TROPICAL CYCLONE ADVICE NUMBER 001
Issued at 09:55 am on Monday, December 11, 2006
BY Anonymous

A **SEVERE CATEGORY 4 CYCLONE** is now current for AMPARA and MATARA District coastal areas. At **06:00 am** local time SEVERE TROPICAL CYCLONE MONTY was estimated to be **80 kilometres northeast of Ampara District** and moving southwest at **10 kilometres per hour**. Severe Tropical Cyclone Monty is expected to cross the coast in the vicinity of Ampara and Matara Districts during Monday. Gales with gusts to 180 kilometres per hour are likely in coastal communities in Ampara and Matara District during the day.

This is to **alert** the residents of Ampara and Matara District about the potential of a very **dangerous storm** tide as the cyclone centre approaches the coast. **Tides are likely** to rise significantly above the normal high tide mark with very dangerous flooding, damaging waves and strong currents.

Widespread heavy rain and further flooding are likely in southern parts of the Ampara and Matara Districts over the next few days.

TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST
Last-Mile HazInfo Simulation. No Repeat No Real Event is Effect.

Example of Output Message from Hazard-Information-Hub to the Last-Mile


```
<alert>
        <identifier>HIH-2006-12-11T143500</identifier>
        <sender>hih@sarvodaya.lk</sender>
        <sent>2006-12-11T10:20:25.0000000+06:00</sent>
        <status>Exercise</status>
        <msgType>Alert</msgType>
        <source>hazard@lirne.net</source>
        <scope>Restricted</scope>
        <info>
            <language>en-US</language>
            <category>Meto</ category>
            < event>A Sever Category 4 Cyclone</event>
            <responseType>Prepare</responseType>
            <urgency>Expected</urgency>
            <severity>Severe</severity>
            <certainty>Observed</certainty>
            <description>At 06:00 am local time SEVERE TROPICAL CYCLONE MONTY was estimated
            to be 80 kilometers northeast of Ampara District and moving southwest at 10 kilometers per
            hour. Severe Tropical Cyclone Monty is expected to cross the coast in the vicinity of Ampara
            and Matara Districts during Monday. Gales with gusts to 180 kilometers per hour are likely in
            coastal communities in Ampara and Matara District during the day.
            This is to alert the residents of Ampara and Matara District about the potential of a very
            dangerous storm tide as the cyclone centre approaches the coast. Tides are likely to rise
            significantly above the normal high tide mark with very dangerous flooding, damaging waves
            and strong currents. Widespread heavy rain and further flooding are likely in southern parts of
            the Ampara and Matara Districts over the next few days. </description>
</alert>
```

RESULTS

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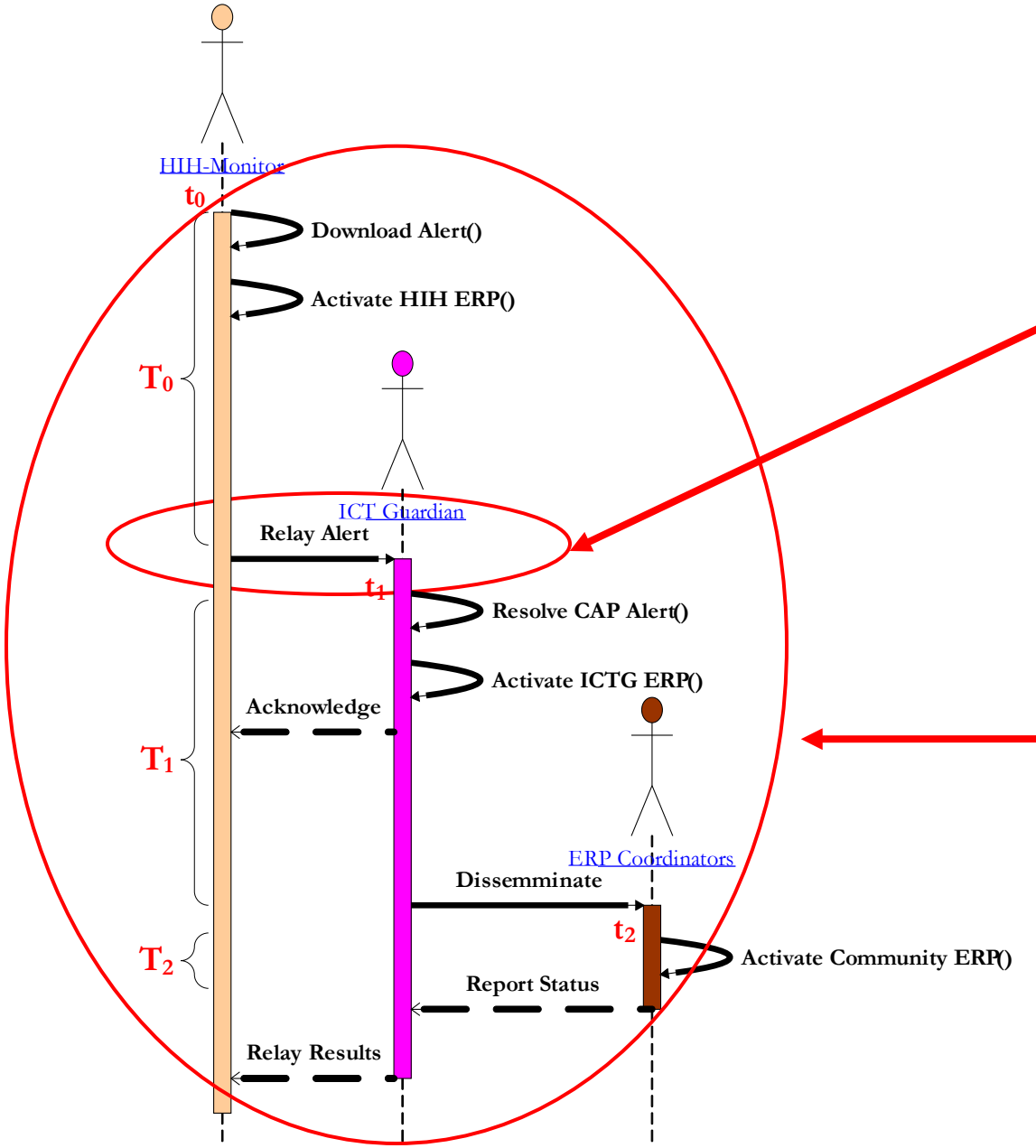
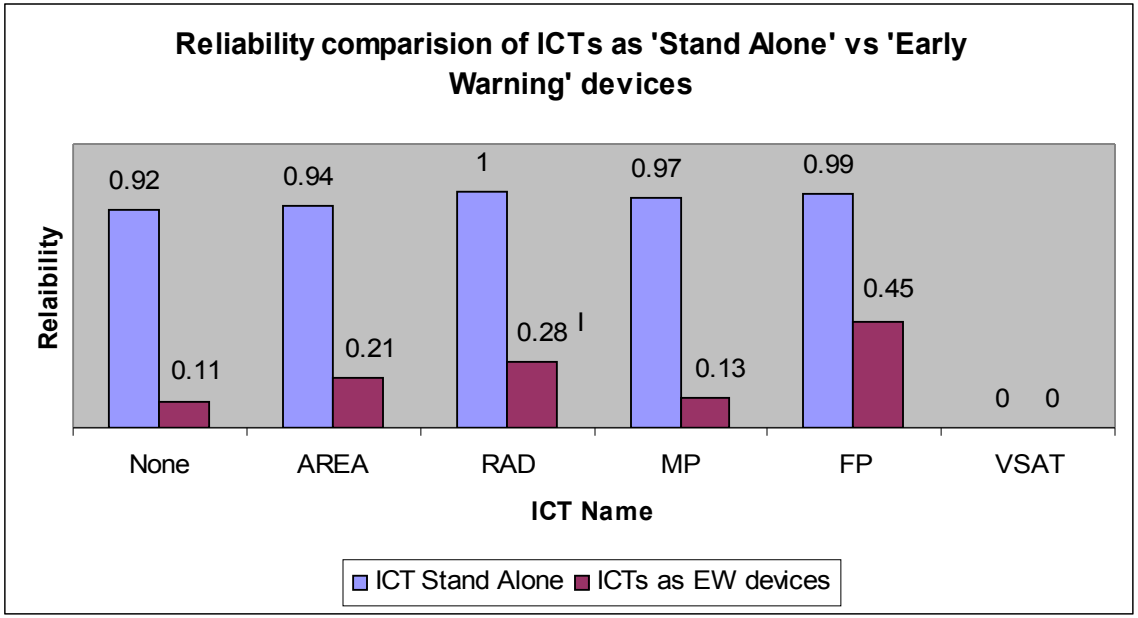
Comparison to study Reliability of ICT in LM-HWs



Reliability is measured as a function of the difference between the time it takes HIH Monitor to "issue" the CAP message and the time the message was "received" by the ICT Guardian.

Reliability is measured as a function of the difference between the time it takes HIH Monitor to "receive" message and the time the message was "received" by the Community.

Reliability of ICTs as a Warning Technology



	Average	*Variance*
Reliability of ICT	0.9750	0.0008
Reliability of ICT in LM-HWS	0.2657	0.0007

VSATs have no results since HazInfo Project system is not implemented

'Nanasala' VSAT Network proxy setup does not allow for IPAS client to receive packets

The data is not uniform fair because the number of equipment used in the trials is not uniform; example data for AREA is based on 16 data-points and RAD is with 2 data-points.

Shortcomings of the system are predominantly due to delays in HIH Monitor and ERP Coordinator related functions (in data to follow)

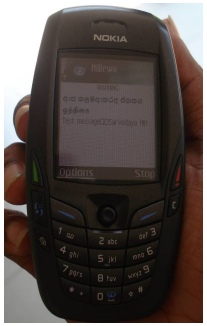
'None' – communities that were not given ICTs through the project used existing ICTs in community

Effectiveness of CAP Alerts over AREA-B

Interface	*HIH Monitor issued CAP Message*	*Receiver Device and {Medium}*	*ICT Guardian received Message elements*
ANNY Internet Browser (AREA)	All sub elements in <Alert> element and message in <Language>en only.	AREA – B {Text}	<msgType>Alert <Scope>restricted <Sender>hih <Status>exercise <Category>met <Urgency>expected <Severity> sever <Certainty>observed <Event>A SEVERE CATEGORY 4 CYCLONE … {restricted 250 characters}

Effectiveness of CAP Alerts over Mobile Phones & RADs

Interface	*HIH Monitor issued CAP Message*	*Receiver Device and {Medium}*	*ICT Guardian received Message elements*
DEWN Internet Browse	<info> sub element with <Language>en <Description> … {no size restriction} <Language>si <Description> … {no size restriction} <Language>tm <Description> … {no size restriction}	MP {Text}	"Warning" <info> <Language>en <Description> A SEVERE CATEGORY 4 CYCLONE… <Language>si <Description> …{sinhala} <Language>tm <Description> … {tamil} {restricted by 140 characters}
		RAD {Text}	



Effectiveness of Internet Public Alerting (~~CAP~~) over VSAT

Interface	*HIH Monitor issued Message*	*Receiver Device and {Medium}*	*ICT Guardian received Message elements*
IPAS Internet Browser	<Description> with <Language>en only … {no size restriction}	Personal Computer {Text}	<Description> A SEVERE CATEGORY 4 CYCLONE … {no size restriction}

Voice Alerts over CDMA

Interface	HIH Monitor issued CAP Message	Receiver Device and {Medium}	ICT Guardian received Message elements
CDMA 2000 1x_RTT	<Description> … {no size and language restriction}	CDMA2000 1x_RTT Telephones {Audio}	<Description> A SEVERE CATEGORY 4 CYCLONE … {no size restriction}

Effectiveness of ICT as a Warning Technology

Complete Full-CAP Messaging is defined to be one that complies with the CAP Profile for Sri Lanka, contains all three languages: Sinhala, Tamil, and English, and also is disseminated in modes of Audio (i.e. Voice) and Text.

Measure	*AREA*	*RAD*	*MP*	*FP*	*VSAT*
•Language Diversity ('si', 'tm', 'en')	0.20	0.20	1.00	1.00	0.20
•Full CAP ('XML')	0.85	0.70	0.70	0.70	0.70
•Mediums (audio, text)	0.95	0.85	0.85	0.95	0.85
Rating of Full CAP Completeness	**0.16**	**0.12**	**0.60**	**0.67**	**0.12**

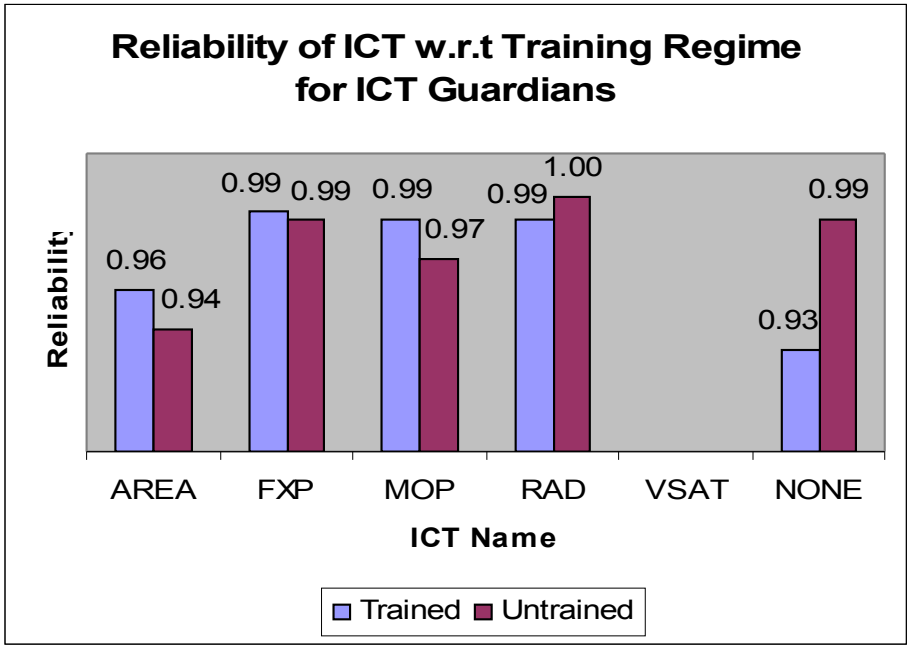
Successfully Alerting is defined to be a function where a text or voice message is relayed to an ICT device belonging to a Community-First-Responder and is completed if the message is received by the Community-First-Responder and then Community-First-Responder returns a message via same or alternate path to the Sender.

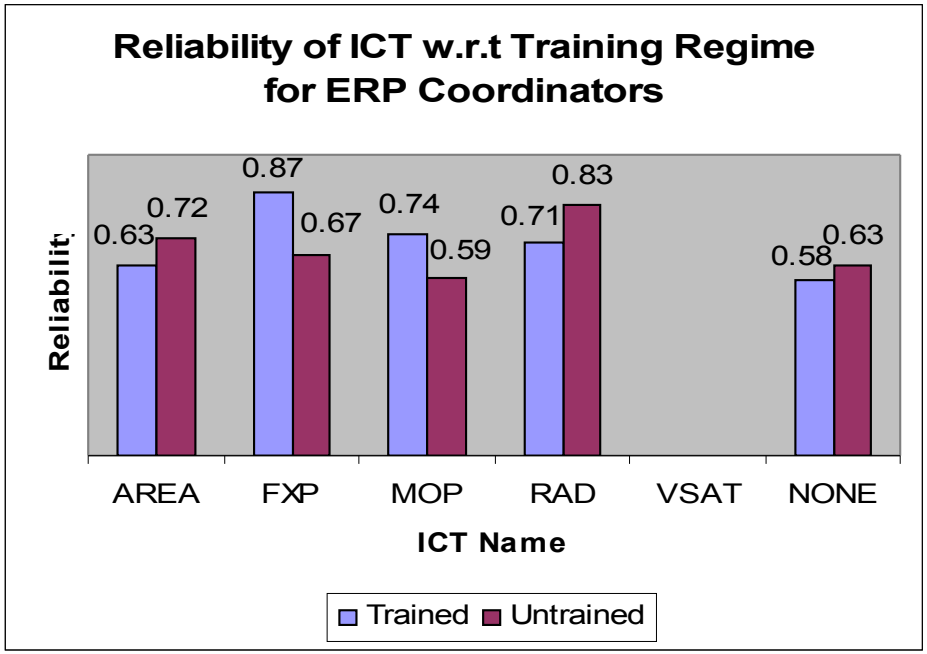
Measure	*AREA*	*RAD*	*MP*	*FP*	*VSAT*
•Message receipt acknowledgement	0.70	0.95	0.95	1.00	0.70
•Wakeup Features	0.90	0.95	0.85	0.85	0.85
•Geographical Signal Coverage	0.95	0.85	0.85	0.70	0.95
•Bi-Directional Capability	?	0.90	1.00	1.00	1.00
Rating of Alerting Functionality	**0.60**	**0.69**	**0.72**	**0.59**	**0.56**

Reliability and Effectiveness of ICT as a Warning Technology

	AREA	*RAD*	*MP*	*FP*	*VSAT*	***Average***	***Variance***
Full CAP Completeness	0.16	0.12	0.60	0.67	0.12	0.3340	0.0764
Alerting Function	0.60	0.69	0.72	0.59	0.56	0.6320	0.0048
Effectiveness	**0.10**	**0.08**	**0.43**	**0.40**	**0.07**	**0.2147**	**0.0333**
Reliability	**0.21**	**0.28**	**0.13**	**0.45**	**--**	**0.2675**	**0.0185**
Rating	***0.02***	***0.02***	***0.05***	***0.18***	**--**	***0.0693***	***0.0055***

Contribution of the Training Regime in Community





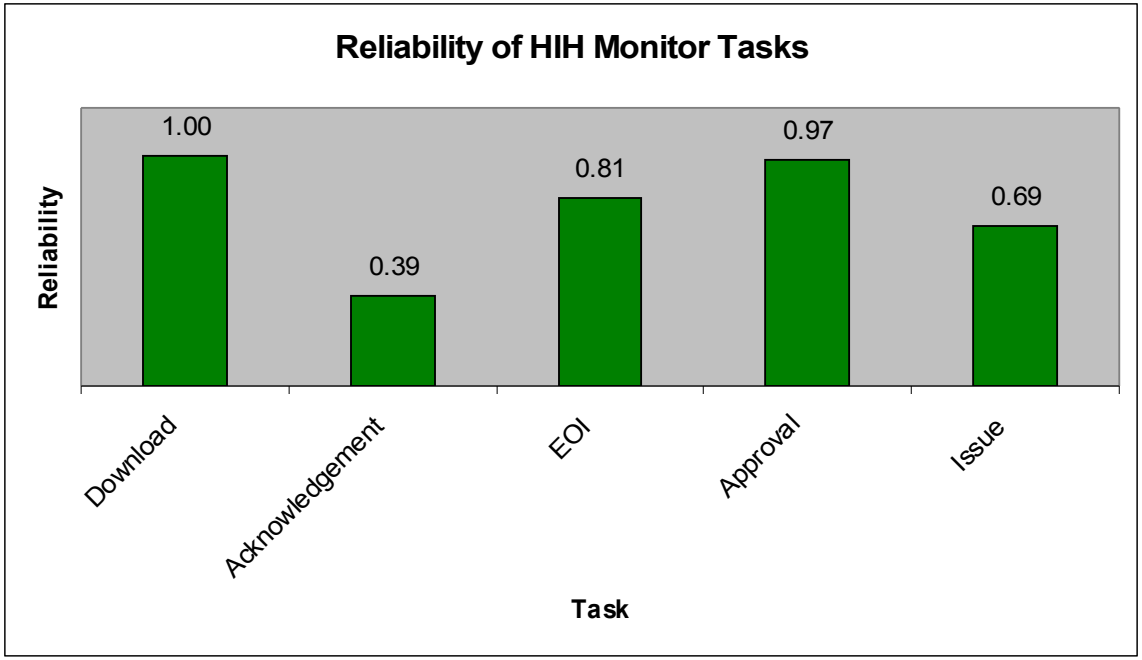
All 28 ICT Guardians received training

Only 16 of 32 Community ERP Coordinators received ERP Training

ICT Guardians were coached during Live-Exercises; random events over longer period would show different results

ERP Coordinators were also coached there fore results are biased but still prove to be below required level

Contribution of the Training Regime in Hazard Information Hub

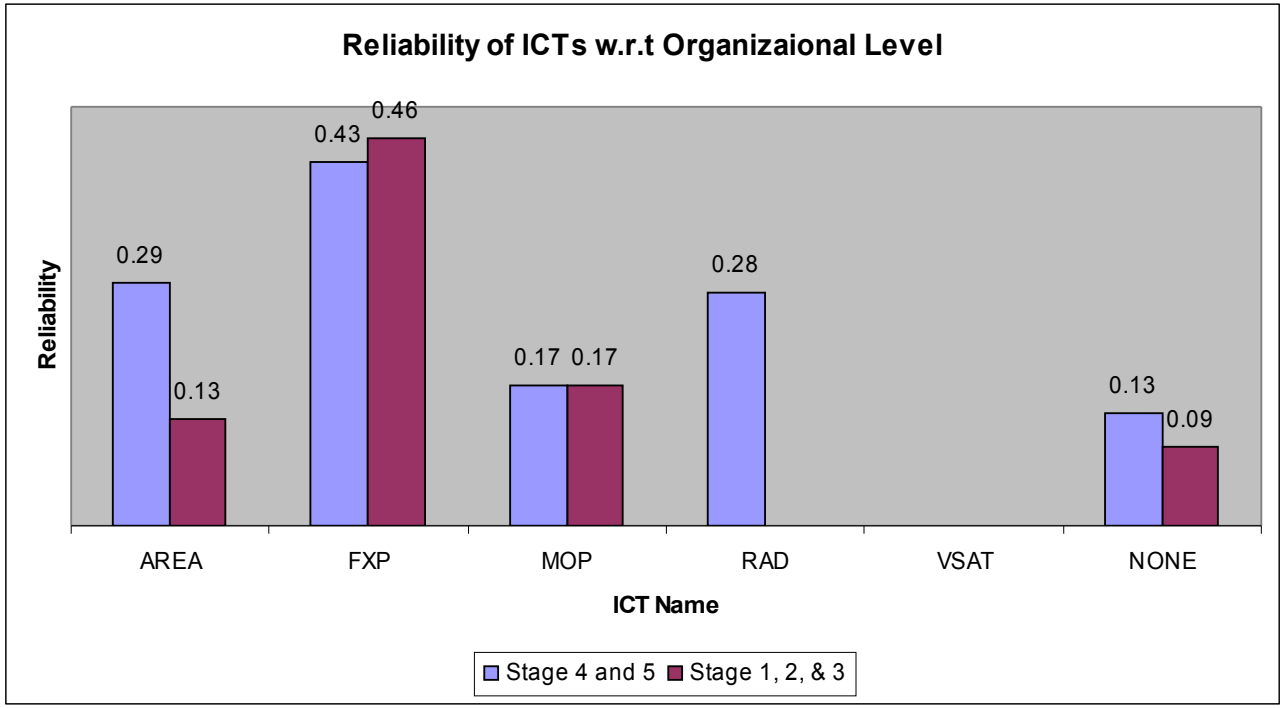


	Average	*Variance*
HIH Monitor Message Relay Process	0.7725	0.0609

Expected value = 95%

For example an event such as the December 2004 Tsunami that had a minimal 90 minute duration between time of hazard initiating and the time of impacting Sri Lanka. With a 77% Reliability, the function: Relaying of Message (i.e. completing the tasks described above) to the Last-Mile alone would take at least 20 minutes. Assuming the sensor and relay networks would get a confirmed bulletin across to the HIH in 15 minutes and the HIH takes another 20 minutes, then the Last-Mile Communities would have less than 55 minutes to execute the Community ERPs.

Contribution of the Village Organizational Level

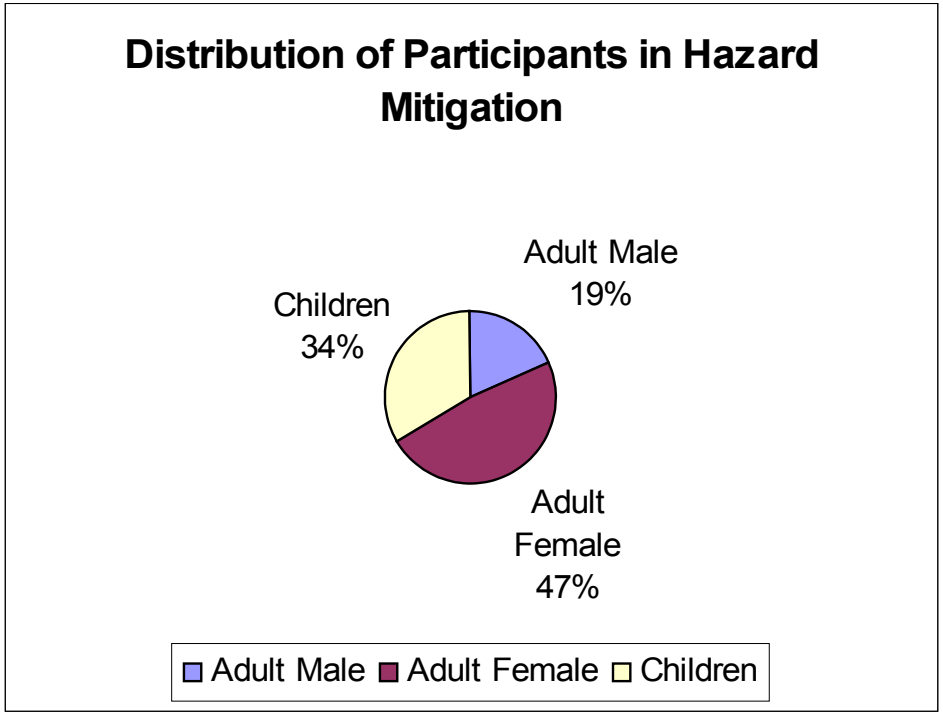


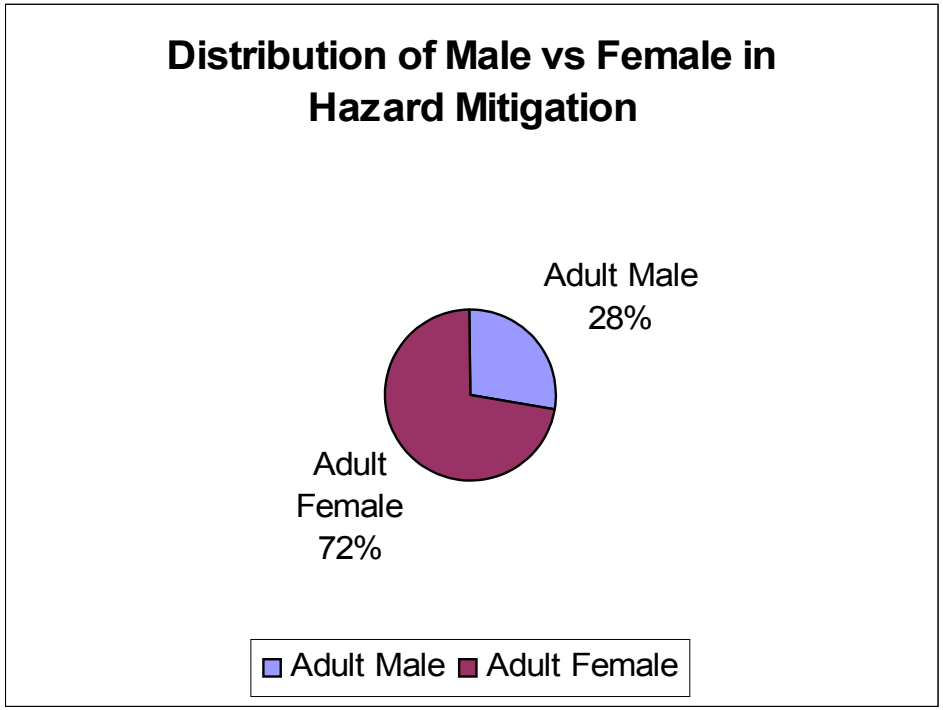
Organizational capacity is not important for communities to adopt existing technologies such as the Mobile Phones and Fixed Phones. This observation is also evident from Control Villages, which used personal Mobile Phones and Fixed Phones

Organizational capacity is important for communities to adopt to new technologies such as the AREA. Unfortunately RAD was not tested in a less organized village to see if prediction is correct.

Observation is that it is easier to organize DM Mitigation activities in Organized villages

Gender specific response to Hazard Mitigation action



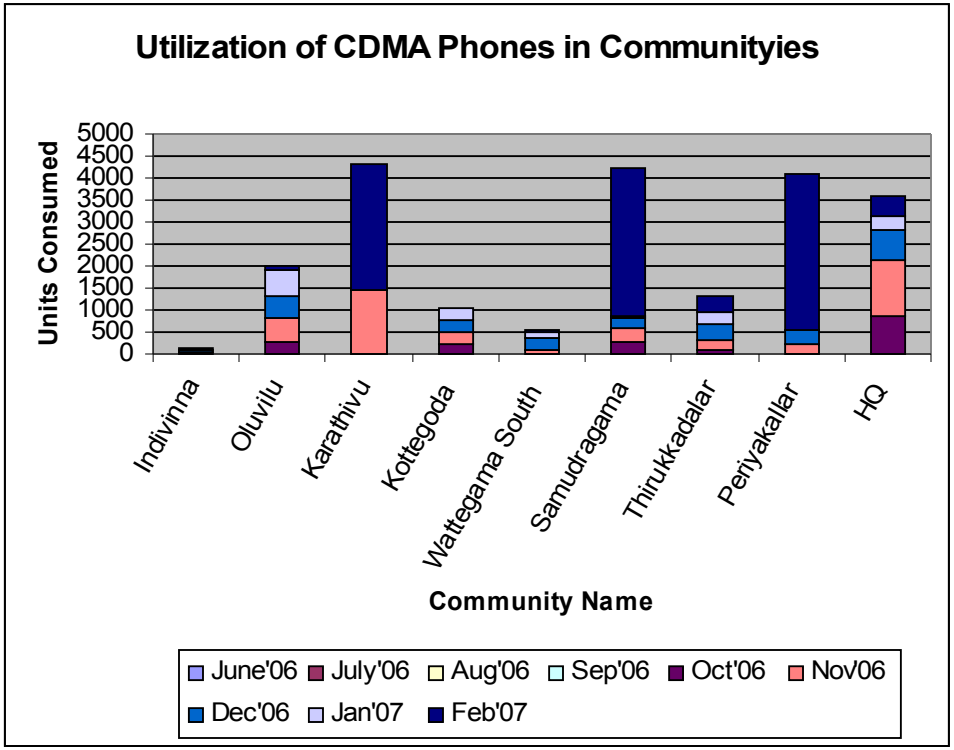


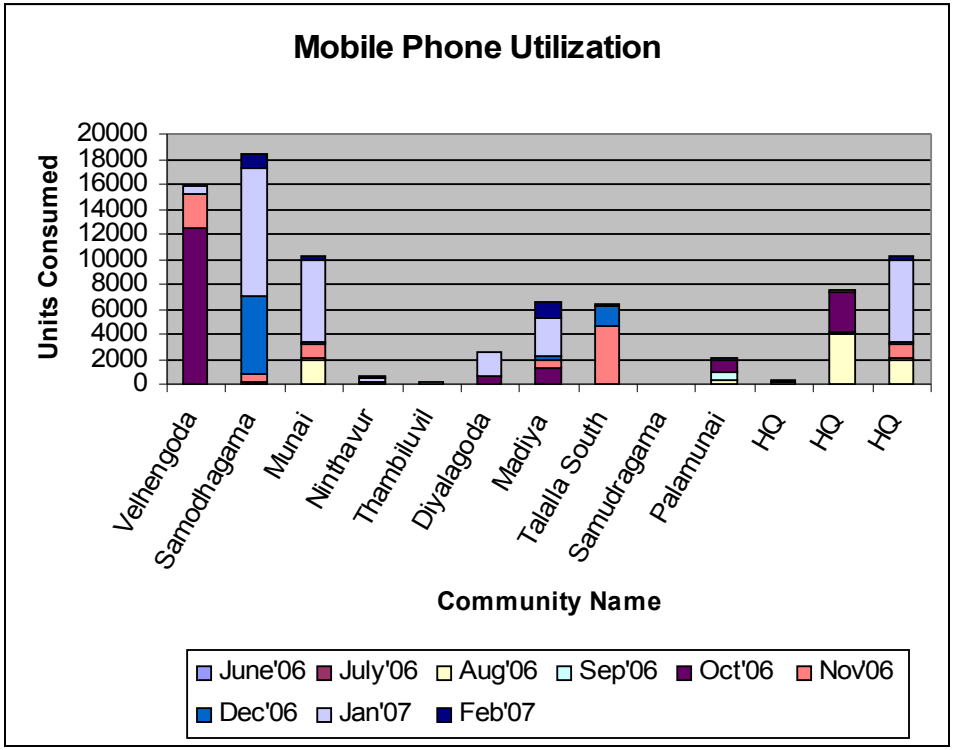
72% Adult participants were Female because the simulations were conducted between 9am and 12pm where most Men were occupied with their jobs.

The women showed enthusiasm and willingness to participate in all disaster management activities.

Also see a high participation of children because the mothers brought their children along for all activities as they could not leave them home alone

Degree of integration of ICT into daily life of villages





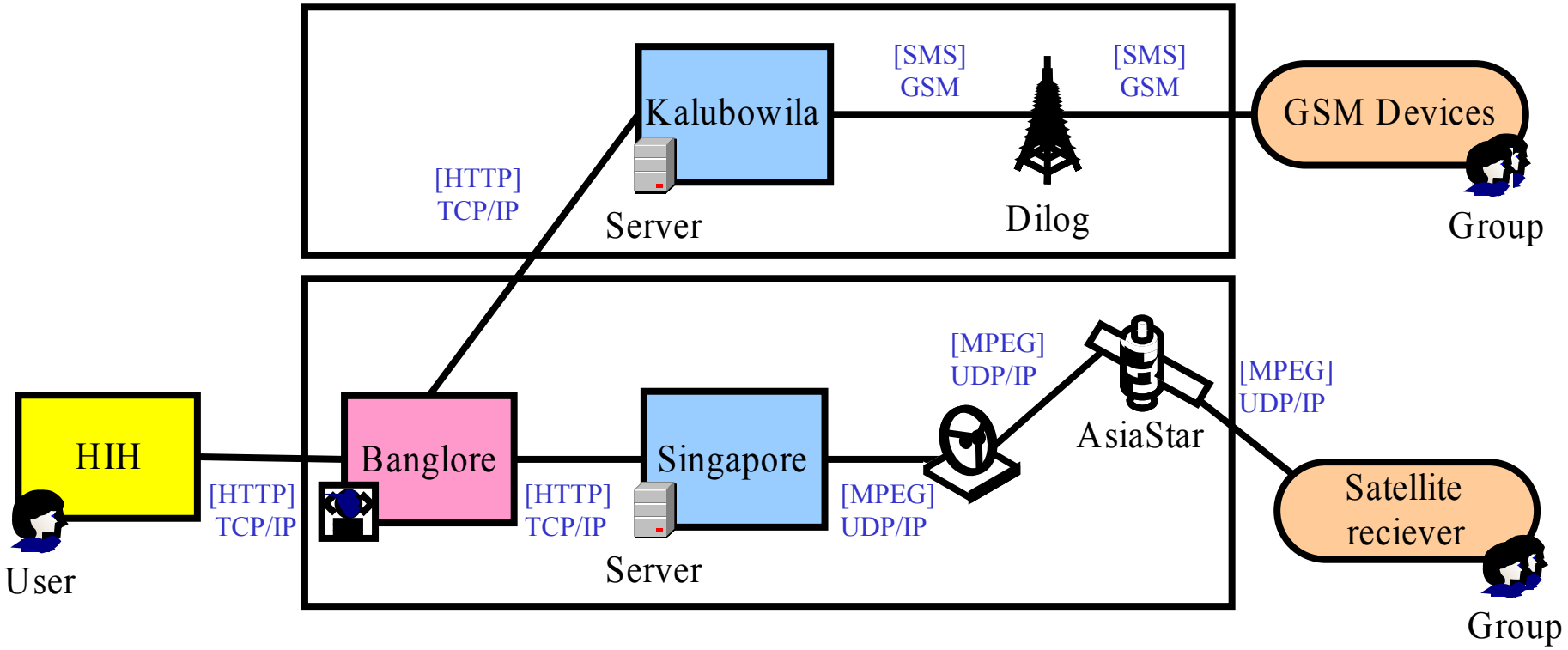
Number of units consumed was only available for CDMA Fixed phones and GSM Mobile Phones. Data was gathered from monthly bills.

Communities did not engage in recording a daily journal as the project had requested them to and had provided a simple format to maintain the information.

Random interviews revealed that communities enjoyed listening to BBC over the AREA and Sarvodaya Talk Channel

RAD did not enable ‘calling’ facilities. The FM radio to listen to local stations

CAP Interoperability Silent Tests



CONCLUSIONS

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Conclusions – General Overview

A. The five tested ICTs can be incorporated into the communities and form a critical infrastructure.

C. All ICTs used in the HazInfo Pilot must be upgraded to receive Complete Full-CAP Messages before they can be used in the Last-Mile Communities of Sri Lanka.

E. Recommended CAP Profile for Sri Lanka can be implemented in such a last mile system

G. System must first develop the Human Capacity: HIH-Monitors, ICT Guardians, and ERP Coordinators, in order to supplement the deficiencies of an end-to-end fully-automatic early warning system.

I. Simulated drills must be conducted regularly to develop the Cognitive Framework to ensure all ERPs can be smoothly carried out without confusion.

Conclusions – General Overview

A. From simulations it is apparent that given proper training of HIH staff, timely access to external hazard event information and the appropriate ICT, the time taken to process and disseminate an alert from the Hazard Information Hub (HIH) can be absolutely minimal.

C. Timing advantages can only be effectively achieved by a "CAP Broker" that will integrate and improve interoperability among the ICT CAP systems and provide the single input - multiple output facility that HIH Monitors need to speed up their tasks

E. The CAP Broker can be developed by redesigning the existing tested WorldSpace ANNY, Dialog-University-of-Moratuwa-Microimage DEWNS, and Solana Network's IPAS software systems. In addition the CAP Broker would require a Geological Information Systems (GIS) based Graphic User Interface (GUI).

G. A disadvantage was that the absence of a culture of last mile dissemination of early warnings in Sri Lanka – in this sense, HazInfo project was breaking new ground.

I. The practice until now has been for information to be 'broadcast' to the whole country in a central manner. Introducing Addressability and the community-based approach was a challenge, and gathering momentum in the field was at times slow due to this reason.

Conclusions – Hypothesis 1

Hypothesis: Villages that have ICTs deployed for dissemination of hazard information will respond more effectively to hazard warnings than villages that have to rely on their existing channels of information for warnings.

Conclusion: All 4 Control Villages that took part in the Live-Exercises had made an alliance with the neighbouring Sarvodaya community to receive a telephone call by the Community Chairperson (potential ICT Guardian). The messages were received over their personal GSM mobile or wireless CDMA fixed telephones in the form of a voice call. The Control Villages had prepared in advance to receive the messages. The Reliability of the 4 Control Villages lag because they did not receive the alert directly from the HIH. **It is not sure whether the Control Villages would perform this well if it was not a drill or was an unplanned random event. The Reliability of both Communities with ICTs and without ICTs was too weak to make a clean comparison between the 2 sets and support the hypothesis.**

Conclusions – Hypothesis 2

Hypothesis: *Villages that are provided training in recognizing and responding to hazards along with deployment of ICTs will respond more effectively to hazard warnings than villages that received no training.*

Conclusion: The nature of the Live-Exercises could not determine the effectiveness of the training regime. Overall, it was observed that the response competency level resulting from training was way below expected level. The drills carried out in the communities were predominantly staged by the organizers. Since the organizers were the Shanthi Sena HazInfo Trainers the outcomes of the simulated exercises were identical in each of the communities and shows nor disparity between the set of Trained and Untrained Communities. However, the **project found that training was imperative for obtain good quality simulation results, reinforcing community emergency planning and raising community awareness about hazards and interest in local risk management**.

Conclusions – Hypothesis 3

Hypothesis: *Stage 4 & 5 Sarvodaya villages that are more organized, i.e., have a formal structure that enables coordination and direction of activities will respond more effectively to hazard warnings than less organized stage 1, 2 & 3 villages.*

Conclusion: communities with adequate capacity and organizational structure in their respective Districts proved effective in organizing all project activities. Data in Figure 2 does not show a gap between the less-organized and organized communities for both FP and MP. The reason could because these 2 ICTS exist in the Sri Lankan market; hence, the communities are exposed to this equipment. The AREA, which was introduced to the Communities through the project, shows a significant gap between the organized and less-organized Communities. **It can be concluded that organized communities that have the formally established structure and capacity are capable of adopting new technologies compared to the less-organized communities.**

Conclusions – Hypothesis 4

Hypothesis: ICTs that in addition to their hazard function can also be leveraged in other areas to enrich the lives of the villages will potentially have lower downtime than ICTs that are poorly integrated into the day to day life of the beneficiaries.

Conclusion: The VSAT perhaps is the most highly utilized ICT. The Sarvodaya Community Disaster Management Centre staff used the high bandwidth internet link with an internal hard-wired and wireless network for skype, email, and Internet services necessary to generate and issue alerts. GSM Mobile Phones and CDMA Fixed Phones were used when necessary for business communications; all voice calls; almost no one used their sms or internet facilities. WorldSpace Sarvodaya Talk Channel was used during Hambantota flood relief efforts; channel is now operational 24/7.

Overall every ICT has proven to have a unique feature that contributes to the daily functions of the community. Basically if ICT is given and the usage cost is very low then they will use it.

RECOMMENDATIONS

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Recommendations

- Message formatting – the Hazard Information Hub and the Government
- Further test ICT tools assessments and methodologies
- Table Top Exercises for selected members in the communities
- Training and certification of HIH Monitors
- Training of ICT Guardians
- Community-based emergency communication and planning
- Contribution to CAP research groups through working groups
- Enhance and test ICTs with compete and Full CAP features
- Develop a free and open source CAP Broker
- Build the Closed User Group Digital Audio Broadcast

Immediate Future Work

1. Message formatting – the Hazard Information Hub and the Government

3. Further test ICT tools assessments and methodologies

5. Table Top Exercises for selected members in the communities

7. Training and certification of HIH Monitors

9. Training of ICT Guardians

11. Community-based emergency communication and planning

13. Contribution to CAP research groups through working groups

15. Enhance and test ICTs with compete and Full CAP features

17. Develop a free and open source CAP Broker

19. Build the Closed User Group Digital Audio Broadcast

Natural Language CAP Broker (R&D)

Developing Community-Based DM Capacity in Sarvodaya (Implementation)

Thank You

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