

Real-Time Health Early Warnings Dissemination System for Unscathed Populations (HeadsUp) : Biosurveillance pilot in India and Sri Lanka

ICTs as a tool for strengthening Pandemic Preparedness
Pandemic Preparedness Forum,
United Nations System for Influenza Coordination

June 10, 2010

Queens Hotel, Bangkok, Thailand



Sarvodaya



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Outline

□ **INTRODUCTION TO THE RESEARCH**

- Synergies of RTBP and Early Warning Systems
- Research question and specific objectives

□ **DISEASE INFORMATION REQUIREMENTS**

- Determinants of notifiable diseases in India and Sri Lanka
- Cycle of data collection, analysis, and dissemination

□ **COMMUNICATION SYSTEM EVALUATIONS**

- Data collection :: mHealthSurvey mobile application
- Event detection :: T-Cube Web Interface
- Disseminations :: Sahana Messaging/Alerting Module
- Cost effectiveness before and after

□ **CONCLUSIONS & REFERENCES**



Synopsis of IDRC funded PANACeA projects

PAN Asian Collaboration for Evidence-based e-Health Adoption and Application

Initiative to generate evidence in the field of e-health within the Asian context, by forming a network of researchers and research projects from developing Asian countries.

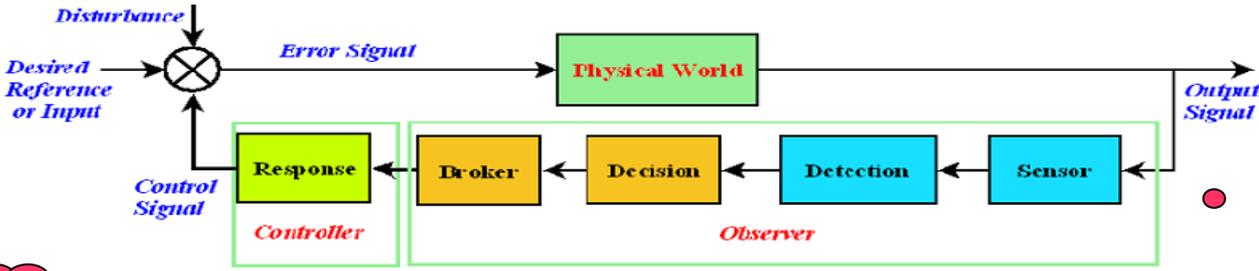
<http://www.aku.edu/CHS/panacea/about.shtml>

Some PANACeA Initiatives (more :: <http://tinyurl.com/39ypljm>)

- Outbreak Management System
- Systematic review of ICTs in disasters
- e-Health system for community health care recording and reporting
- Mobile telemedicine system for ambulance and movable community health care
- Mobile telemedicine kit for disaster relief



Doctrine of Real-Time Biosurveillance (RTBP)



Health Disaster Management

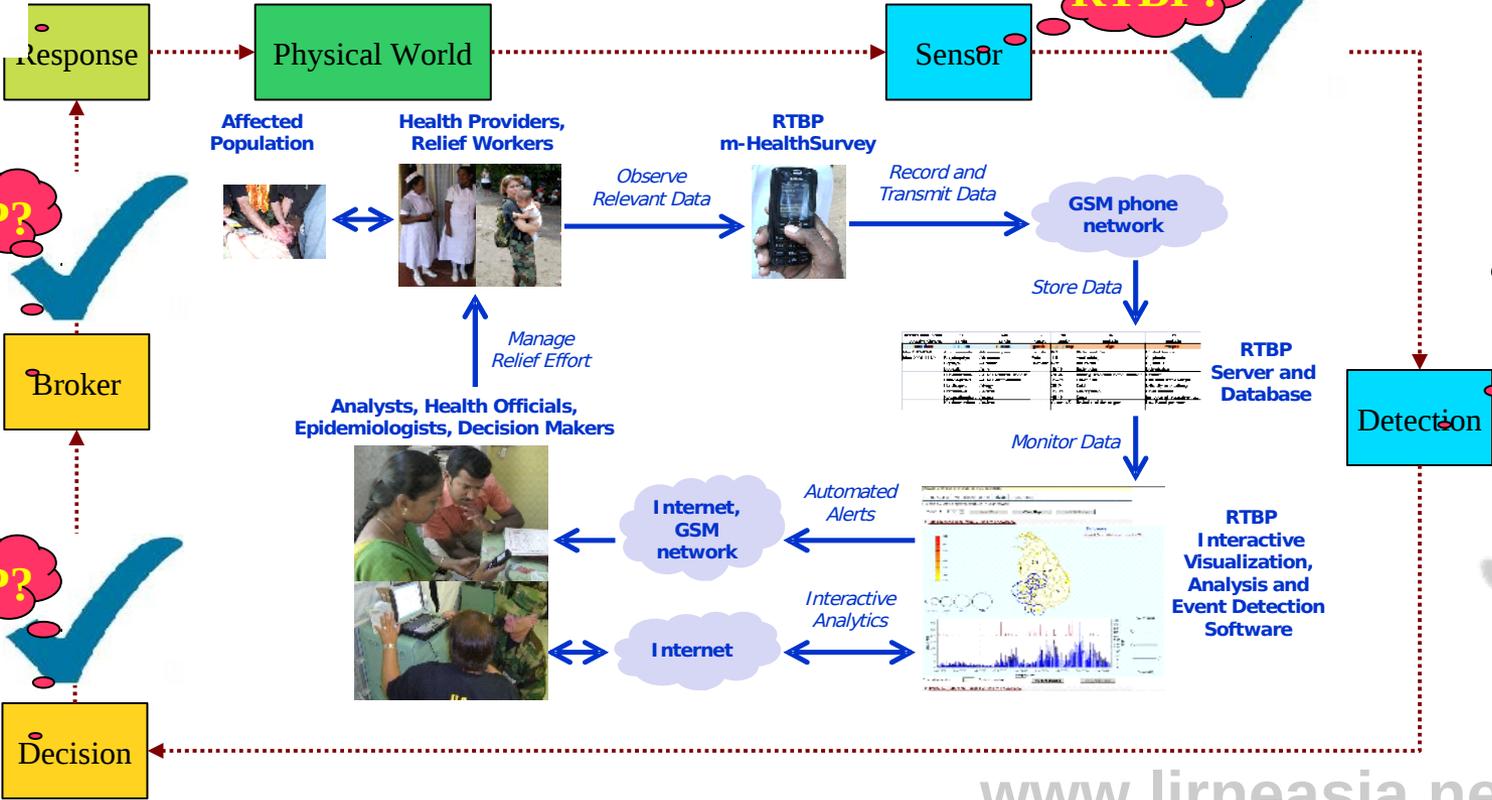
RTBP?

RTBP?

RTBP?

RTBP?

RTBP?

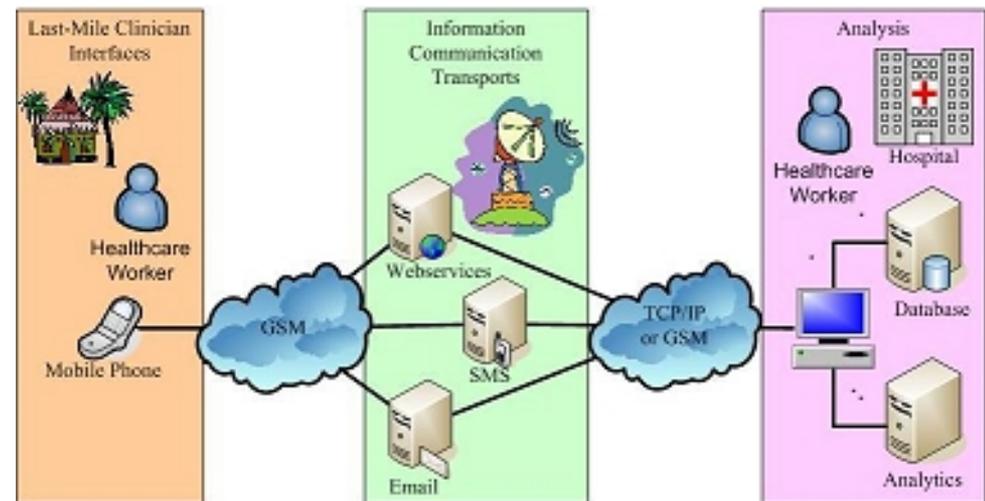


Evaluating a Real-Time Biosurveillance Program: Piolt

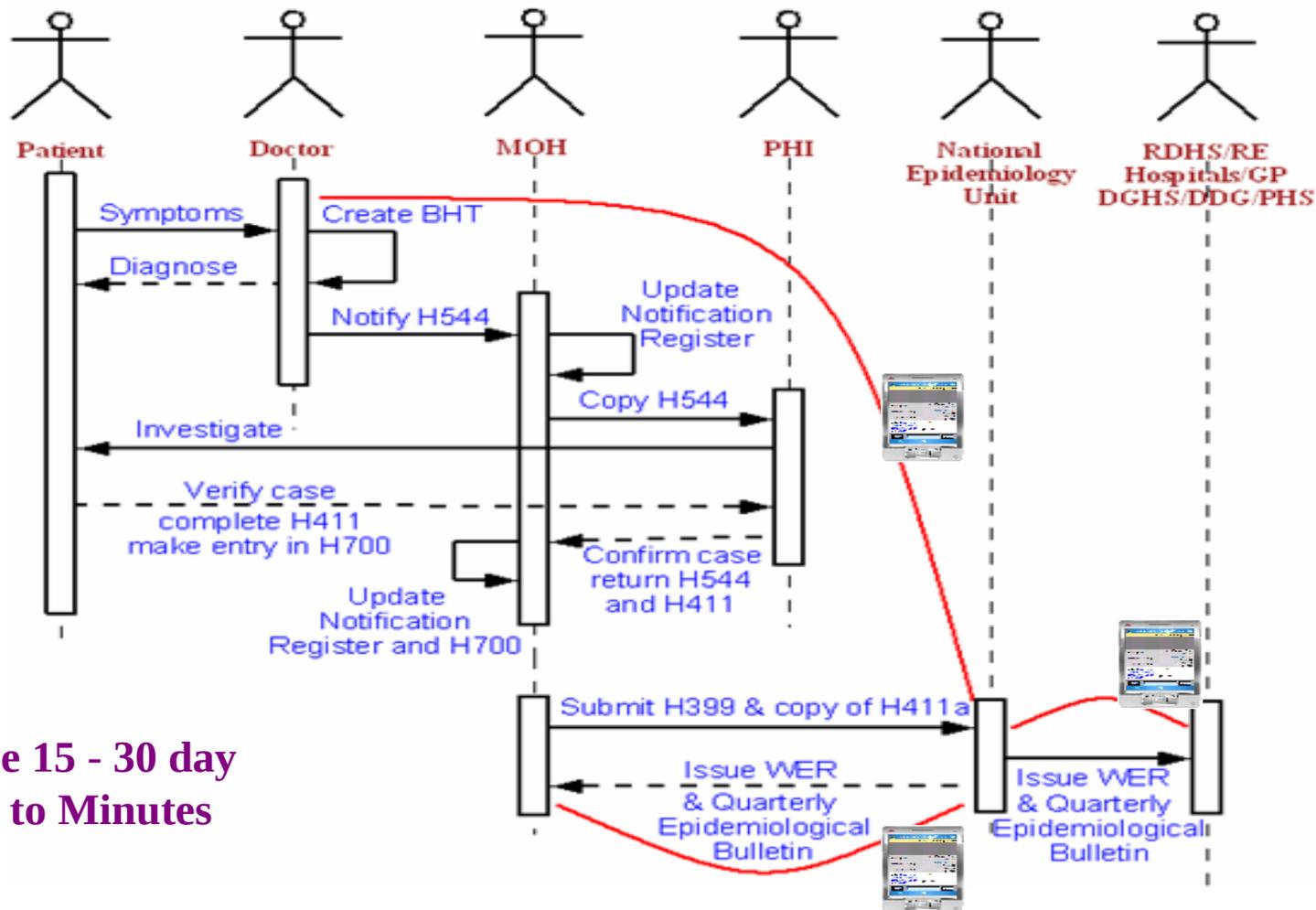
Research Question: “Can software programs that analyze health statistics and mobile phone applications that send and receive the health information potentially be effective in the early detection and mitigation of disease outbreaks?”

Specific Objectives

- Evaluating the effectiveness of the m-Health RTBP for detecting and reporting outbreaks
- Evaluating the benefits and efficiencies of communicating disease information
- Contribution of community organization and gender participation
- Develop a Toolkit for assessing m-Health RTBPs



Sri Lanka Epidemiology and RTBP overlay

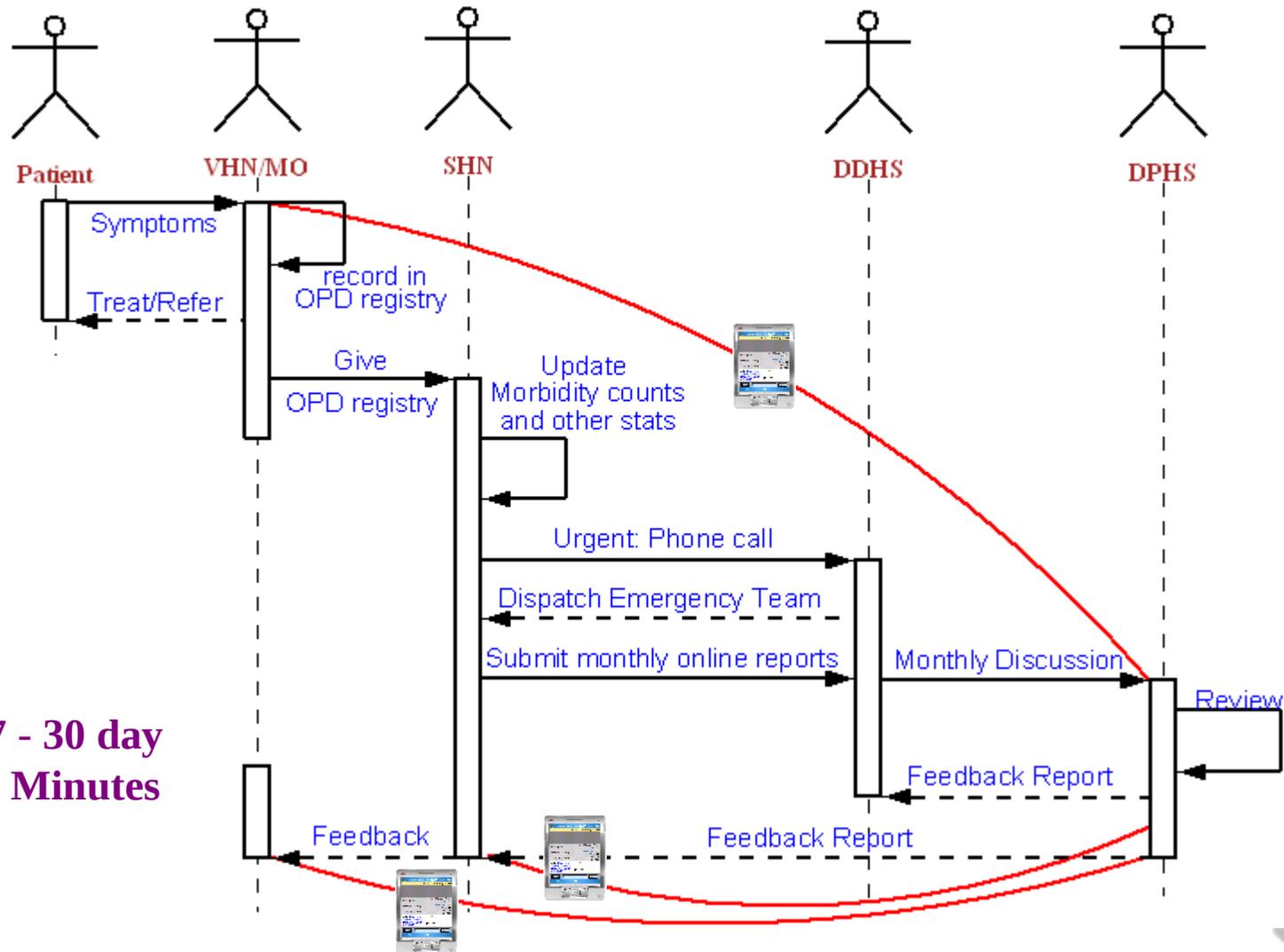


Reduce 15 - 30 day delays to Minutes

- **Black arrows:** current manual paper/postal system for health data collection and reporting
- **Red lines:** RTBP mobile phone communication system for health data collection and reporting



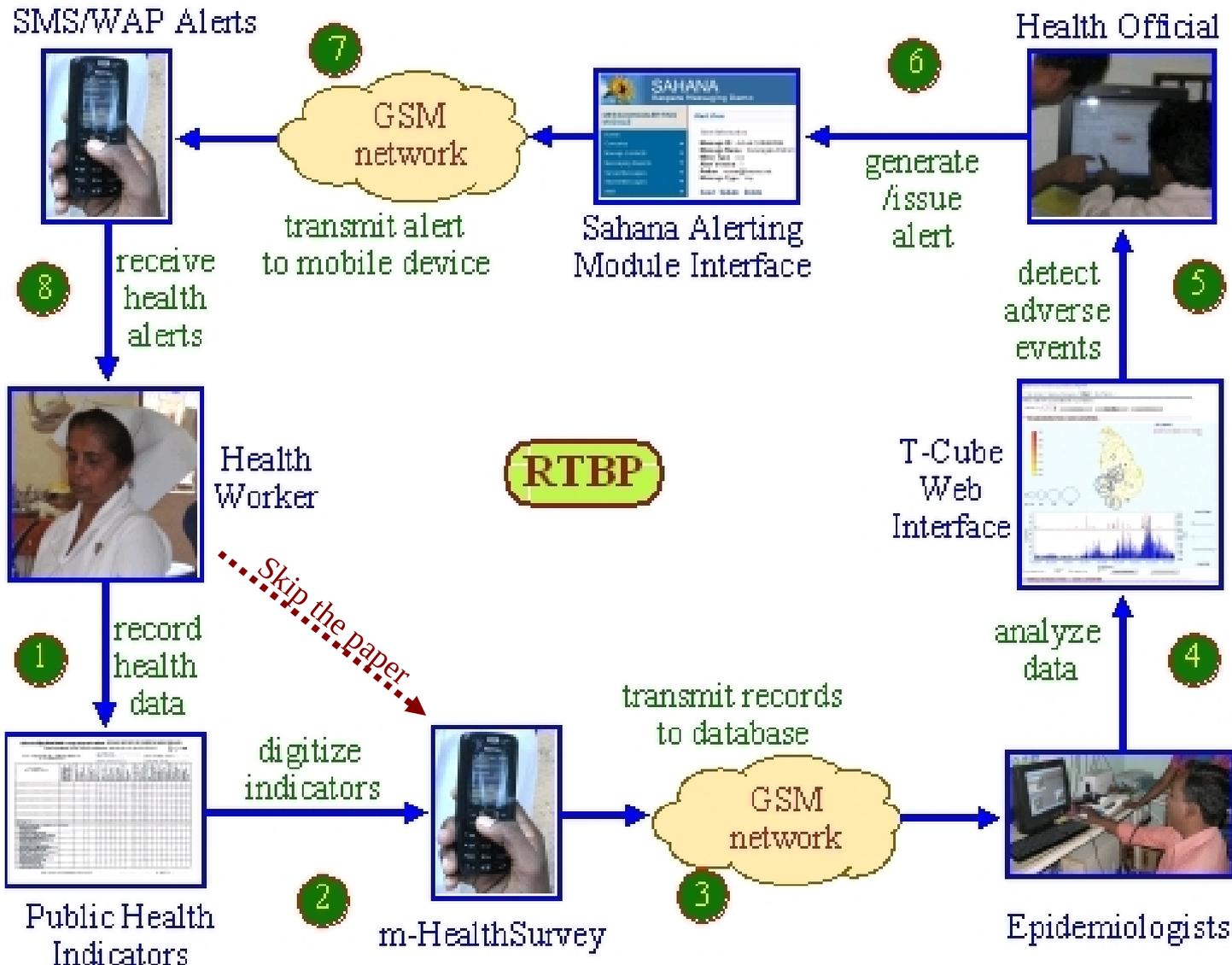
India morbidity reporting and RTBP overlay



Reduce 7 - 30 day delays to Minutes

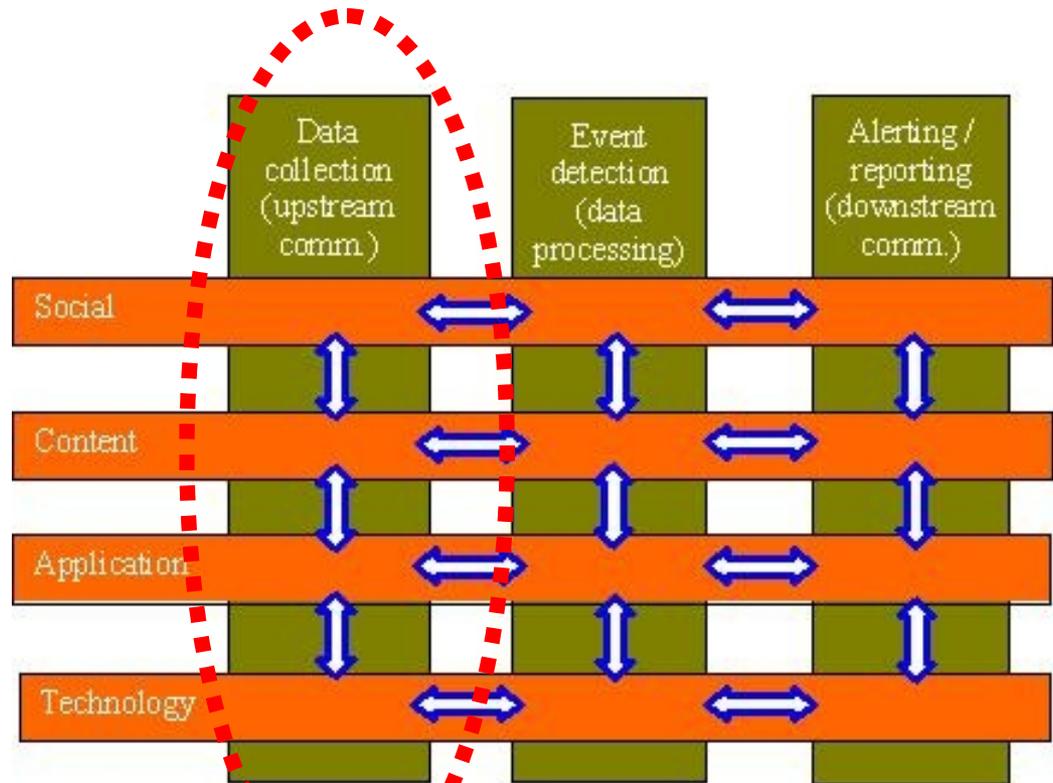
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- **Red lines:** RTBP mobile phone communication system for health data collection and reporting

Data collection, Event detection, and Situational-Awareness/Alerting in RTBP



Evaluation metric verticals and horizontals

- Three verticals – data collection, event detection and reporting
- Four layers – social, content, application, Transport
- Arrows showing the Interoperability between layers and verticals
- Objectively assess by calculating various indicators: costs, efficiencies, error rates, etc
- Subjectively assess through interviews and simulations



Talk about this



Our pilot in India and Sri Lanka

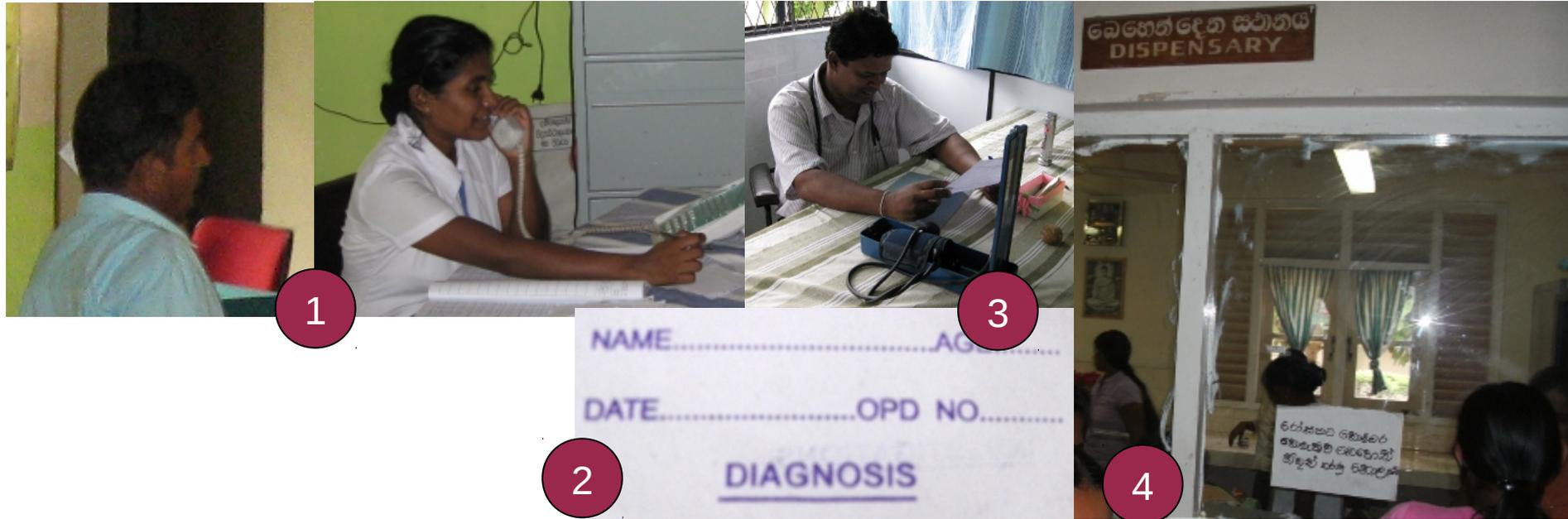


- 24 Health Sub Center Village Nurses
- 4 Public Health Center Sector Health Nurses, Health Inspectors, and Data Entry Operators
- 1 Integrated Disease Surveillance Program Unit of the Deputy Director of Health Services
- Thirupathur Block, Sivagangai District, Tamil Nadu, India



- 12 District/Base Hospitals and Clinics
- 15 Sarvodaya Suwadana Center Assistants
- 4 Medical Officer of Health divisions & 1 Regional Epidemiology Unit
- Kurunegala District, Wayamba Province, Sri Lanka

Data collection process



(1) Patient is received by the Nurse

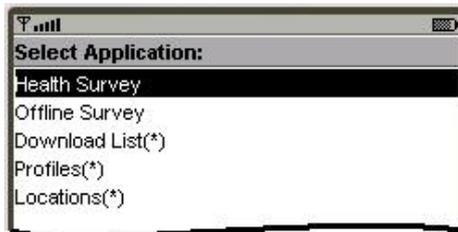
(2) Nurse issues a diagnosis chit to patient fills in Name, Age, Gender, and OPD No

(3) Medical Officer fills in the chit with diagnosis and treatment

(4) Patient presents chit to pharmacy to receive medication

(5) Data Entry Operator digitizes and submits the data

mHealthSurvey Midlet by IIT-M



Select Application:

- Health Survey
- Offline Survey
- Download List(*)
- Profiles(*)
- Locations(*)

(a)



Configure Healthcare worker Profile

ID:(*) 6900v

Retype ID:(*) 6900v

First Name:(*) Harry

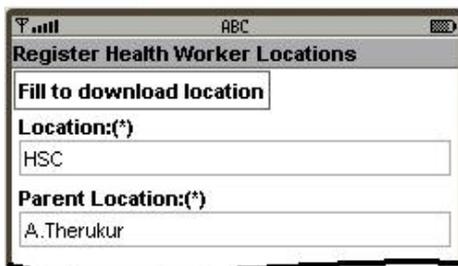
Last Name:(*) Potter

Type:(*) VHN

Phone: +91 555 1212

E-Mail: harry@potter.uk.co

(b)



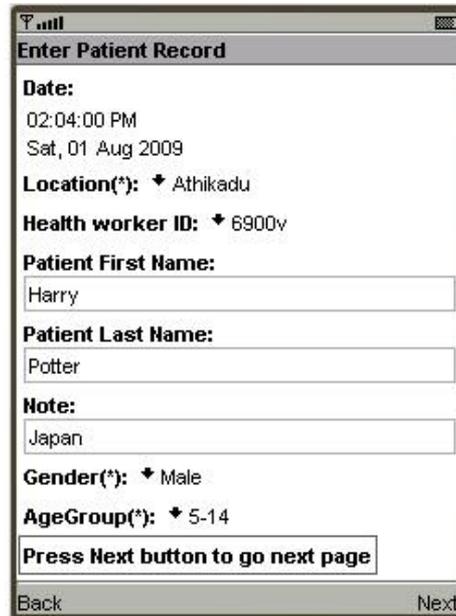
Register Health Worker Locations

Fill to download location

Location:(*) HSC

Parent Location:(*) A.Therukur

(c)



Enter Patient Record

Date: 02:04:00 PM
Sat, 01 Aug 2009

Location:(*) Athikadu

Health worker ID: 6900v

Patient First Name: Harry

Patient Last Name: Potter

Note: Japan

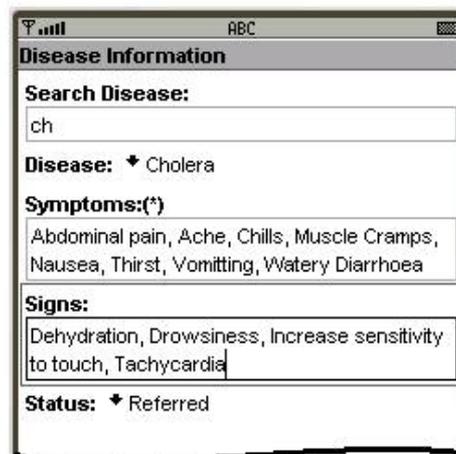
Gender:(*) Male

AgeGroup:(*) 5-14

Press Next button to go next page

Back Next

(d)



Disease Information

Search Disease: ch

Disease: Cholera

Symptoms:(*) Abdominal pain, Ache, Chills, Muscle Cramps, Nausea, Thirst, Vomiting, Watery Diarrhoea

Signs: Dehydration, Drowsiness, Increase sensitivity to touch, Tachycardia

Status: Referred

(e)

- (a) Main menu
- (b) Profile registration
- (c) Retrieve locations
- (d) Patient record screen I
- (e) Patient record screen II



mHealthSurvy software design

- ❑ J2ME: Built on Java 2 Micro edition
- ❑ CDC: works with CDC 1.1 and above (JSR)
- ❑ MIDP: works with MIDP 2.0 or above
- ❑ GPRS: transport technology
- ❑ Each record is 2kb and costs INR 0.01 or LKR 0.02 (USD 0.0002) i.e < **USD 10 Handset/Month**
- ❑ **Mobile phone around US\$ 100**
- ❑ Tested on Nokia3110c, Motorola SLVR L7, Gionee v6900. Amoi A636, Sony Ericsson s302c



m-HealthSurvey Certification Exercise at the early stages



Exercise

Part I – installation and configuration (min)

Part II – submit up to 6 records (min)

Part III – standard operating procedures (points)

Benchmark

12.00

20.00

50.00

Sri Lanka

10.75

10.80

20.43

India

17.48

27.26

15.00

Outcome

Certified trainers (> 90 points)

Certified Users (90 => points > 70)

Uncertified (points <= 70)

02 of 15

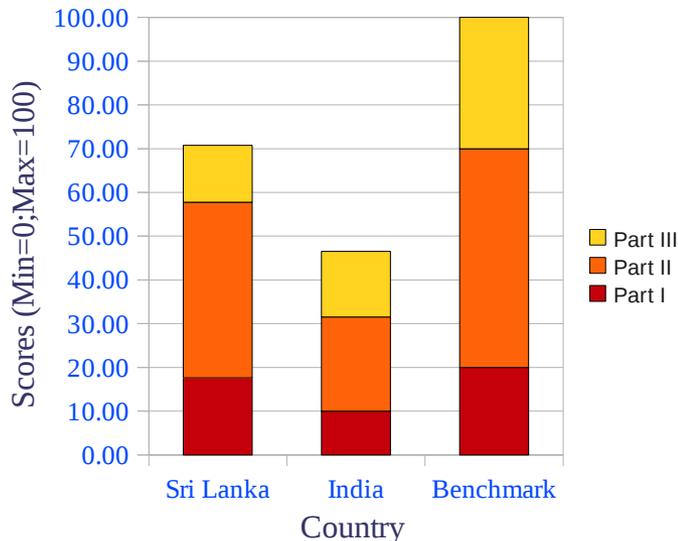
13 of 15

Nil

04 of 23

19 of 23

Average Country Scores



Age 18 – 35

No health training

No prior experience

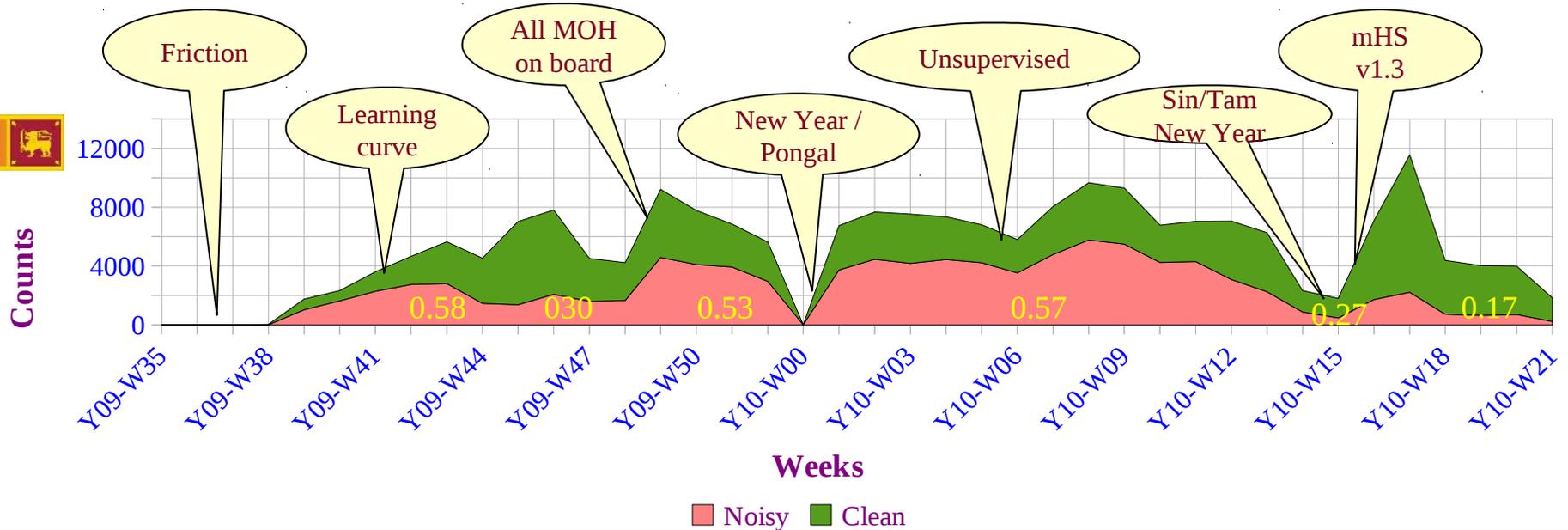
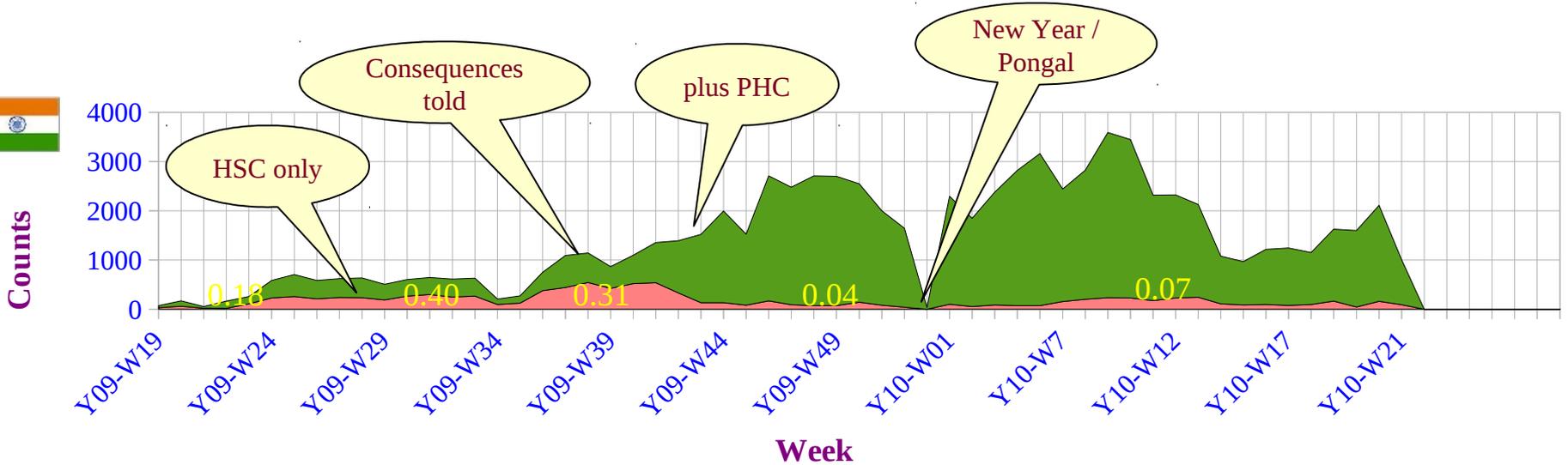


Age 35 – 55

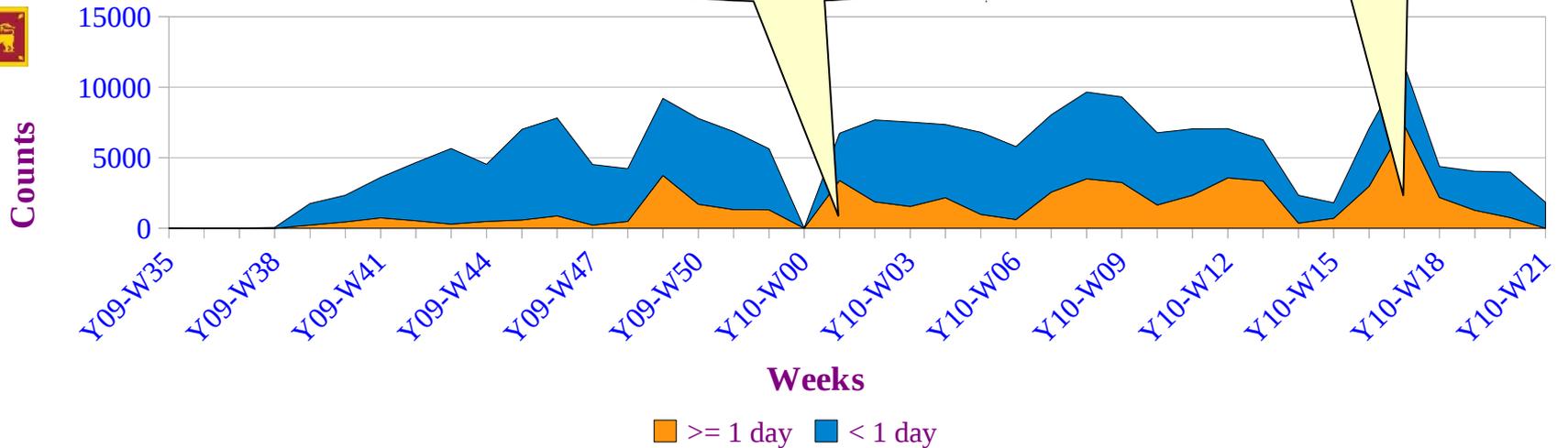
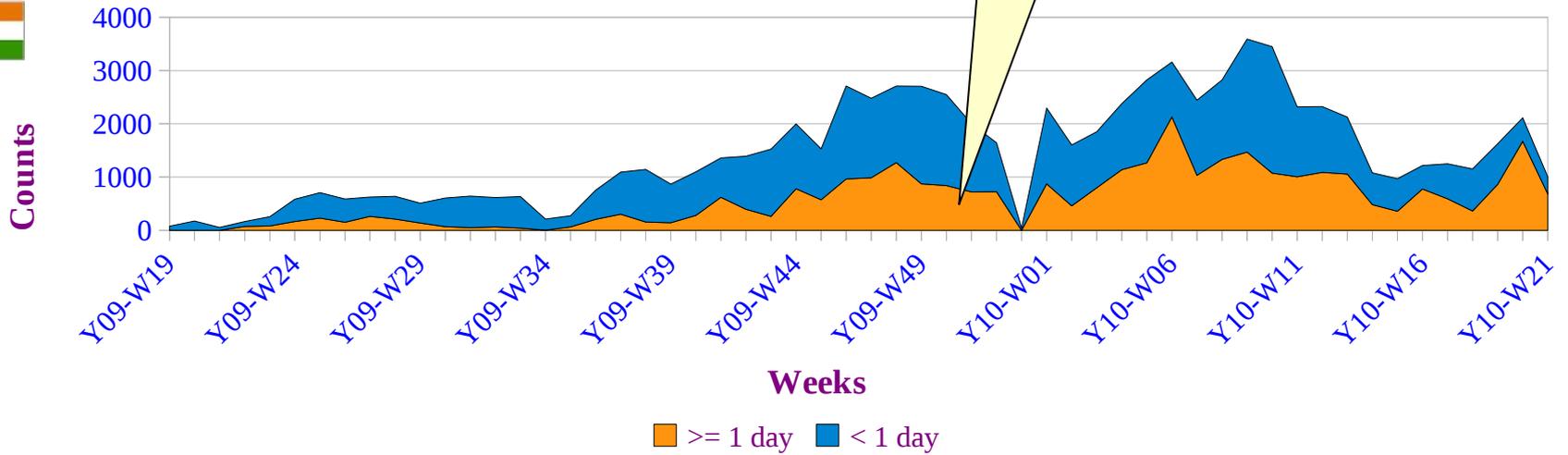
Trained Health Workers

10 – 25 yr experience

Signal to Noise Ratios



Off-time vs Rea-time



Content ontology, semantics, syntax problems

Problem

Examples

Synonyms:

goal fever/jail fever/typhus fever, dementia/memory loss,
entric fever/typhoid fever, encephalitis/meningitis

Insertion of symbols

body ache/body-ache,
body pain,/body pain

Order of Words

muscle weakness/weakness in muscle
stomach pain/pain in the stomach

Adjectives

Severe memory loss/memory loss

Local language

Leg vettuthal

Disjunctions

Nasal stuffiness or sneezing
Over bleeding with abdominal pain

Long sentences

Not able to identify color

Treatment

Oral pills, remove catheter, vaccination

Instructions

Please specify details/specify symptoms

UK vs USA spellin

Diarrhoea/diarrhea, Vomiting/vommiting

Test results

BP 140/90, BP 120/100

Multiple instances

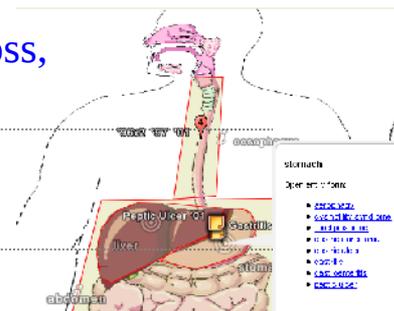
muscle weakness/weakness in muscle
stomach pain/pain in the stomach

Singular vs plural

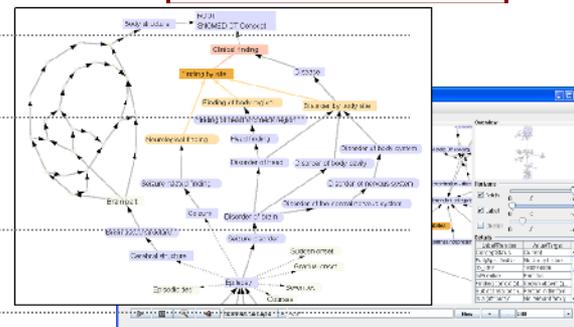
Fits/fits , cut/cuts

Tense

Faint, fainted, fainting



SNOMED-CT



LOINC

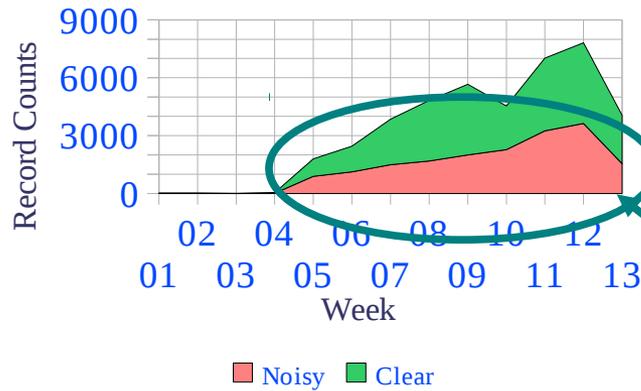


Fix the data collection shortcomings: noisy and off-time

From: 01-Sep-2009
To: 30-May-2010

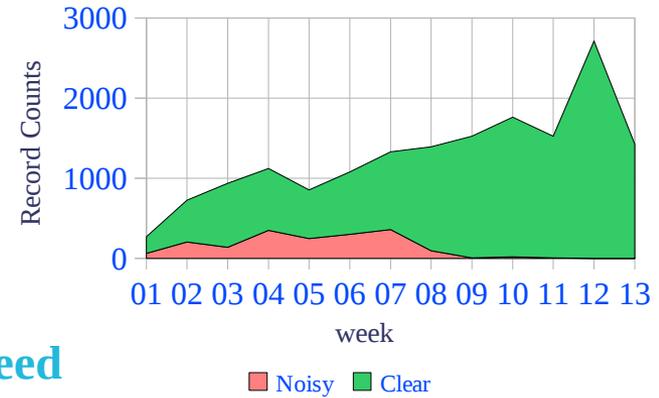
From: 01-Jun-2009
To: 30-May-2010

Case Records:
220000+



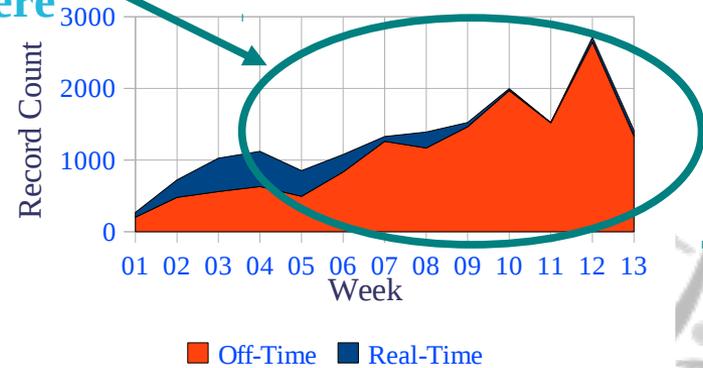
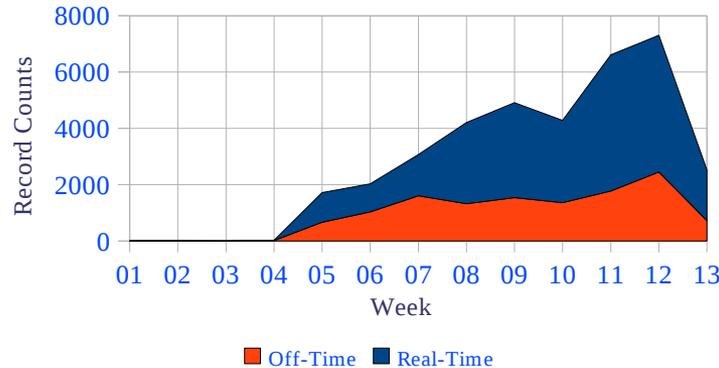
Noisy
vs
Clean
data

Case Records:
81000+



Need
solutions
here

Real-
Time
vs
Off-
Time
data



mHealth data collection lessons



- ❑ Nurses sending data
- ❑ Near zero noise because impacts their work
- ❑ No time to enter data patient care and routine work comes first
- ❑ Under reporting to avoid extra work
- ❑ Improvise mHealthSurvey for collection and reporting of other
- ❑ Older slow to learn but will catchup
- ❑ No prior experience beyond voice
- ❑ Resolve technical problems on their own relative to PCs
- ❑ Replaced handsets on their own

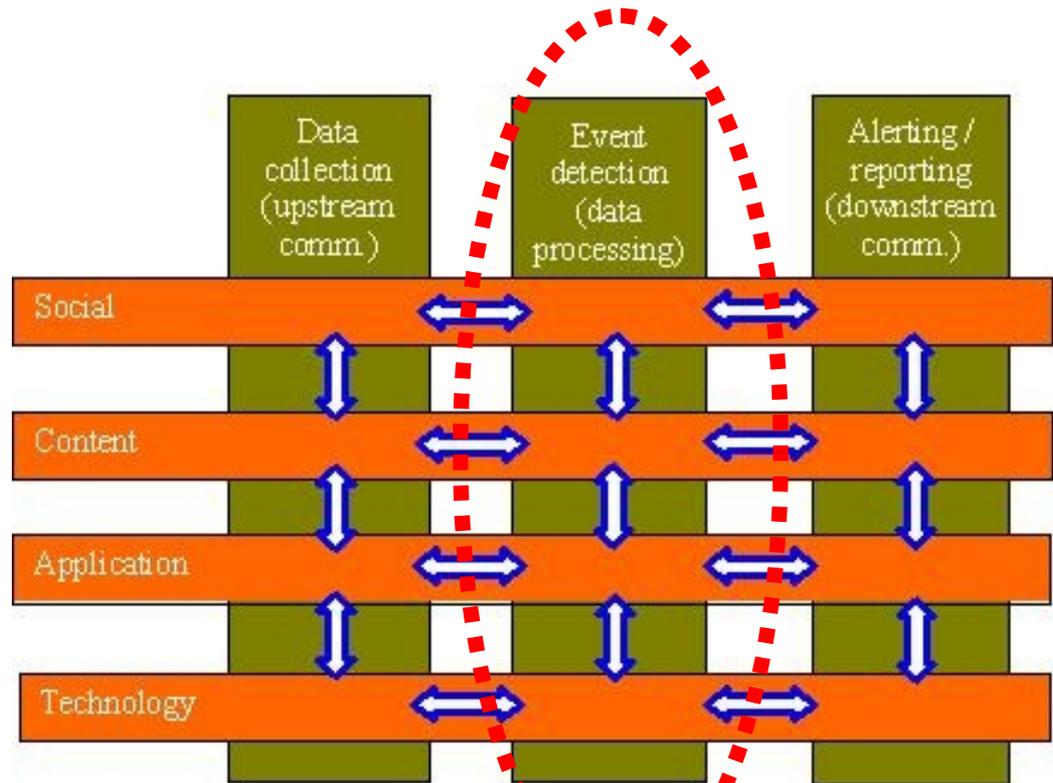


- ❑ Outsourced data entry clerks
- ❑ No incentive because 1) lack of knowledge 2) not direct impact
- ❑ Data entry is their only job
- ❑ No strings attached with reporting quantity
- ❑ Nothing like that
- ❑ Young were quick to learn
- ❑ Knew all capabilities of mobile
- ❑ Resolve technical problems on their own relative to PCs
- ❑ Replaced handsets on their own



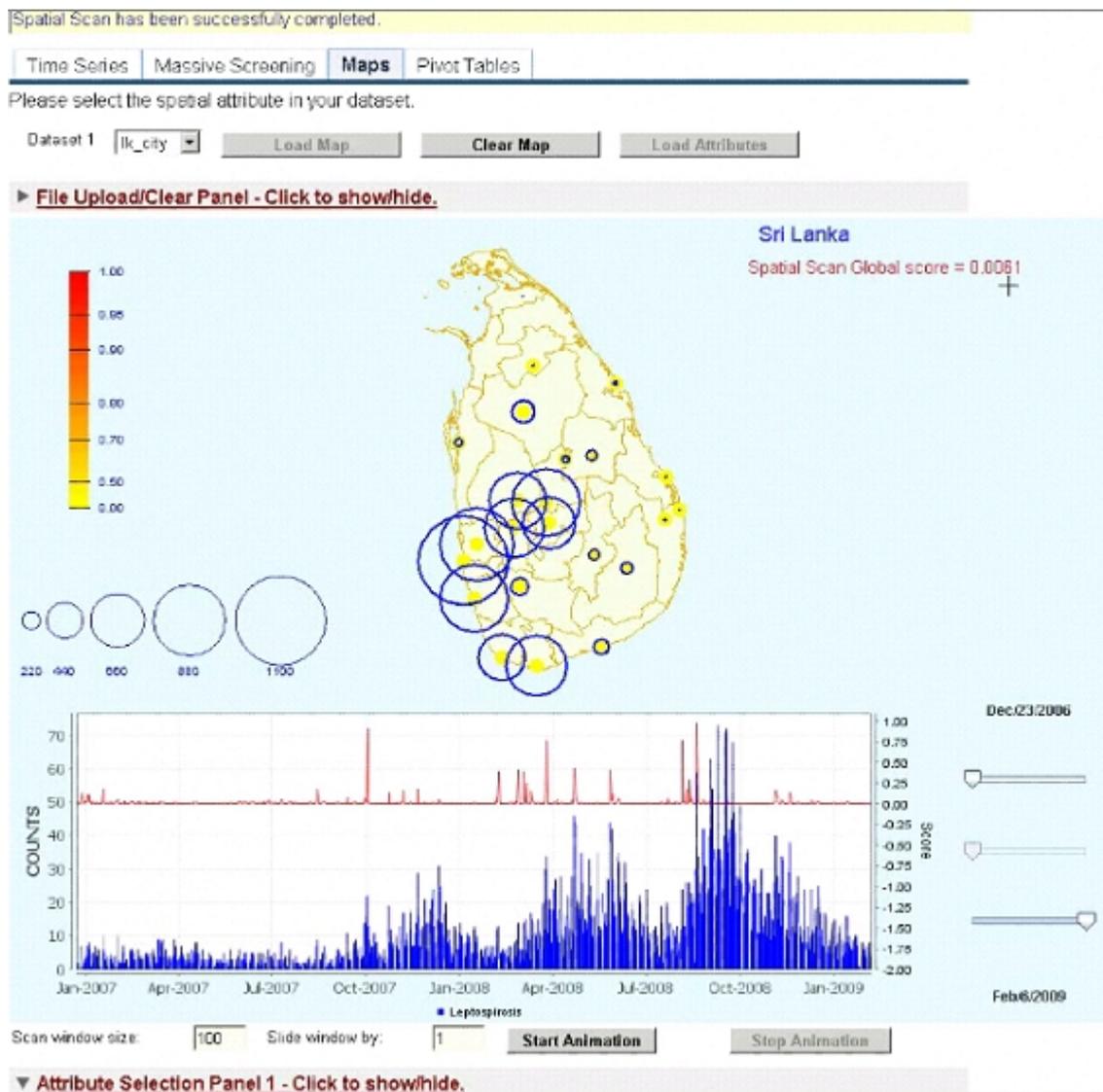
Evaluation metric verticals and horizontals

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Talk about this

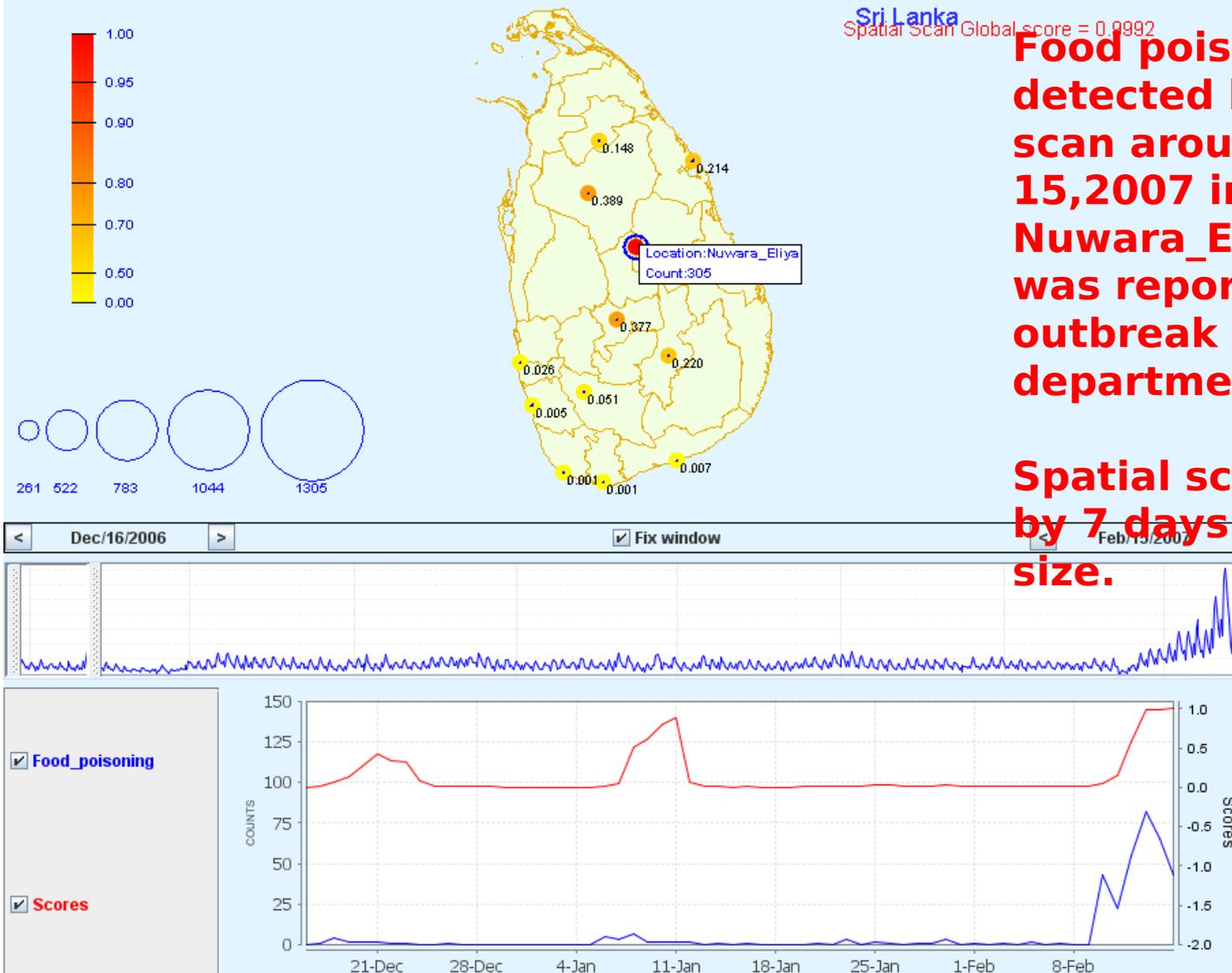
T-Cube Web Interface (TCWI) by *Auton Lab*



- ❑ AD Tree data structure
- ❑ Trained Bayesian Networks
- ❑ Fast response to queries
- ❑ Statistical estimations techniques
- ❑ Data visualization over temporal and spatial dimensions
- ❑ Automated alerts



Replication study using Sri Lanka WER data 2007 - 2009

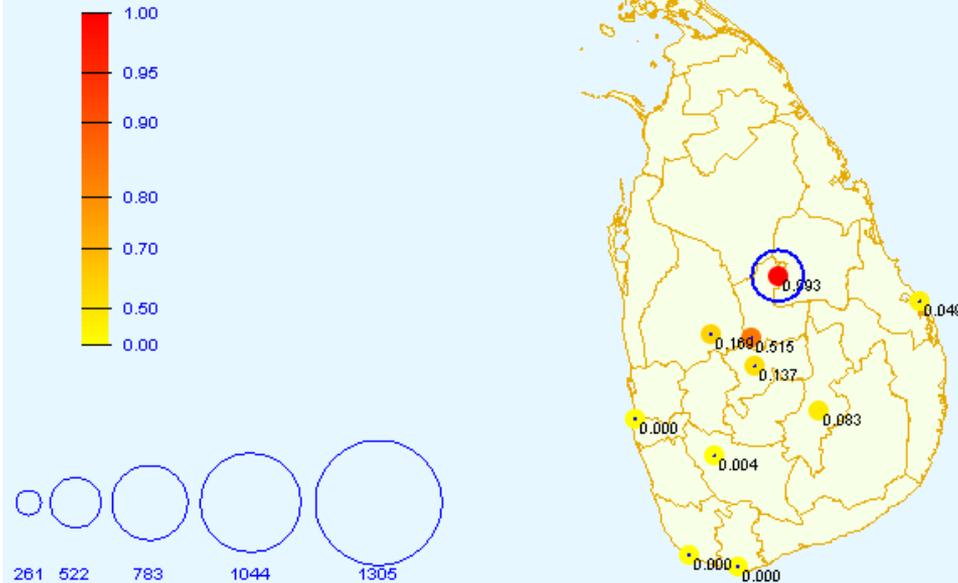


Food poison spike as detected by spatial scan around Feb 15, 2007 in Nuwara_Eliya, which was reported as outbreak by health department.

Spatial scan is run by 7 days windows size.

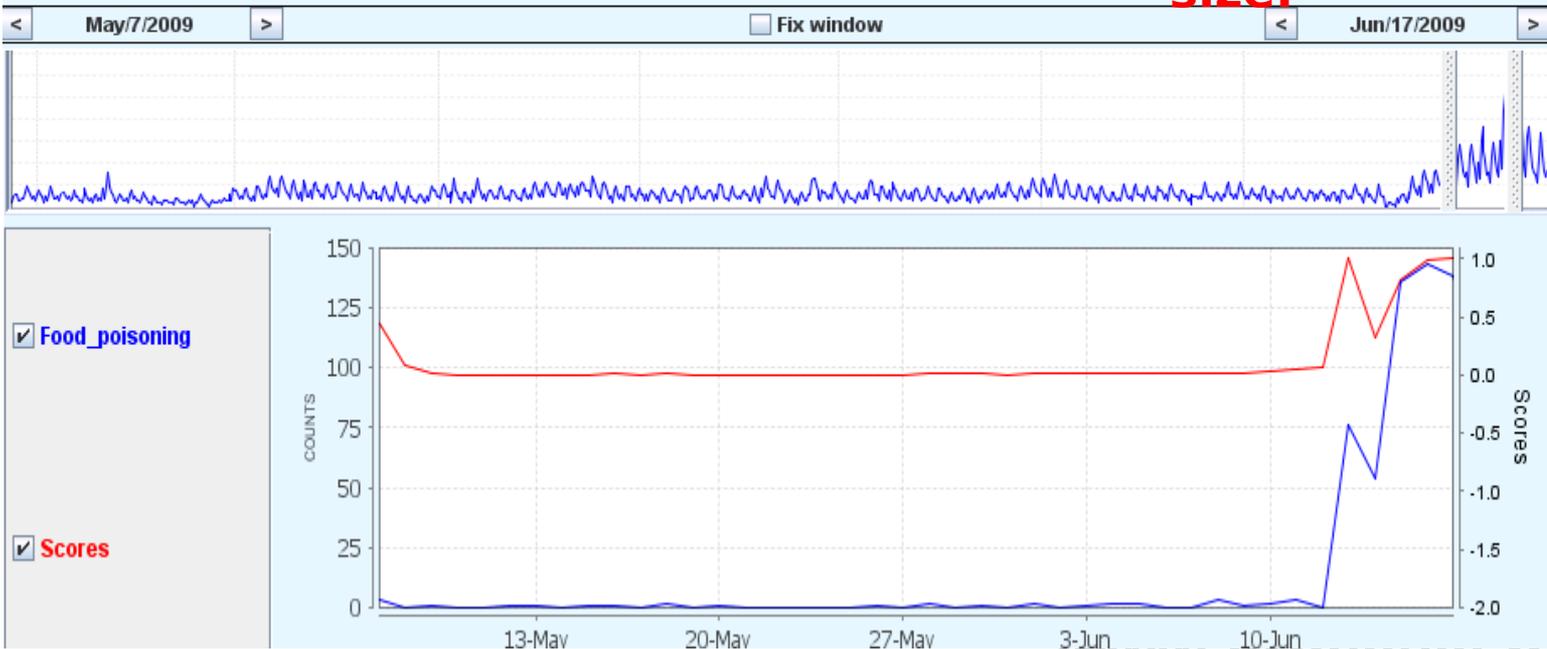


Sri Lanka
Spatial Scan Global score = 0.9983



Another Food poison spike as detected by spatial scan around June 17, 2009 in Nuwara_Eliya, the same location.

Spatial scan is run by 7 days windows size.



TCWI some early lessons



- Health departments unfamiliar with statistical estimation methods for detection analysis
- Requirements were to observe :: Integrated Disease Surveillance Program (IDSP) P/S disease list
- No incentives to use and usage is almost nil



- Health departments unfamiliar with statistical estimation methods for detection analysis
- Requirements were to observe :: set of Notifiable disease and Weekly Epidemiological Returns report
- Have incentives and using due to known delays in present system

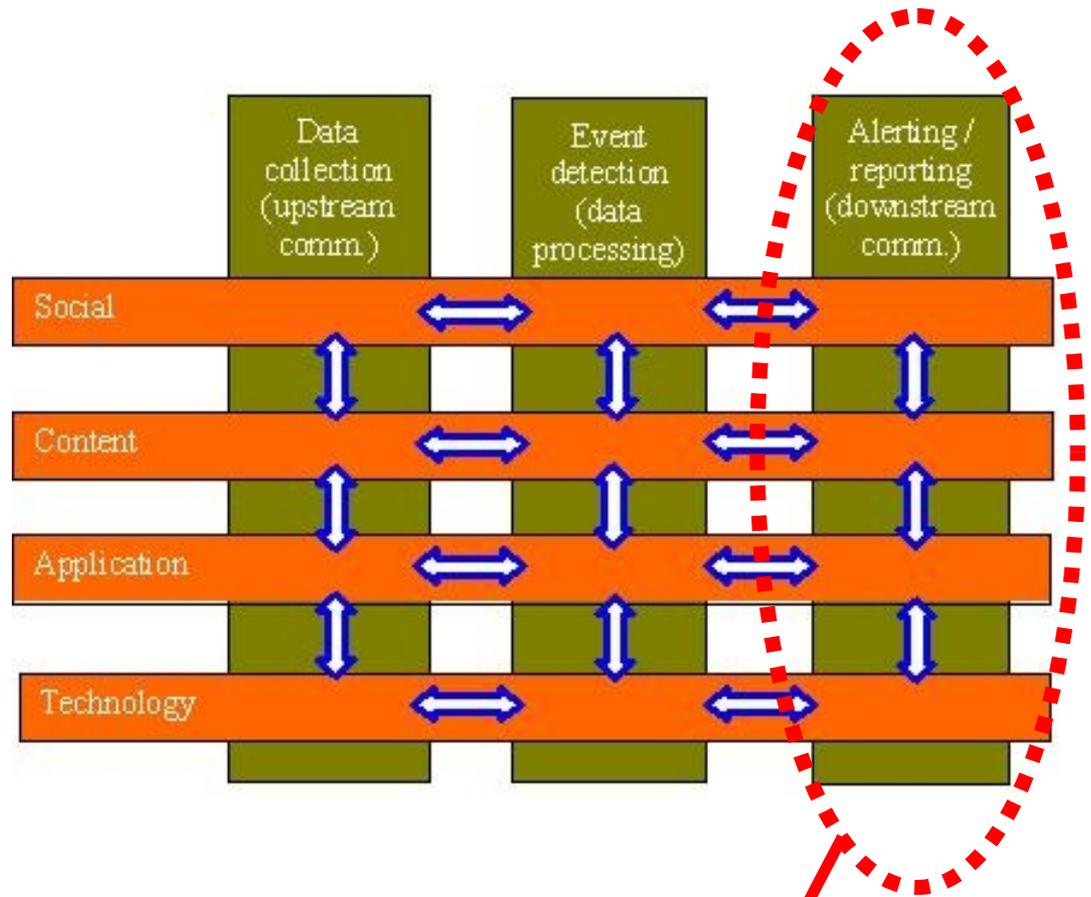
Studying the TCWI Acceptance through TAM

RESULTS TO BE ANNOUNCED



Evaluation metric verticals and horizontals

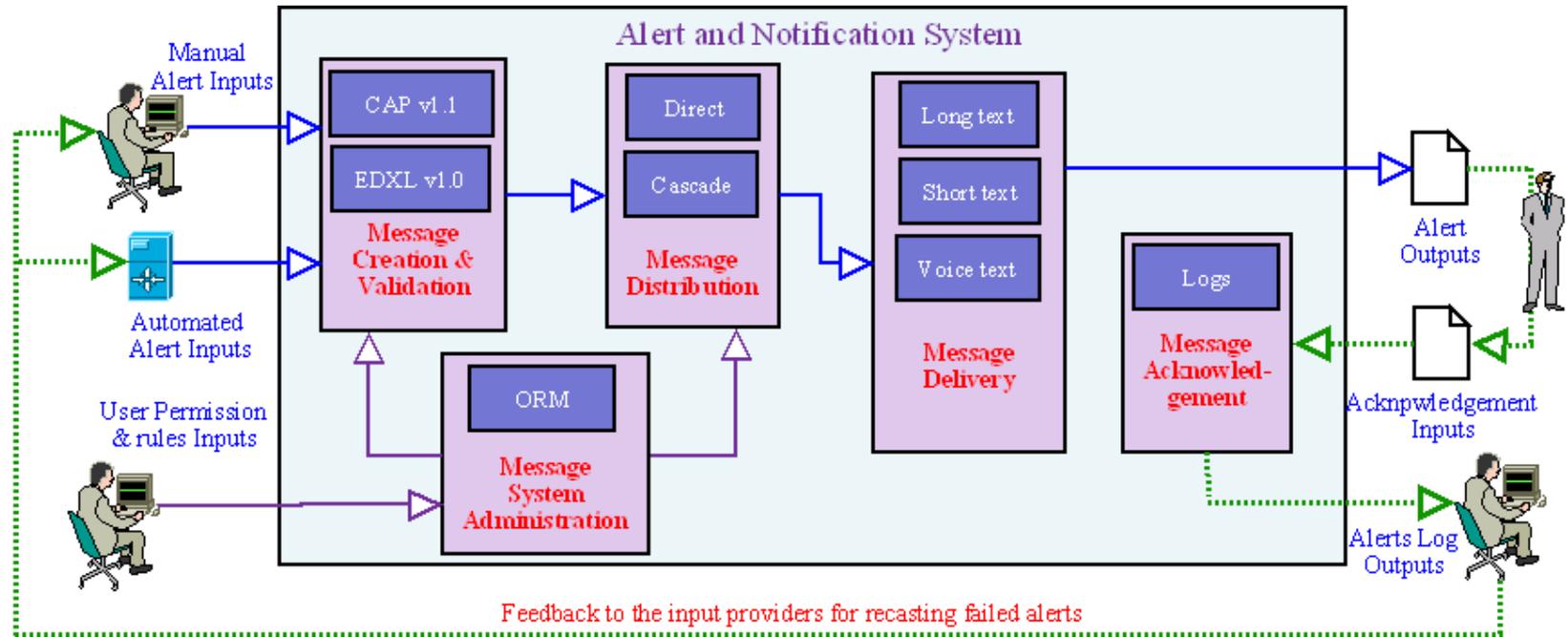
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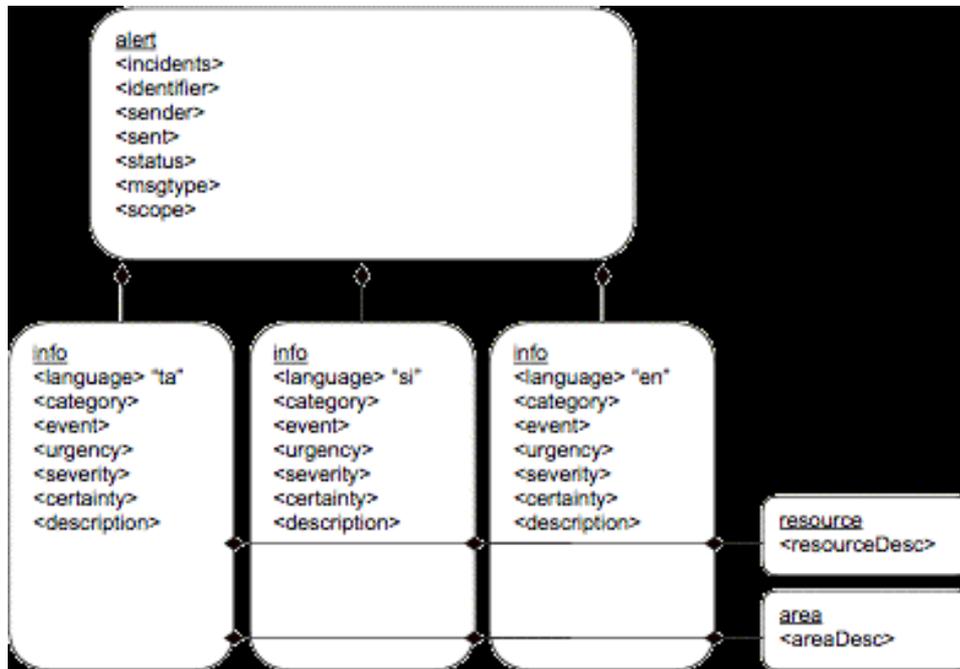
Alerting and Situational Awareness Subsystems



- ❑ Took LIRNEasia's work from HazInfo project and extended it to RTBP
- ❑ HazInfo embedded a Messaging Module in the Sahana Disaster Management Framework
- ❑ Adopted the USA CDC Public Health Information Network PCA guidelines
- ❑ Developed the new Sahana Alerting Module with CAP as the underlying content standard
- ❑ Future we will add EDXL and enhance it to a Publisher Subscriber Broker



Common Alerting Protocol for all-media all-hazards messaging



- Content standard developed by the Organization for the Advancement of Standardized Information Structures (OASIS)
- Now adopted by the International Telecommunications Union (ITU)
- Designed for All-Media All-Hazards
- Allows multi-language messaging
- Standard is a good guide for setting up warning, alerting, situational-awareness national or institutional procedures



Sahana Messaging/Alerting CAP/EDXL Broker by Respere

MESSAGING/ALERTING MODULE

- Home
- Consoles
- Manage Contacts
- Messaging Reports
- Survey Messages
- Stored Messages
- Alert
- New
- View
- Remove
- Templates
- Common Alerting Protocol

SAHANA MAIN

- Sahana Home
- Messaging/Alerting Module
- User Preferences

Logged In
User: sahanaria
[Logout](#)

Alert Information Resource Area

Message Identifier: Actual-1246440944

Sender: pdhs@nw.health.gov.lk

Status: Actual ? HFI P

Message Type: Alert ? HEL P

Source: Wayamba PDHS

Scope: Restricted ? HELP

Language: English

Category: Health Add

Event: Disease Outbreak

Priority: Low

Sender Name: Dr. Lukshman Edirisinghe

Headline: A Dengue outbreak is in eff

Description: A dengue outbreak is in effect for Kurunegala District of Sri Lanka. All Medical Officers are Advised to execute preventive measures.

Recipient List

Contacts

- Groups
 - Respere
- Individuals
 - Mfan
 - Nuwan_W
 - Mfan_M

Select Contacts

nuwan@lirneasia.net, +94773710394, lukshman.edirisinghe@yaloo.com.au, +947775551212

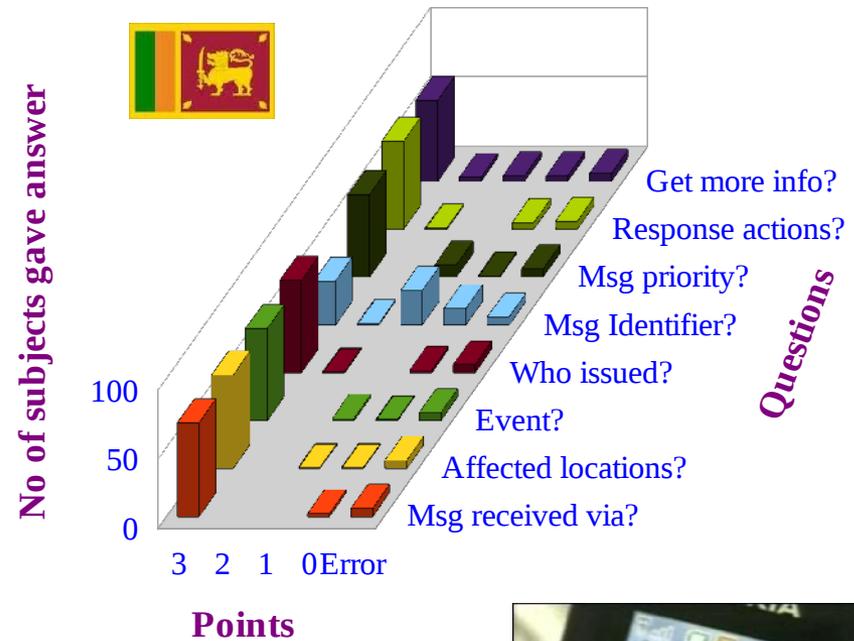
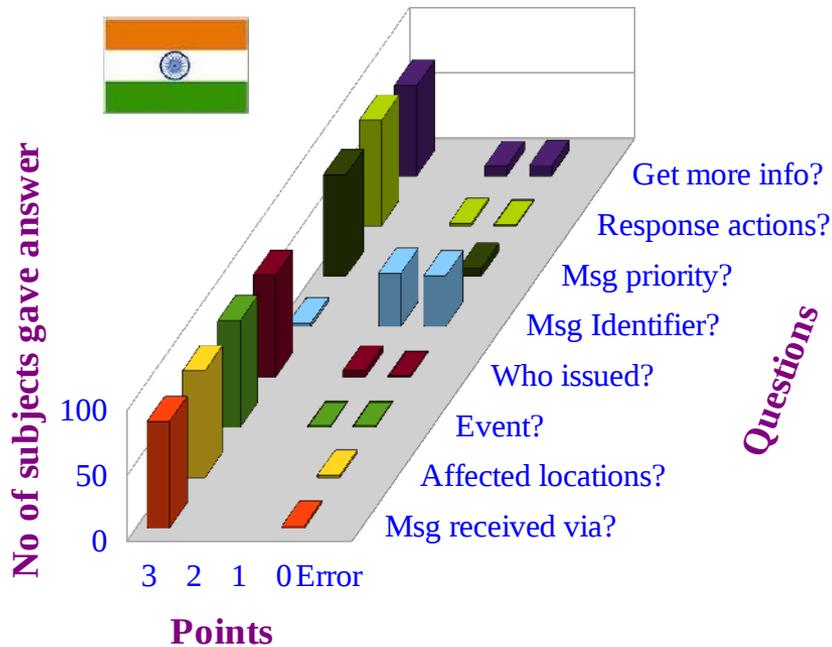
Select Delivery Type

Delivery Category	Delivery Type	Select
Short Text	SMS	<input checked="" type="checkbox"/>
	HF	<input type="checkbox"/>
	RDF	<input type="checkbox"/>
Long Text	Email	<input checked="" type="checkbox"/>
	Web	<input type="checkbox"/>
Voice Text	VoiceXML	<input type="checkbox"/>
	IVR	<input type="checkbox"/>

- Single input multiple output engine; channeled through multiple technologies
- Manage publisher /subscribers and SOP
- Adopt PHIN Communication and Alerting Guidelines for EDXL/CAP
- Relating the template editor with the SMS/Email Messaging module
- Do direct and cascading alert from a regional jurisdictional prospective
- Designing short, long, and voice text messages
- Addressing in multi languages



CAP SMS Alert/Situ-aware comprehension exercises



Assessment design

- Participants receive 4 SMS text with varying values of the CAP attributes
- India = 23 and Sri Lanka = 19 health workers participated in the exercise

Outcomes

- Everyone did quite well in the exercises except for 1 or 2 exceptional cases
- Both India and Sri Lanka having trouble with msg-identifier; could be because msg-identifier getting truncated by the 160 char SMS constraint
- Recommendation :: put msg- identifier in subject header (but may cutoff rest due to 160 char SMS); use the term “reference number” instead or both



CAP SMS Alert/Situ-aware Credibility, Persuasiveness, Validity



[76] samples

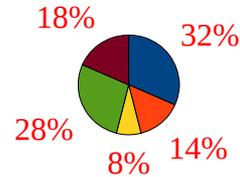


[84] samples

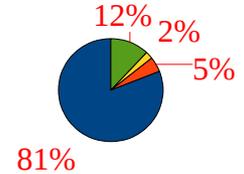
Authenticate message?

Use Web/Contact

Call MOH (38%)
Call Issuer (11%)
Refer Internet (11%)
Other (23%)
No Answer (16%)



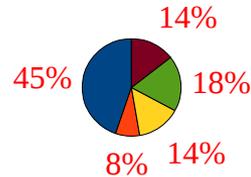
Investigate the area (81%)
Contact Msg Sender (5%)
Other (2%)
No Ans (12%)



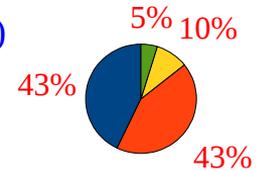
Verify authenticity?

Sender Name

Call MOH (45%)
Call Issuer (8%)
Refer Internet (11%)
Other (23%)
No Answer (16%)



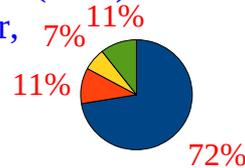
Investigate the area (43%)
Contact MO (43%)
Other (10%)
No Ans (5%)



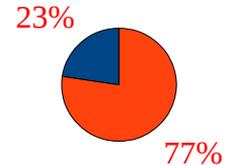
Summarize message

Counts, disease, locations, response

Disease, Locations, Issuer (72%)
Disease, Location, Issuer, Response (11%)
Other (7%)
No Answer (11%)



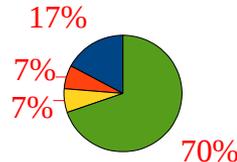
Disease, Location (23%)
No Ans (77%)



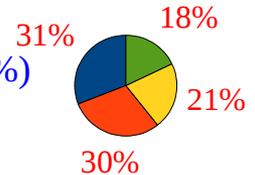
Recommendations?

localize

Give patient details (17%)
Information adequate (7%)
Other (7%)
No Answer (70%)



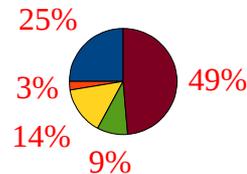
Msg layout good (31%)
Msg in local language (30%)
Other (21%)
No Ans (18%)



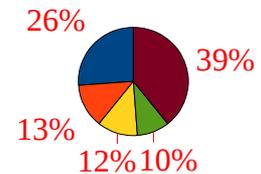
Other delivery methods

Email, Web, Voice

Email (25%)
Email & Web (3%)
Voice (14%)
Other (9%)
No Answer (49%)



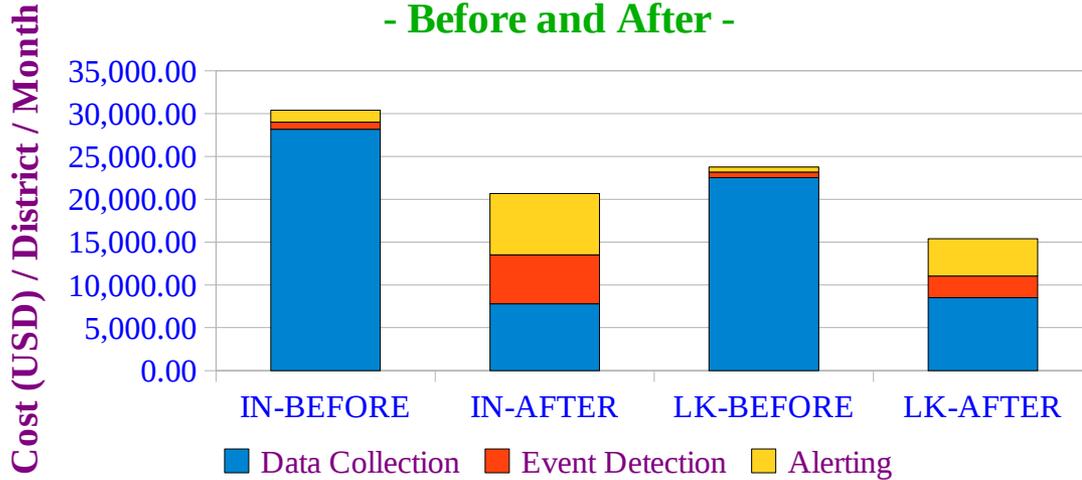
Telephone (26%)
Email (13%)
Telephone & Email (12%)
Other (10%)
No Ans (39%)



Cost benefits before and after introduction of RTBP

[BEFORE = present paper based system; AFTER = RTBP; IN = India; LK = Sri Lanka; OpEx = Operational Expenses; CapEx = Capitol Expenses]

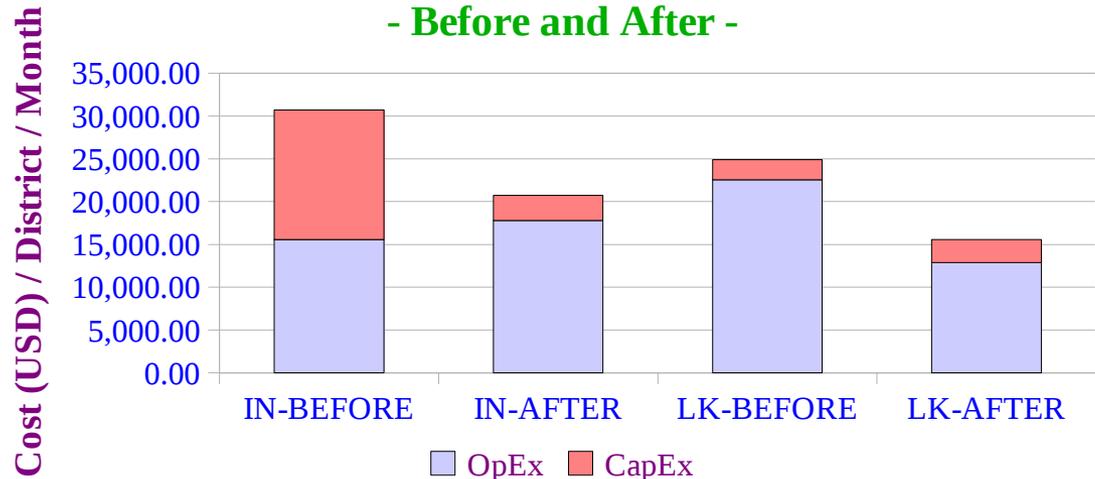
Functional component cost comparison India and Sri Lanka - Before and After -



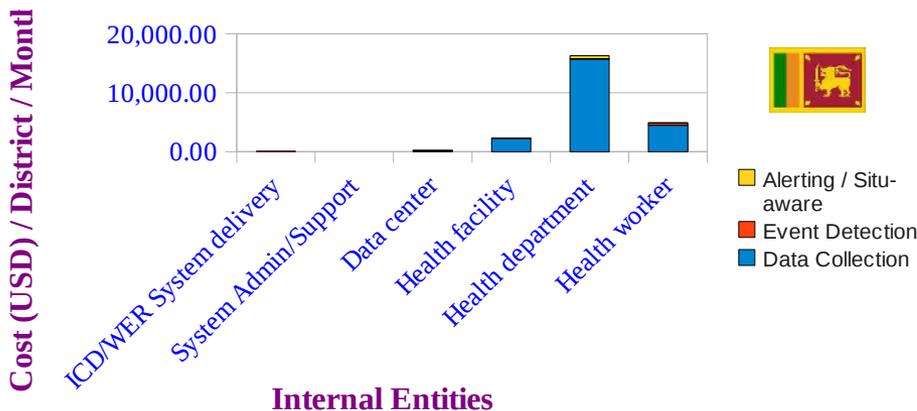
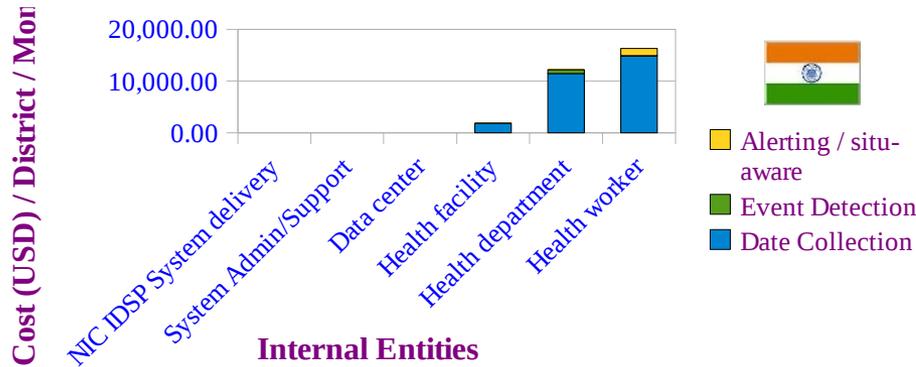
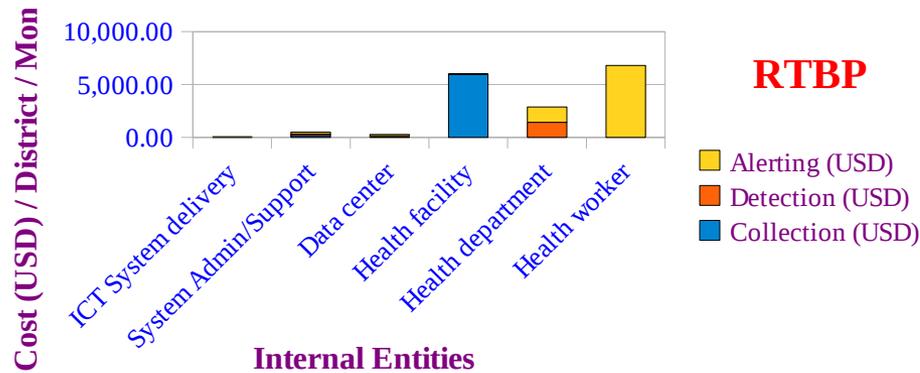
- Both India BEFORE and Sri Lanka BEFORE spend on data collection now
- For half the cost RTBP can introduce collection of a richer data set along with detection and alerting components too

- BEFORE operational expenses are the bulk of the costs
- RTBP can shrink the capitol expenses in India
- Its the filing cupboards and none ICT based delivery that eat up most of the cost

OpEx and CapEx comparison for India and Sri Lanka - Before and After -



RTBP can fix the imbalance



■ Ideally health facilities should be powered for data collection, health departments for detection and alerting, with health workers fully on response

■ India/Sri Lanka – almost zero resources on detection and mitigation

■ Sri Lanka – health departments consume bulk of the resources



Economic Efficiencies :: India



IDSP

- Report morbidity/PS-list disease: 77
US\$ 4,390.00 / disease
- Report morbidity/PS-List avg cases::600
47.00 / case
- Program for District pop: 1150753
US\$ 0.30 / inhabitant

Data Collection

- Report ALL diseases: 117
US\$ 800.00 / disease
- Report ALL cases: 6175 avg per month
1.25 / case
- Program for District pop::1150753
US\$ 0.08 / inhabitant

RTBP

- Monitor PS-list disease: 25
US\$ 402.00 / disease
- Program for District pop: 1150753
US\$ 0.01 / inhabitant

Event Detection

- Monitor ALL disease: 117
US\$ 135.00 / disease
- Program for District pop: 1150753
US\$ 0.01 / inhabitant

- Disseminate PS List disease: 25
665.00 / disease
- Program for District pop: 1150753
US\$ 0.01 / inhabitant

Alerting

- Disseminate Communicable disease: 43
US\$ 800.00 / disease
- Program for District pop: 1150753
US\$ 0.03 / inhabitant



Economic Efficiencies :: Sri Lanka

Surv & Notif

- Report Notifiable disease: 25
US\$ 10,800.00 / disease
- Report WER cases::70
321.00 / case
- Program for District pop: 1550000
US\$ 0.17 / inhabitant

Data Collection

- Report ALL diseases: 179
US\$ 570.00 / disease
- Report ALL cases: 22835 avg per month
0.37 / case
- Program for District pop::1550000
US\$ 0.07 / inhabitant

RTBP

Event Detection

- Monitor Notifiable disease: 25
US\$ 311.00 / disease
- Program for District pop: 1550000
US\$ 0.01 / inhabitant

- Monitor ALL disease: 179
US\$ 54.00 / disease
- Program for District pop: 15500
US\$ 0.01 / inhabitant

Alerting

- Disseminate PS List disease: 25
285.00 / disease
- Program for District pop: 1150753
US\$ 0.01 / inhabitant

- Disseminate Communicable disease: 49
US\$ 633.00 / disease
- Program for District pop: 1150753
US\$ 0.03 / inhabitant

Conclusions

- ❑ **mhealthSurvey** is a worthy candidate for patient disease/syndrome digitization; however, must be robust to **minimize the noise and delays**; need a better GUI if Medical Officers are to enter high volume real-time data opposed to a data entry clerk
- ❑ Need a complete and comprehensive standardized disease syndrome **ONTOLOGY** perhaps a **hybrid of SNOMED-CT and LOINC**
- ❑ **T-Cube false alarm rates** must be minimized through the iterative enhancement and machine learning
- ❑ **Sahana CAP Broker** SMS, Email, and Web messaging has proven to be a winner for real-time adverse health event information dissemination but **need Voice** as well
- ❑ Although the value is seen in **T-Cube Web Interface** and **CAP/EDXL Messaging** The **policies must be reformed** to go beyond the century old paper based system to using ICT based event detection and alerting/situational-awareness
- ❑ There should not be any institutional fears arising from the cost reductions instigated by the introduction of ICTs (e.g. RTBP) as is will still require the same work force
- ❑ Before the **cost benefits** can take affect the **laws and regulations must be changed to remove the paper and the storage** cupboards that are government mandates



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m-Health can strip 10kgs off the Village Health Nurses
Written by Nuwan Waidyanatha on February 20, 2010 1 Comment



The village Health Nurse (VHN) is a rural level primary health care worker – duties range from holding medical camps in schools to running a Health Services Centre (HSC) in the village providing primary health care to walking door-to-door providing antenatal and post natal care. These mobile services require prompt documentation; the paper work is later converted to statistics that is reviewed by the district and state Health Officials. An idea Sir Gee is to replace the 2 heavy bags with a 100gram mobile phone with built in applets to capture the same data.

The Real Time Biosurveillance Program, an mHealth pilot carried out by Indian Institute of Technology Madras's [Biosurveillance](#)

