

# EVALUATION OF AN INFORMATION COMMUNICATION TECHNOLOGY PILOT IN SUPPORT OF PUBLIC HEALTH IN SOUTH ASIA

*- REAL-TIME BIOSURVEILLANCE PROGRAM -*

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\*LIRNEasia is a REGIONAL INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) POLICY AND REGULATION THINK TANK ACTIVE ACROSS THE ASIA PACIFIC. TO THAT END, LIRNEasia ENDEAVORS TO CATALYZE THE TRANSFORMATION OF GOVERNANCE AND REGULATION OF ICTs IN THE EMERGING ASIA PACIFIC REGION FROM OBSTRUCTIVE, INHIBITING REGIMES, INTO ONES THAT WILL ALLOW OPPORTUNITIES FOR PEOPLE TO USE ICTs IN WAYS THAT WILL IMPROVE THEIR LIVES. OUR IMMEDIATE PRIORITY IS BUILDING A TEAM OF ASIA PACIFIC ICT POLICY AND REGULATORY PROFESSIONALS THAT CAN WORK ON EQUAL TERMS WITH THE BEST IN THE WORLD.

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# 1 ABSTRACT

The Real-Time Biosurveillance Program (RTBP) was a multi-partner initiative to study the potential for new Information and Communication Technologies (ICTs) to improve early detection and notification of disease outbreaks in selected regions of Sri Lanka and India. Experts in the field of biosurveillance and health informatics have argued that improvements in disease detection and notification can be achieved by introducing more efficient means of gathering, analyzing, and reporting on data from multiple locations. New ICTs are regarded as an important means to achieve these efficiency gains. The primary research objective of RTBP was to examine these claims more closely by producing evidence to indicate in what ways and to what extent the introduction of new ICTs might achieve efficiency gains when integrated with existing disease surveillance and detection systems.

Under the current disease surveillance systems in Sri Lanka and India, patient data from regional and community health centers continues to be gathered largely through paper-based forms and procedures. These forms are then sent to regional health officials where data analysis is carried out by qualified staff to identify potential disease outbreaks. Notifications are then issued from the regional health administrations to local authorities, again using paper-based reporting methods.

The RTBP substituted or complemented each of these existing procedures with ICT-based components. Patient records were gathered using software application implemented on mobile phones and transmitted to a central server using commercial cellular data services. Patient data were drawn from the central server and its statistical analysis for any significant trends that might be indicative of emerging threat to public health was carried out using advanced software developed by Carnegie Mellon University's Auton Lab. Results were then made available to regional and local health officials as electronic notifications accessible through a variety of devices, including mobile phones.

The project achieved a number of key objectives at the outset, including the development of a Java-based application for collecting patient data using low cost mobile phones; the successful implementation of Auton Lab's analytic software and T-Cube Web Interface for analyzing patient records and near real-time prediction of disease outbreaks; and the adoption and implementation of Common Alerting Protocol for multi-channel health alerting. Moreover, the project team successfully integrated each of these three key components into an operational system that collected individual patient records, over 330,000 in Sri Lanka and over 130,000 in India, over a 15 month course of study. Over the life of the project, the system identified over a dozen instances of potential disease outbreaks, with four of those (Chicken Pox, Acute Diarrheal Disease, Respiratory Tract Infection, and Mumps) being confirmed by health authorities. The project demonstrated that new ICTs can dramatically reduce turnaround time for outbreak detection and alerting, from current period of weeks to a matter of days or even hours. The project also demonstrated the feasibility of using low cost mobile phones and existing commercial cellular infrastructure and services to enable affordable, real-time reporting of patient records from frontline health centers.

The project also identified a number of existing and ongoing challenges with the implementation of each of the components of the RTBP. It was found, for example, that the standard mobile phone numeric key pad is not the most efficient means of digitizing patient records. Frontline health workers

found it difficult to use, particularly when entering large numbers of records. Many records entered into the system also contained errors that could likely be eliminated through improved user interface design and application on the mobile phone. Future research in this area should investigate innovative data entry methods such as optical character recognition, quick response (QR) codes, or touch screen interfaces in order to optimize efficiency and accuracy of data entry at frontline health centers, with the consideration that such methods are suited to implementation on low cost devices, as well as study the utility of post-collection data analyses tailored to detect entries suspicious of human error, to enable scalable and agile data quality assurance

The utility of the T-Cube Web Interface detection analyses proved to be more than simply detecting disease outbreaks. Health officials involved with the project indicated that it could be a useful tool to support long term planning and allocation of health resources as well as identifying its ability to monitor a wide range of health concerns that affect regional and national health planning. The project realized that the reliability of detection analyses was predominantly affected by the low quality data that is a consequence of the doctors' bias in preliminary diagnosis and inconsistencies in the terminology. In addition, to become widely accepted, the tools must be compatible with pre-existing processes and with the intuition of the expert users. Achieving this goal required a few iterations. Health officials who have been using TCWI, had initially been offered a generic user interface with programmable statistics and queries, and they found it relatively difficult to use, given that they did not have a strong background in statistics and were technically poor in operating the tool with training typically involving a couple of iterations of 4 hours each time. Thereafter, the designers customized the TCWI eliminating the underlying complexities and simplifying execution of majority of usage scenarios often to just a click of a button. This approach proved to be effective. Experience from working with health officials suggests that future implementations of TCWI will need to be customized to the individual implementation with the health department's requirements and a more rigorous training and certification program would need to be developed and introduced for senior health officials to ensure its effective use for disease surveillance. The licensing cost of TCWI may seem relatively high when accounted for a handful of users. However, is less than 5% of the entire RTBP total cost of ownership when compared with national level implementations, and the attainable benefits in timeliness and accuracy of disease outbreak detection and identification grossly outweigh the acquisition and maintenance costs. It should be noted that TCWI has not only been found useful in its primary area of application – detection and characterization of emerging diseases. We have shown its utility in monitoring dynamics of chronic conditions such as diabetes or high blood pressure, in resource allocation planning, and we identified opportunities in other areas such as agriculture. Future work on TCWI should explore those opportunities, as well as target configurability and usability of the tool perhaps, among other means, with the use of machine learning to incorporate user feedback in learning improved event detection models throughout the system lifetime.

Downstream alerting of health knowledge in relation to adverse events, with field health workers, is almost nonexistent in the current practices of both countries. To fill this gap RTBP was successful in developing and testing a health alerting component using the Sahana Alerting Broker. Sahana is a Free and Open Source Software (FOSS) collection of disaster management modules that work as a platform for integrating multi-organization response efforts in providing critical information to communication needs of the responders.

A series of staged tests revealed that alerting messages could be sent to frontline health care workers by means of mobile phone or email, as well as other means as necessary. Message protocols used Common Alerting Protocol with a specific adaptation of that standard based on a protocol used by US Centres for Disease Control for health alerting. Our research also discovered that the alerting component was being used by health officials to meet other messaging requirements in order to improve efficiencies in routine operations. This finding suggests the potential value of introducing a more general purpose health notification system using mobile phone text messaging. Future research in health alerting and notification should examine possibilities for integrating a national system with regional or international alert systems in order to enable timely notification of concerns across borders in the region.

In terms of institutional support for the RTBP, the project faced various challenges in both Sri Lanka and India. Much of the initial support came from the assistance of the community-based organization Sarvodaya. However, with early demonstration of success, government health officials in Sri Lanka increasingly began to show support for the project. For example, the Sri Lankan Health Ministry has secured internal resources and private partnerships to expand the RTBP into two districts in order to examine the scalability of the system in anticipation of further expanding it to a national scale. While the State of Tamil Nadu government in India was an early adopter and supporter of the project, its ongoing interest in the project going forward is uncertain.

Overall results from our work demonstrate the feasibility of introducing an RTBP from a technical and operational standpoint. Initial findings show significant efficiency gains in terms of disease reporting, outbreak detection, and health alerting; with cost savings over 35% in both countries when compared to the existing systems. However, further research is needed to better understand the challenges associated with scaling such a system up to a regional or national level of implementation. In particular, further work needs to be done to optimize data entry over low cost mobile devices, to address usability and training requirements for the analytics platform, and to continue to enhance and integrate health alerting into national and regional systems and practices. Moreover, extensive stakeholder consultation will be necessary to ensure the various policy, legal, and operational implications of a national or regional RTBP are better understood, addressed, and effectively managed in the future.

### **1.1 Keywords**

public health, epidemiological surveillance, mobile phones, statistical data mining algorithms, spatio-temporal visualization tools, common alerting protocol, policy research

## **2 RESEARCH PROBLEM**

**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?”*

The existing disease surveillance and notification systems in India and Sri Lanka were introduced a century back but were revised over time, prompted by the emergence of epidemics such as yellow fever, SARS, and H1NI. The two countries' emphasis is on monitoring around twenty-five reportable

infectious diseases (termed notifiable diseases). This legal requirement is a slow and labor-intensive process that sees several weeks pass before epidemiologists receive aggregates of this handful of diseases for any kind of analysis (Appendix A section 10.3.2). The limitations have led to human and socio-economic losses: Leptospirosis outbreak in Sri Lanka<sup>1</sup>, Chikungunya in Tamil Nadu<sup>2</sup>, and chronic kidney disease<sup>3</sup>. An unusual number of patients presenting with similar symptoms concentrated in a particular geographic areas could have signaled epidemiologists of an abnormal event and may have effectively mitigated their consequences. In addition, lifestyle or non-infectious diseases like diabetes, hypertension, asthma, and arthritis are affecting national health budgets and loss of household productivity in developing countries (Sampath et al, 2010).

There are already significant indications of disease burden occurring in the world as a result of climate change and population increase; there are many causative factors including infective agents like bacteria and viruses. What would happen if these microorganisms mutated and reappeared in a different form in India or Sri Lanka? The disease could be carried into the country by two individuals who arrive from overseas but live in two different parts of the country. Is the present system able to distinctly identify the outliers with possibly similar symptoms reported by two different healthcare workers in the different areas? If not, then it is important that the infected cases with similar symptoms be centrally detected immediately before a mass contamination and spreading takes place.

Another significant risk factor that needs attention is the emergence of novel and pandemic viruses; the frequent travel/migration of people to and from the areas which are currently affected by the influenza, known to be highly virulent and mutable viruses. To add to the complexity the symptoms (fever, cough, respiratory tract infection, and pain) may be common enough to be considered unimportant and be neglected in tropical habitats. However, an unusual increase in a geographic area is alarming to epidemiologists. Certainly, a human being does not have the capacity or diligence to search through all the hospital information strings to identify clusters of similar patterns in spatially distributed data sets.

Statistical analysis of large datasets is time-consuming. A surveillance system must be ready to detect changes in complex, multivariate data very quickly (ideally, in real-time), while maintaining the ability to test a huge number of hypotheses regarding geospatial co-locations, temporal correlations of the individual cases and their demographic characteristics, in order to detect a possible outbreak. That requires advanced algorithms for detection of abnormal patterns, which would efficiently handle large sets of multivariate data and effectively signal statistically significant departures from the expected. Advances in algorithms, data structures and artificial intelligence allow for practical applications of data-driven outbreak detection methods that can handle the complexity of the task at hand by learning from examples in historical data and from real or simulated outbreaks recorded in it<sup>4</sup>.

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<sup>1</sup>Agampodi, S., Somaratne, P., Priyantha, M., Peter, M. (2008). An interim report of Leptospirosis outbreak in Sri Lanka – 2008, publication of the Epidemiology Unit of Sri Lanka.

<sup>2</sup>Ganesan, M., Prashant, S., Janakiraman, N., and Waidyanatha, N., (2010), Real-time Biosurveillance Program: Field Experiences from Tamil Nadu, India. Health, Poverty and Human Development, Indian Association for Social Sciences and Health (IASSH) (in press)

<sup>3</sup>Siriwardana, C. (2008, August 12). Sri Lanka Kidney disease epidemic leaves doctors baffled, world wide web news article, Science and Development Network.

<sup>4</sup>Neil, D. and Moore, A. (2006). “Methods for Detecting Spatial and Spatio-Temporal Clusters”, In Handbook of Biosurveillance, M. Wagner, A. Moore, and R. Aryel, Eds. London: Elsevier Academic Press, 2006, pp. 243-254.

Socio-economists see that the key problem is not software but accurate and timely entry of data by healthcare workers. Therefore, the project had extended the user interfacing to the last-mile by using cellular networks that span the nation as opposed to waiting for broadband connectivity to be widely available. The belief is that the introduction of Wireless Local Loop (WLL) applications, as opposed to traditional computer desktop applications with broadband connections, will increase the likelihood of early detection and warning of communicable diseases; the demand-side ICT market study “Teleuse on a Shoestring<sup>5</sup>” reveals that coverage of the WLL market is far beyond that of the fixed line market in India and Sri Lanka. It is hoped that adopting data acquisition software applications that work on mobile phones will reduce the latencies in communicating epidemiological information.

In both countries, the current paper-based system does not feed the infectious disease information to central processing in a timely manner. It is evident from the Weekly Epidemiology Report (WER) published by the epidemiology unit in Colombo that reporting is lagging by 3-4 weeks. The lag is not caused by the time taken to edit the information to fit the template, but rather because the Integrated Disease Control Nurses in the Districts lag in processing the statistics and delivering timely information up the chain through the paper-based system. Similarly, the Integrated Disease Surveillance and Program (IDSP) manually collects data and uses spreadsheets to analyze them once again using humans who only look for weekly aggregates of known diseases and symptoms that may reach or surpass the thresholds. Investigating data a week later may not be fast enough to reveal an escalating disease burden that may have reached the tipping point.

### 3 OBJECTIVES

**“The problem that this program promised to solve was to strengthen existing disease surveillance and detection communication systems by reducing latencies in detecting and communicating disease information and set a standard interoperable protocol for disease information communication with National and International Health Organizations in the region”**

#### **List of the objectives in point form (all have been completed)**

- ✓ Deploy a human-centric mobile phone sensor system for gathering health-related information through healthcare workers from clinics and hospitals
- ✓ Train the healthcare workers to use the technology and adopt processes for submitting outpatient disease and syndrome information
- ✓ Evaluate the usability, adaptability, and effectiveness of the mobile phone-based data acquisition process
- ✓ Deploy advanced detection software algorithms such as spatio-temporal scanning, Bayesian modeling, and multivariate time series analysis for statistical data mining for State/Regional

<sup>5</sup>Zainudeen, A. and De Silva, H. (2007). Beyond Universal Access. CPRsouth: Research for improving ICT governance in the Asia-Pacific, Manila, Philippines.

#### Epidemiology Units to detect disease outbreaks

- ✓ Train the state/regional epidemiology units with the tools and processes to analyze the gathered health-related data to detect disease outbreaks in near real-time
- ✓ Evaluate the ability of the detection system to assist the national/state/regional epidemiology units with their task of discovering outbreaks ahead of time, efficiently carrying out the analysis in a timely manner, reliably predicting disease outbreaks with minimal ambiguity, and interpreting the analyzed information with zero complexity,
- ✓ Deploy a disease outbreak notification software tool for state/regional epidemiology units to use for notifying divisional and community healthcare workers of a possible disease outbreak as well as monitor the situations with feedback reports on the response actions
- ✓ Train the state/regional epidemiology units on the software tool and processes in notifying possible disease outbreak as well as instructions on protocols
- ✓ Evaluate the notification system for its usability, reliability, and effectiveness in managing communications with healthcare workers during and emerging disease outbreak emergency situation
- ✓ Disseminate the outcome of the research to policy makers, practitioners, and researchers to study the lessons learned

The overall intention of the project is to develop a complete real-time detection and warning system, comprised of four components:

1. establish the electronic communication system
2. introduce computer based detection and monitoring
3. implement the RTBP
4. evaluate the biosurveillance program

## 4 METHODOLOGY

The methodology, evaluative tools, and outcomes of the RTBP are discussed in the supplemental document titled, “An evaluation toolkit and guide for a Real-Time Biosurveillance Program” (abbreviated as *eval-toolkit-n-guide*), which will be published in an open access domain along with this technical report. Readers are encouraged to refer to the supplemental document to get an in-depth knowledge of the evaluations although this document will brief on the methodology and outcomes for the sake of completeness. There may be minor overlaps between the two documents.

### 4.1 Proposed evaluation method

The original design of the proposed RTBP research matrix was to investigate the divergence of the outcomes between groups that were exposed to the RTBP and those who were not (unexposed) as well as to cross segregate those groups to ones that were well-organized with a community health facility and those who were less organized without a community-based health facility, shown in Figure 1.

In Figure 1, ‘H’ denotes healthcare worker, and ‘C’ denotes community. The cells in magenta are the organized communities with the presence of a community-based healthcare facility (row denoted with

+ symbol) and the cells with orange background are the communities that do not have a formal community-based healthcare facility (rows denoted with a - symbol). Basically, each healthcare worker (yellow cells) will cover an organized community and a less organized community.

	Exposed to RTBP				Unexposed to RTBP			
	Division 1		Division 2		Division 3		Division 4	
+	C01	C05	C09	C13	C17	C21	C25	C29
	II01	II03	II05	II07	II09	II11	II13	II15
-	C02	C06	C10	C14	C18	C22	C26	C30
+	C03	C07	C11	C15	C19	C23	C27	C31
	H02	H04	H06	H08	H10	H12	H14	H16
-	C04	C08	C12	C16	C20	C24	C28	C32

Figure 1: Original proposed comparison-based (quasi-experimental) evaluation framework

This approach was practically unaccomplished for a few reasons:

- 1) There was no formal involvement of a community-based organization in India.
- 2) Only one epidemiological center (IDSP Unit) participated in the project in Sri Lanka, as opposed to two in India.
- 3) Resources were concentrated in proving the concept of the workability of the technology-based program.
- 4) Resources were inadequate to document subjective evidence in the villages or communities to test the hypotheses.
- 5) Complexities and expenses of practically conducting a comparison-based or quasi-experiential evaluation were too large.
- 6) Non-uniformity of utilization and services between two comparative health facilities made it difficult to normalize the evidence.
- 7) Collapse of the Sri Lankan government at the early stages caused the project to divert resources to fill the deficit of digitizing health records, which was initially anticipated to be done by government healthcare workers.

### **Hypotheses based on the original proposed research design as in Figure 1**

1. Healthcare workers in divisions 1 & 2, exposed to the RTBP, will respond more effectively in communicating disease to the respective epidemiology center than the healthcare workers in the control divisions 3 & 4, who were unexposed to the RTBP.
2. Epidemiology units in divisions 1 & 2, exposed to the RTBP, will detect disease outbreaks accurately and contain the outbreak more efficiently than epidemiology units in control divisions 3 & 4, who were unexposed to the RTBP.
3. Healthcare workers and epidemiology units in divisions 1 & 2, exposed to the RTBP, will show interest and recognize the benefits in adopting e-Health programs, as opposed to the healthcare workers and epidemiology units in the control divisions 3 & 4, who were unexposed to the RTBP.

4. Communities in divisions 1 & 2, exposed to the RTBP, will have more confidence in national disease surveillance and notification programs than the communities in the control divisions 3 & 4, who were unexposed to the RTBP.
5. Healthcare workers and epidemiology units in divisions 1 & 2, exposed to the RTBP, will, in addition to their RTBP function, leverage ICTs in other areas and thereby enrich their daily activities more than the healthcare workers and epidemiology units in the control divisions 3 & 4, who were unexposed to the RTBP.
6. Communities that have non-governmental community-based healthcare organizations will perform better in monitoring, communicating, and containing disease outbreaks than communities that do not have a formal non-governmental community-based healthcare organization.

## 4.2 *Revised evaluation method*

Nevertheless, the evaluation framework was revised to one that was objective-based (determine whether the RTBP under study met the design requirements), decision facilitation (resolve issues important to developers and administrators for individuals to make decisions about the future of the RTBP), quasi-legal (establish mock drills, exercises, certifications, and other formal adversary proceeding to judge the RTBP), professional reviews (regular site-visit approach with researchers spending time with the users in the field), and responsive (seek to represent the viewpoints of those who were users of the RTBP; to not be judgmental but be illuminated). Thus, the essence of the RTBP was a formative study aimed at producing insight as to the effectiveness of the component or subsystems and identifying potential improvements to those components (Friedman and Wyatt, 2006)<sup>6</sup>.

The overall vision and strategy for evaluating the RTBP was adopted from the literature by Ammenwerth et al (2004)<sup>7</sup>. General methods for subjective and objective quantitative and qualitative evaluation of bioinformatics systems were introduced by Friedman and Wyatt (2006). More specific to RTBP, Lewis (2003)<sup>8</sup> and Wagner (2008)<sup>9</sup> have proposed biosurveillance system and public health informatics evaluation methods with a broad set of evaluation criteria on the usability of the technology, effect on structural or process quality and social consequences of introducing the technology. Anderson and Aydin (2005)<sup>10</sup> describe methods and key aspects of qualitatively evaluating the organizational impact of introducing ICTs in healthcare. To perform the economic analyses to compare the existing paper-based system with the RTBP introduced technology system, the researchers calculated the investments, specifically as the total cost of ownership, and then analyzed the efficiency

<sup>6</sup>Friedman, C. and Wyatt, J. (2006). Evaluation methods in Bioinformatics, second edition, Health Informatics Series, Springer Science+Business Media.

<sup>7</sup>Ammenwerth, E., Jytte Brender, J., Pirkko Nykänen, P., Prokosch, H-U., Rigby, M., and Talmon, T. (2004). Visions and strategies to improve evaluation of health information systems Reflections and lessons based on the HIS-EVAL workshop in Innsbruck, International Journal of Medical Informatics, Elsevier publications, Vol. 73, pp 479-491.

<sup>8</sup>Lewis, D. (2008) Evaluation of Public Health Informatics. Public Health Informatics and Information Systems (eds O'Carroll, P., Yasnoff, W., Ward, M., and Ripp, L), Health Informatics Series, pp 239-266.

<sup>9</sup>Wagner, M. (2008). Methods for testing Biosurveillance systems, Handbook of Biosurveillance (eds. Wagner, M., Moore, M., and Aryel, R.), pp 507-515, Elsevier academic press.

<sup>10</sup>Anderson, J. and Aydin, C. (2005). Evaluating the organizational impact in healthcare information systems, Second edition, Health Informatics Series, Springer Science +Business Media.

gains, cost benefits, cost effectiveness ratios, and one-sided sensitivity.

The abstract technology design of the RTBP was an integral of data collection, event detection, and alerting functional components. The evaluation framework (Figure 2) for field-testing of biosurveillance systems examined the attributes of the system or system functional components that were further divided into four general categories:

- *Institution* challenges (e.g., healthcare workers, health officials, epidemiologists, policy makers),
- *Content* standards (e.g., ontologies, semantics, syntax, vocabulary, data-standards),
- *Application* or computing resources (e.g., mobile applications, detection analytics software, databases)
- *Technology* (e.g., mobile devices, computers, servers, modems, wireless links, Internet connections, cellular networks).

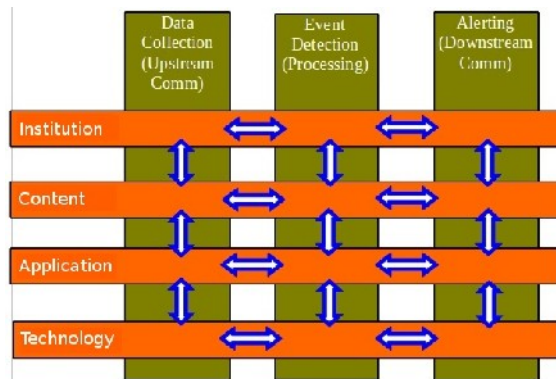


Figure 2: Functional components, evaluated layers, and interoperating elements of the RTBP framework

The arrows between the vertical functional components and horizontal evaluation layers depict the interconnection (or interoperability) between the respective elements. The micro-level research questions and methods for evaluation were subdivided into those that were based upon calculations, interviews/questionnaires, and observations. The methodology in sections 6, 7, & 8 of the eval-toolkit-n-guide elaborates on the specifics.

The healthcare workers, health officials, other staff, and community-based organization members that were involved in evaluating the RTBP (all participants were exposed to the RTBP) are as follows -

**Kurunegala District, Sri Lanka:** Four Medical Officer of Health (MOH) divisions--Wariyapola, Udubeddewa, Pannala, and Kuliyaipitiya-- belonging to the Kurunegala health administrative district with each MOH division covering an average population of 500,000 are the autonomous departments responsible for public health surveillance and response in their division; 15 Sarvodaya Suwadana Center volunteers were recruited by the project, in the capacity of research assistants to digitize the patient data at hospitals and assist with other project activities. The 15 research assistants were assigned to 12 hospitals for gathering outpatient data. Public Health Inspectors (PHIs), Personal Program Assistants (PPAs), and Medical Officers of Health (MOH) acted in the capacity of health officials and authorities engaged in assessing the event detection and alerting tools. In addition, the Kurunegala Regional epidemiology unit and the Wayamba Province director of health services departments assisted in the planning, policy and decision process of the RTBP.

**Sivaganga District, India:** Four Primary Health Centers (PHC) in the Thirupathur block—Nerkuppai (Block PHC), Sevani Patti (Additional PHC), Keelasevalpatty (Additional PHC), Thirukostiyur (Additional PHC)—covering an average population of 500,000, have two primary responsibilities – 1) provide primary level healthcare, and 2) administer the Health Sub Centers (HSC) and affiliated village

health nurses (VHNs). Twenty-four VHNs were involved in submitting disease health records of patients seeking care at their respective HSCs. Two data-entry assistants were recruited to digitize outpatient health records from Nerkupai and Keelasevalpatty PHCs while the sector health nurses (SHNs) of the Thirukostiyur and Sevanipatti PHCs digitized outpatient records. The SHNs and Public Health Inspectors of the PHCs acted in the capacity of health officials for the purpose of evaluating the detection and alerting tools; also, the deputy director of Health Services associated Integrated Disease Surveillance (IDSP) staff participated in assessing the detection and alerting tools. The deputy director of health services, district health educator, and chief entomologist engaged in the planning, policy, and decision process in relation to the RTBP.

## 5 PROJECT ACTIVITIES

Table 1: Activities and description (implementation and management) with timeliness

Task	Notes	Begin End Dates
<u>Project Pre-Launch</u>	<i>Activities before launching the project</i>	
<i>Hold a Partner Meeting</i>	Two-day workshop was organized and hosted by Indian Institute of Technology Madras's Rural Technology and Business Incubator (IITM's RTBI). All partners presented their role in the project, then agreed on the work plan and deliverables  blog, work plan, presentations, and report - <a href="http://irneasia.net/2008/08/rtbp-partner-meeting-repot/">http://irneasia.net/2008/08/rtbp-partner-meeting-repot/</a>	B: 2008-Jul-11  E: 2008-Aug-06
<i>Recruit Research Assistants</i>	The post for a research assistant (RA) was advertised and then recruited a B.Sc. Science graduate in India and B.Sc. Biology graduate in Sri Lanka. The Indian RA resigned in April 2009 and was immediately replaced with an available staff member in RTBI: PhD graduate in Agriculture. The Sri Lankan RA resigned in January 2010; the post was re-advertised and recruited a pre-intern medical doctor in March 2010.	B: 2008-Jul-11  E: 2008-Oct-01
<i>Select Divisional Health Areas, Healthcare Worker Personnel, and Communities</i>	The individual principal investigators consulted with the local health authorities to decide on the pilot districts: India: Sivaganga and Sri Lanka: Kurunegala; the areas were selected based on RTBI and Sarvodaya's prior experience working in those districts. Four Primary Health Centers and 24 Health Sub Centers in India and Four medical officers of health divisions with twelve hospitals in Sri Lanka were chosen. India: Village Health Nurses and Sector Health Nurses were the resource engaging in the health record digitization with the Integrated Disease Surveillance Program staff engaging in detection analysis and alerting; Sri Lanka: Sarvodaya Suwadana Center recruits engaged	B: 2008-Sep-01  E: 2008-Nov-01

Task	Notes	Begin End Dates
	in the digitizing of health records and Medical Officer of Health department and regional epidemiology unit engaged in the detection analysis and alerting components.	
<i>Procure RA Equipment</i>	Quotations were taken for laptops and mobile phones, then purchased for use by the RAs	B: 2008-Oct-01 E: 2008-Nov-31
<u><i>Design System</i></u>	<i>Understand the local environment and collect system requirements</i>	
<i>Write Software Requirement specifications</i>	IITM's RTBI, CMU's Auton Lab, UoA/LIRNEasia/Respere wrote the SRS; given that the innovation was not clear to the technology developers, the actual software had to be developed and tested to understand the scope through a practical hands-on experience; for example, the TCWI SRS could not be written until Auton Lab had a clear idea of the data that was collected (attributes and frequency)  User Requirement Specifications (Appendix B): <a href="http://lirneasia.net/2009/02/rtbp-urs-v1/">http://lirneasia.net/2009/02/rtbp-urs-v1/</a>	B: 2008-Sep-01 E: 2009-Jun-2009
<i>Demo Prototype</i>	The mHealthSurvey mobile application was first demonstrated in November 2008 to the health workers in India; feedback was incorporated; it was demonstrated to the Sri Lankan data entry operators and health departments in April 2009.  India demo blog: <a href="http://lirneasia.net/2009/02/m-health-strip-10kgs-vhn/">http://lirneasia.net/2009/02/m-health-strip-10kgs-vhn/</a>  The doctrine on the TCWI was presented to the RTBP team by Auton Lab, which included an introduction to the statistical testing methods; one day workshop was held at Sarvodaya HQ, Moratuwa, Sri Lanka  T-Cube demo: <a href="http://lirneasia.net/2009/04/analytics-training-rtbp/">http://lirneasia.net/2009/04/analytics-training-rtbp/</a>	B: 2008-Nov-01 E: 2009-Apr-10
<i>Organize Healthcare Worker Planning Workshop</i>	Workshops were conducted in Indian and Sri Lanka with the health workers and health officials in the respective district; a short questionnaire was conducted to understand the demographics of the pilot locations  Sri Lanka workshop <a href="http://lirneasia.net/2008/10/rtbp-lk-plan-workshop/">http://lirneasia.net/2008/10/rtbp-lk-plan-workshop/</a>  India workshop: <a href="http://lirneasia.net/2009/02/vhn-mobile-voice/">http://lirneasia.net/2009/02/vhn-mobile-voice/</a>	B: 2008-Oct-01 E: 2008-Nov-25

Task	Notes	Begin End Dates
<i>Release Beta</i>	<i>The first release of the working system for internal testing</i>	
<i>Develop beta Release</i>	<p>The first release of the mHealthSurvey was in Nov 2008 but required several modifications; the working solution was ready in April 2009.</p> <p>The TCWI first release was with the replication study conducted in March 2009. The beta implementation was in June 2009.</p> <p>SABRO first release was in August 2009 and was tested by the research team</p>	<p>B: 2008-Nov-01</p> <p>E: 2009-Aug-31</p>
<i>Procure System Equipment</i>	The teams in India and Sri Lanka obtained quotations for the suitable mobile phones, servers, and Global System for Mobile (GSM) Communications modems. The equipment was purchased in April in time to install and configure the hardware for the implementations and training.	<p>B: 2009-Jan-01</p> <p>E: 2009-Mar-31</p>
<i>Training</i>	<i>Healthcare Worker and Epidemiology Unit training</i>	
<i>Prepare Training Manuals and Operational guidelines</i>	<p>The technology partners: RTBI, Auton Lab, and Respere develop comprehensive user manuals (see Appendix C Sections 12.1 – 12.3)</p> <p>LIRNEasia, RTBI, and UoA developed a series of standard operating procedure guides for the three components: data collection, event detection, and alerting (see Appendix C Sections 12.9 – 12.11)</p> <p>SOP: <a href="http://lirneasia.net/2009/12/rtbp-sop-v0-3/">http://lirneasia.net/2009/12/rtbp-sop-v0-3/</a></p>	<p>B: 2009-Apr-01</p> <p>E: 31-Oct-2009</p>
<i>Organize Healthcare Worker Training Workshop</i>	<p>mHealthSurvey training workshops was conducted in Karaikudi, Tamil Nadu with 29 healthcare workers and five health officials; members from LIRNEasia and RTBI conducted the training, report: <a href="http://lirneasia.net/2009/05/vhn-training/">http://lirneasia.net/2009/05/vhn-training/</a></p> <p>mHealthSurvey training was conducted with 16 Suwacevo and four divisional coordinators at the Sarvodaya Kurunegala district office, members from RTBI and LIRNEasia conducted the training, report: <a href="http://lirneasia.net/2009/05/lk-healthworker-training/">http://lirneasia.net/2009/05/lk-healthworker-training/</a></p> <p>mHealthSurvey users were given follow up training with individuals and in small groups as and when required</p> <p>LIRNEasia and RTBI conducted the first training of TCWI and SABRO in India and Sri Lanka in October 2009. This was</p>	<p>S: 2009-May-01</p> <p>E: 2010-Apr-30</p>

Task	Notes	Begin End Dates
	<p>introductory and intended only to get the users to start testing the software. A more detailed training of TCWI followed in December 2009 and January 2010 that was conducted by Auton Lab; report: <a href="http://lirneasia.net/2009/05/autonlab-april-visit/">http://lirneasia.net/2009/05/autonlab-april-visit/</a></p> <p>A second round of training on SABRO with the health officials was conducted in March 2010 before evaluating the alerting component. This was simultaneously carried out by LIRNEasia and RTBI in Kurunegala and Sivaganga districts, respectively; reports: <a href="http://lirneasia.net/2010/04/rtbp-kuru-alert-exer/">http://lirneasia.net/2010/04/rtbp-kuru-alert-exer/</a></p>	
<i>Activation</i>	<i>Finalize all system components of RTBP</i>	
<i>Deploy final release of ICT system</i>	mHealthSurvey, TCWI, and SABRO went through several iterations of modifications as the researchers and developers came to learn the shortcomings as well as the users requesting changes once they had some hands on experience with the tools.	B: 2009-Jun-31 E: 2010-Mar-20
<i>Conduct Interoperability Testing</i>	Project could not complete this task. One reason was the SABRO software took longer than anticipated to mature. Second reason was the users were not as competent with CAP as the investigators had anticipated.	
<i>Commission System for evaluation stage</i>	The acceptable working technology solution, conducting of training, and introduction to standard operating procedures was completed by November 2009. However, there are shortcomings that required fixing. The researchers determined that the workable components could be commissioned for the sake of the pilot test.	B: 2009-Nov-01 E: 2009-Nov-20
<i>Evaluation</i>	<i>Running of mock-drills over a 1 year period</i>	
<i>Plan simulation evaluation activities</i>	The evaluation activities began with the mHealthSurvey certification exercise in early July 2009. The evaluations were conducted over 18 months. The planning of the events was done in stages; i.e. each time an exercise was completed the next set of evaluation exercises were planned. The final subjective evaluation exercise was the assessing the alerting component, which ended in June 2010.	B: 2009-Jul-01 E: 2010-Mar-31
<i>Design RTBP Evaluation Toolkit</i>	At the early stages of planning the evaluations, the researchers carried out literature surveys and discussions to decide on the achievable and sufficient evaluations. These methods were document in the Evaluation guidelines: <a href="http://lirneasia.net/2009/10/rtbp-eval-guide/">http://lirneasia.net/2009/10/rtbp-eval-guide/</a> . The eval-toolkit-n-guide is an extension of this document, which includes the results	B: 2009-Apr-01 E: 2010-Mar-31

Task	Notes	Begin End Dates
	and methodology.	
<i>Organize simulations planning workshop</i>	Evaluation planning workshops were held in India and Sri Lanka involving all project stakeholders. Participants range from health officials, health workers, and community-based organization members; report: <a href="http://lirneasia.net/2010/01/eval-plan-workshop-beauty-of-rtbp/">http://lirneasia.net/2010/01/eval-plan-workshop-beauty-of-rtbp/</a>	B: 2009-Dec-01 E: 2010-Jan-31
<i>Hold a Public Lecture</i>	India public lecture was planned to be held at the IITM's RTBI Research Park in conjunction with the interim findings meeting and media events. Dr. Shariq Khoja (Aga Khan University, Pakistan) could not travel to deliver the lecture because he could not obtain the visa.  Sri Lanka public lecture was delivered by Dr. Angelo Ramos (Molave Development Foundation, Inc. Philippines). It was held at the Sri Lanka Medical Association; report:	B: 2010-May-01 E: 2010-Sep-31
<i>Run simulated exercises</i>	Data collection (mHealthSurvey): calculated the timeliness, data quality, and miscoding errors; assessed the self-intuitiveness and usability through a certification exercise; interviews and group discussions to realize the acceptability and improvements; economic analysis mHealthSurvey certification exercise report: <a href="http://lirneasia.net/2009/06/gow-visit-june-2009/">http://lirneasia.net/2009/06/gow-visit-june-2009/</a> Reports: <a href="http://lirneasia.net/2009/10/rtbp-cert-exer-young-old/">http://lirneasia.net/2009/10/rtbp-cert-exer-young-old/</a> Event detection (T-Cube Web Interface): interviews and group discussions to realize the policy and procedures; replication study to assess the functionality; cohort study to realize the utility and reliability; simulation to assess the usability; technology acceptance assessment to evaluate the usefulness, perceived ease of use, behavioral interaction, attitude towards using, and psychological attachment; economic analysis Alerting (Sahana Alerting Broker): <a href="http://lirneasia.net/2010/04/rtbp-kuru-alert-exer/">http://lirneasia.net/2010/04/rtbp-kuru-alert-exer/</a>	
<i>Analysis</i>	<i>Assess the results and discuss the findings</i>	
<i>Discuss research findings at a workshop in each country</i>	India interim findings workshop took place at the IITM's Research Park, which brought together selected field health workers, health officials, and staff from Sivagana district as well as the RTBP team members from India, Sri Lanka, and USA; report: <a href="http://lirneasia.net/2010/07/rtbp-in-news/">http://lirneasia.net/2010/07/rtbp-in-news/</a>  Sri Lanka interim findings workshop took place in Kurunegala district at the Blue Skyp Hotel, with Provincial Director,	B: 2010-Apr-01 E: 2010-June-15

Task	Notes	Begin End Dates
	Provincial Staff, chief Medical Officers, Public Health Inspectors, Sarvodaya Suwacevo, RTBP researchers from Sri Lanka and India; report: <a href="http://lirneasia.net/2010/07/rtbp-lk-findings/">http://lirneasia.net/2010/07/rtbp-lk-findings/</a>	
<i>Comparison Research Meeting</i>	The comparison research findings meeting took place in Negambo, Sri Lanka, which involved all project partners, mainly researchers. The one-day workshop discussed and finalized the research outcomes as well as formalized the recommendations that would lead to the next cycle of research.	B: 2010-Aug-01 E: 2010-Sep-15
<i>Final Report</i>	Final Technical Report would have been due in July 2010; however with the extension of the project it was rescheduled for delivery on 31-December-2010	B: 2010-Dec-10 E: 2011-Jan-02
<u><i>Research Disseminations</i></u> <i>Publications to be produced by Researchers on the topics below</i>		
<i>Epidemiology Policy</i>	Sections 6.7 – 6.10 outline all the policy briefs, publications and proceedings produced through the project, which address all other the topics listed.	B: 2009-Apr-01 E: 2010-Dec-31
<i>Epidemiology e-Health Programs</i>		
<i>Interoperability in Epidemiology through e-Health</i>		
<i>E-Health RTBP Implementation challenges</i>		
<i>Outcome of the RTBP in India and Sri Lanka</i>		

## 6 PROJECT OUTPUTS

### 6.1 User Requirements Specification (URS)

The RTBP is based on the concept of a *closed system*; system with feedback and error correction. The input to the system are simple environmental attributes, which are features such as the season and the day of week that cause trends in the data, and response attributes, which are the remaining features such as syndrome, diagnosis, gender, and age. The output generated by the system is detections of

possible disease outbreaks or patterns of adverse events. The feedback loop for error correction is the intervention and prevention actions to minimize the health risks.

The User requirement derived follow from the close analysis of the existing disease surveillance and notification systems in both Sri Lanka and Indian. First, we introduced the key actors, their roles, and the functionality required for the purpose of data collection, analysis, and alerting. Secondly, we introduced the minimal set of attributes required to attain the system requirements for collection of health data, analysis of outbreaks, and sharing health risk information.

Based on the initial analysis, an *axiomatic design framework*<sup>11</sup> was applied to identify the customer attribute, functional requirements, and design parameters of the proposed ICT system. This is an objective study aiming to ensure the time independent complexities are eliminated (see Appendix A).

Following the preliminary design and analysis of the business we collaborated with the users (health workers, health officials, and decision makers) in a top-down bottom-up approach (Gadomski et al 1998) to develop the URS document (see Appendix A).

## **6.2 Software Requirement Specifications (SRS)**

The technology developers used the URS as a guide along with further interactions with the researchers and end-users to develop the individual SRS documents for the – mobile health data collection software, biosurveillance module database with implementation Graphic User Interfaces, statistical data mining algorithms with visualization tools for event detection, and extending the Sahana Alerting Broker with Common Alerting Protocol data standard for issuing SMS, Email, and Web text alerts.

Each of the SRS went through a series of revisions throughout the development life cycle. It was difficult for the users to conceptualize the software deliverables and as a result changes were requested after they had the opportunity to test the tangible software executables. The project also made some changes to the software developments after the users were operating the applications and the researchers/developers realized the unforeseen shortcoming. Appendix B carries the latest version of all the SRS documents for each of the components.

## **6.3 Technology Products**

The sections below give a brief less technical description of the software components for data collection, data warehousing, event detection, and alerting that are referred to as the mHealthSurvey mobile application, Biosurveillance Module, T-Cube Web Interface, and Sahana Alerting Broker, throughout this document.

### **6.3.1 mHealthSurvey**

The mHealthSurvey mobile health software is a Java 2 Micro Edition (J2ME) application that works on

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<sup>11</sup>Suh, Nam (2005). Complexity Theory and Applications (MIT Pappalardo series in Mechanical Engineering), Oxford University Press, 2<sup>nd</sup> Edition.

any Java-enabled mobile supporting the Mobile Information Device Profile 2.0 (MIDP2.0) and Connection Limited Device Configuration 1.1 (CLDC1.1) common Java Specification Request (JSR) stack. The application was tested on Nokia 3110c/5320c, Amoi A636, Gionee v6600, Gionee v6900, Motorola, Sony Ericsson s302c.

Members of the project team recognize that more advanced platforms (e.g., Android, Linux, iPhone) are now becoming commonplace but viewed J2ME as a powerful technology relative to cost and other constraints in this setting and for the purpose of piloting the system. For example, it is widely available on low cost GSM handsets and offers a built-in consistency across products in terms of running anywhere, anytime, over most devices.

Users must first download the mHealthSurvey Java executable from the hosted server simply by pointing the mobile phones' WAP browser to the given web address. Once it is saved on the mobile phone, the continued process will prompt the user to install the application. Prior to submitting health records, the user must configure the software to adhere to their profile. This is done through the download list function, the initial function executing any of the other functions. The download list essentially retrieves all disease, symptom, and signs values along with the predefined relationships and the health worker type, location, gender, group, and clinical status predefined selectable values. The download list function is also the initial test verifying the success of the installation and the application's ability to communicate with the server and database.

The user unique health workers specific profile is registered on the mobile phone, which is used to tag the health records for accountability factors. The set of health worker assigned working area locations (clinic and hospital villages, towns, or cities) is also retrieved from the database. Thereafter, the application is ready to begin submitting digitized records.

The basic functions of the health-survey or patient record digitizing form comprises attributes such as the case date/time, health worker id, location name, gender, age-group, disease, symptoms, and signs. An additional field labeled as '*notes*' is provided for feeding any other relevant information besides content in the standard attributes. The application utilizes a search and fill method for completing the disease, symptoms, and signs as well as a method that automatically populates the related symptoms and signs when the disease is selected; thus reducing the data entry time but giving the option to add to and delete from the proposed list of symptoms and signs.

The comprehensive user manual in Appendix C Section 13.1 describes the mHealthSurvey functionality.

### **6.3.2 Sahana Biosurveillance Module (BSM)**

The mobile phone application submitted information is staged in the *Sahana*<sup>12</sup> Biosurveillance Module (BSM) relational database. The database contains a set of master tables and transaction tables. The master tables hold the knowledge base of the domain specific information that is coupled with a set of procedure to ensure that data integrity is maintained. The transaction tables hold the dynamic

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<sup>12</sup>Information on Sahana Software Foundation can be found here <http://www.sahanafoundation.org/>

information mainly received through the mHealthSurvey.

The relational database consists of a person, location, facility, services, diagnosis, and cases entities. The person tables hold information on health worker profiles and is able to hold patient identification details like their name, identification document numbers, vital statistics, etc.; location defines the geographical areas and administrative boundaries; facilities define the hospitals and clinics; services are for defining and procedures such as investigations, quarantining, laboratory testing; etc.; diagnosis holds the disease, symptom, signs, and causality relationship; cases are for saving the patient clinical health records. All the entities are related in some way with the case entity being central to all.

The mHealthSurvey interfaces with the MySQL database through a set of PHP scripts. The BSM PHP scripting architecture conforms to a Representational State Transfer full (REST-like) architecture; where data is shared between the user interfaces and database through standard HTTP POST and GET functions.

The software requirement specification in Appendix B Section 11.3.1 describes the functionality of the Sahana Biosurveillance management system.

### **6.3.3 T-Cube Web Interface (TCWI)**

T-Cube Web Interface (TCWI) tool is designed to efficiently visualize and manipulate large-scale datasets. These types of data sets are common in epidemiology. Besides executing various complex ad-hoc drill-down queries, TCWI enables a range of methods for statistical testing of multivariate temporal and spatio-temporal data. Users can manipulate and visualize data through the Time Series, Map, and Pivot Table panels.

The user may choose to apply one of the available statistical modeling and anomaly detection techniques. The list of choices includes moving average, moving sum, cumulative-sum, temporal scan, change scan, linear trend, peak analysis and range analysis. The users can interactively manipulate, navigate, summarize and visualize data at interactive speeds. That supports focused investigations, drill-downs as well as summarizing and reporting operations. The users may choose to simply execute a Massive Screening procedure, which performs an automatic and comprehensive search for anomalous patterns across large number of queries spanning multiple dimensions of data. The user could invoke this function interactively, or it could be scheduled to execute periodically to generate a set of alerts. The alerts are sorted according to statistical significance of the corresponding anomalies found in data, and they can be interactively reviewed by the Epidemiologists for the factual confirmation of their practical importance. TCWI supports these efforts by allowing focusing attention on the most surprising patterns in current data and by providing the ability to quickly drill down or roll up the data for further explanations.

TCWI also provides computationally efficient, interactive data summarizing capability. Multidimensional data of counts of events (such as the numbers of reported disease cases) can be aggregated into a multi-way matrix view - a pivot table. Multiple attributes can be selected to denote rows and columns of the table by dragging the corresponding attribute names from the attributes list. Once a table is created and automatically filled with values, the user can click on a cell to view the

corresponding time series graph, or a pie chart depicting the frequency distribution of the underlying data.

The TCWI software requirement specification in Appendix B Section 11.3 describes generic utility and the user manual in Appendix C Section 13.2 describes the user interfaces and algorithms used in RTBP.

### **6.3.4 Sahana Alerting Broker (SABRO)**

The overarching Messaging/Alerting Module is a Sahana Module that is used for the sending and receiving of various messages ranging from polling functions to alerting functions. At present, the module allows for the generic sending and receiving of messages in the form of SMS, sending messages as Email, conducting SMS based surveys and issuing Common Alerting Protocol (CAP) alerts. A sub-module of the Messaging/Alerting Module is the Sahana Alerting Broker (SABRO).

CAP is an accepted standard of the International Telecommunications Union (ITU) labeled as ITU-T X.1313. The Organization for the Advancement of Standardization of Incidence Systems (OASIS) developed and published the XML files and carries the references to the document definition URL (specifically the reference schema). CAP adopts a Document Type Definition (DTD) Extensible Markup Language (XML) data structure that consist of a main element <Alert> and sub elements <Info>, <Area>, and <Resources>.

CAP was integrated into this project because it is an open source, XML-based protocol with clearly defined elements, is capable of supporting data interchange across multiple dissemination channels; with CAP, one input at the central information hub can be translated into multiple outputs for downstream alerting; CAP provides a standardized template for submitting observations to the central authorities (upstream) and thereby supports situational awareness to improve overall management of a critical incident; A CAP-enabled system will more easily integrate with other national and international information systems.

SABRO is a server application that provides an intermediary point of interconnection between the RTBP health departments and the relay network to facilitate interconnection of all ICTs and passage of CAP-compliant messages through a single software application. The sub components of server software consist of five interconnected subsystems: Message creation and validation, Message distribution, Message delivery, Message acknowledgement, Message system administration.

First step is preparing the message templates. The intention of the templates is to pre-populate the CAP content with values that are common across all messages within that category of alerts. This would ease the data entry burden on the message issuers and increase the message generation times. These templates are saved in the database of templates, using easy to select neutral language.

Each message carries a unique identifier, a set of attributes that identifies the source and sender for audits. The scope is set as restricted meaning the message is for those targeted recipients only (i.e. health workers and health officials in the case of RTBP). Category is naturally set to “Health” with the event described as a “disease outbreak.” Priority defines the response action or inaction that should be taken by the receiving health workers or health officials. If the priority was set to “urgent” then recipients may be required to take prompt action; while a “low” priority may mean being vigilant and observe the situation. The description section contains a full synopsis of the alert.

Once the attributes are populated, the sender can select or type in the list of individual recipients or recipient groups in the Contacts section. Thereafter, select the delivery types (or transport methods), i.e. email, SMS, web, for the message to be disseminated to the prescribed recipients via those channels

The Sahana Alerting Broker requirement specifications in Appendix B Section 11.4.3 describe the design requirements and Appendix C section 12.3 describe the user interfaces and functionality.

## **6.4 User Manuals and Standard Operating Procedures**

The early stages of the technology release, comprehensive user manuals were produced. These manuals described all aspect of the technology and their functions (see Appendix C Section 12). In addition to the comprehensive user manuals, a set of quick reference guides were provided to the users (Appendix C Sections 12.12 – 12.14).

The Standard Operating Procedures were an additional set of guidelines outlining the processes that involved other non-technology related functions. Along with the newest release of the improved versions of the each technology, a quick references guide was giving minimal instructions to operate the software. All these documents are provided in Appendix C Sections 12.9 – 12.11 for mHealthSurvey, TCWI, and SABRO.

## **6.5 Evaluation Toolkit and Guide**

The eval-toolkit-n-guide was developed to outline the evaluation methodology for assessing the upstream communication: data collection, data processing: event detection, and downstream communication: alerting/reporting functions. The purpose of the document was to share the research questions and methodology with investigators and researchers alike. It also served as means to document the in-depth knowledge of the RTBP evaluation process.

## **6.6 Training and awareness workshops**

- Partner Planning meeting, 04 – 05 August 2008, IITM's Rural Technology and Business Incubator, Chennai, India, report - <http://lirneasia.net/2008/08/rtpb-partner-meeting-repot/>
- Healthcare workers and official planning meeting, 07-08 October 2008, Medical Officer of Health Office, Kuliapitiya, Sri Lanka, report - <http://lirneasia.net/2008/10/rtpb-lk-plan-workshop/>
- Healthcare worker and official planning meeting, 23-24 November 2008, Thirukostiyur Primary Health Center, Sivaganga District, India, report - <http://lirneasia.net/2009/02/vhn-mobile-voice/>
- Detection Analysis, Introduction to T-Cube Web Interface, 04 April 2009, Samana Thetha – Lanka Jathika Sarvodaya Shramadana Society, Moratuwa, Sri Lanka, report - <http://lirneasia.net/2009/04/analytics-training-rtpb/>
- Mobile application training, 25-26 May 2010, Lanka Jathika Shramdana Society District Office, Kuliapitiya, Sri Lanka, report - <http://lirneasia.net/2009/05/lk-healthworker-trainin/>

- Mobile application training, 29-30 May 2009, Hotel Subha Lakshmi, Karraikudi, Sivaganga District, India, report - <http://lirneasia.net/2009/05/vhn-training/>
- Event detection and Alerting Training, 29-September-01-October-2010, Deputy Director of Health Services office, Sivaganga District, India, report - <http://lirneasia.net/wp-content/uploads/2009/10/RTBP-Field-visit-report-Oct-2009.pdf>
- Event detection and Alerting Training, 06-07 October 2010, Medical Officer of Health office, Kuliyaipitiya, Sri Lanka, report - <http://lirneasia.net/wp-content/uploads/2009/10/Kuru-Field-report.pdf>
- Evaluation planning, Hotel Subha Lakshmi, 17-18 December 2010 Karraikudi, Sivagangai District, Sri Lanka, report - <http://lirneasia.net/2010/01/eval-plan-workshop-beauty-of-rtbp/>
- Evaluation planning, 17-18, 22 December 2010, Blue Sky Hotel, Kurunegala, Sri Lanka, report - <http://lirneasia.net/2010/01/eval-plan-workshop-beauty-of-rtbp/>
- Interim findings, IITM's Research Park, 07 July 2010, Chennai, India, report - <http://www.lirneasia.net/wp-content/uploads/2010/08/RTBP-FindingsWorkshop-REPORT.pdf>
- Interim findings, 12 July 2010, Hotel Blue Sky, Kurunegala, Sri Lanka, report - <http://lirneasia.net/2010/07/rtbp-lk-findings/>
- Final meeting, Hotel Blue Ocean, Negambo, Sri Lanka, report – this final technical report.

## **6.7 Policy Briefs**

- Two policy briefs were produced – one for India and second for Sri Lanka. Copies of both are in Appendix D.

## **6.8 Book Chapters**

- Gow, G. and Waidyanatha, N. (2010). Using Common Alerting Protocol to Support a Real-Time Biosurveillance Program in Sri Lanka and India, Kass-Hout, T. & Zhang, X. (Eds.). Biosurveillance: Methods and Case Studies. Boca Raton, FL: Taylor & Francis, Chapter 14, p. 268-288.
- Prashant, S. and Waidyanatha, N. (2010). User requirements towards a biosurveillance program, Kass-Hout, T. & Zhang, X. (Eds.). Biosurveillance: Methods and Case Studies. Boca Raton, FL: Taylor & Francis, Chapter 13, p. 240-263.

## **6.9 Journal articles**

- Nuwan Waidyanatha and Sabrina Dekker (2011), The RTBP – Collective Intelligence Driving Health for the Users, International Journal of user Driven Healthcare, IGI Global Publications. (In Press).
- Nuwan Waidyanatha, Artur Dubrawski, Ganesan M., and Gordon Gow (2011). Affordable

System for Rapid Detection and Mitigation of Emerging Diseases , International Journal of e-Health and Medical Communications, IGI Global Dissemination of Knowledge (In Press)

- M. Ganesan, Suma Prashant, N. Janakiraman and Nuwan Waidyanatha. Real-Time Bio-Surveillance Program: Field Experiences from Tamil Nadu, India. Health, Poverty and Human Development, Indian Association for Social Sciences and Health (IASSH) (in press)
- Ariyaratne, V., Ratnayake, R., Hemachandra, P., and Edirisinghe, E, Sampath, W., Waidyanatha, N.(2010). Real-Time Biosurveillance Pilot Program, Sri Lanka journal of Bio-Medical Informatics 2010;1(3):139-154

### **6.10 Research papers (Conference/Symposium proceedings)**

- Sampath, C., Ganesan, M., Waidyanatha, N. (2010). mHealth Revolutionizing public health: an economic , 5<sup>th</sup> Communication Policy Research south (CPRsouth 2010), December 11-13, 2010, Xi'an, China
- CPRsouth5: <http://www.cprsouth.org/cprsouth5/cprsouth5-papers-presentations-and-policy-briefs-xian-china/>
- Gordon Gow, Chamindu Sampath, Ganesan M., Janakiraman N., Mifan Careem, Damendra Pradeeper, and Mahesh Kaluarachchchi (2010). Sahana Alerting Software for Real-Time Biosurveillance in India and Sri Lanka, Proceedings of the 1<sup>st</sup> IEEE International Conference on Computer and Information Applications (ICCIA 2010), Dec 03-05, 2010, Tianjin, China, p 37-373.
- IEEE-ICCIA 2010: <http://lirneasia.net/2010/12/rtbp-iccia-2010/>
- Lujie Chen, Artur Dubrawski, Chamindu Sampath, and Nuwan Waidyanatha (2010). Automated Detection of Data Entry Errors in a Real-Time Surveillance System, Proceedings from the 9<sup>th</sup> International Society for Disease Surveillance (ISDS 2010), Nov 30 – Dec 02, Park City, USA.
- Artur Dubrawski, Michael Baysek, Chamindu Sampath, and Nuwan Waidyanatha (2010). Challenges of Introducing Disease Surveillance Technology in Developing Countries: Experiences from India and Sri Lanka, Proceedings from the 9<sup>th</sup> International Society for Disease Surveillance (ISDS 2010), Nov 30 – Dec 02, Park City, USA.
- ISDS 2010 Blog: <http://lirneasia.net/2010/12/rtbp-isds-201/>
- Artur Dubrawski and Nuwan Waidyanatha (2010). Real-Time Disease Surveillance using Affordable Technology, 2010 mHealthSummit, 08-10 November, 2010, Washington D.C., USA
- mHeath Summit 2010: <http://lirneasia.net/2010/11/rtbp-mhealth-summit-2010/>
- Sampath, C., Dubrawski, A., Chen, L., Sabhnani, M, Ganesan, M., Vincy, P. and Waidyanatha, N (2010). T-Cube as a tool for detecting disease outbreaks in real-time, Proceedings of the 13<sup>th</sup> IEEE International Conference on Computing and Communication Technology – Research Innovation and Vision for the Future (IEEE-RIVF 2010), November 02-04, 2010, Hanoi Vietnam

- *IEEE-RIVF 2010*: <http://lirneasia.net/2010/11/rtbp-rivf2010/>
- Chamindu Sampath, Artur Dubrawski, Nuwan Waidyanatha, and Ganesan M. (2010). T-Cube Web Tool for rapid detection of disease outbreaks in India and Sri Lanka: lessons learned, 2nd *eHealth Sri Lanka Conference, Health Informatics Society of Sri Lanka, 15 – 16 September 2010*.
- Chamindu Sampath, Nuwan Waidyanatha, Gordon Gow, Ganesan M., Mifan Careem, Pradeeper Damendra, and Mahes Kaluarachchi (2010). Sahana Alerting Module for Real-Time Biosurveillance in India and Sri Lanka: lessons learned, 2nd *eHealth Sri Lanka Conference, Health Informatics Society of Sri Lanka, 15 – 16 September 2010*.
- *HISL 2010*: <http://lirneasia.net/2010/09/rtbp-hissl-ehealth2010/>
- Anderson, P., Careem, M., Damendra, P., Gow, G., Samarajiva, R., and Waidyanatha, N. (2010). Common Alerting Protocol All-hazards All-media for saving lives: two case studies, Symposium on Disaster Impact and Assessment in Asia – Centre for Research on the Epidemiology of Disasters, August 25 – 27, 2010, Hue City, Vietnam.
- Dubrawski, A, Chen, L., Beysek, M., Prashant, S., Ganesan, M., (2010) Real-Time Biosurveillance Pilot in India and Sri Lanka, IEEE-HealthCom 2010, proceedings of the 12<sup>th</sup> International Conference on e-Health Networking, Applications, and Services, July 04 – 06, 2010, Lyon, France.
- IEEE-HealthCom 2010: <http://lirneasia.net/2010/07/rtbp-ieee-healthcomm-2010/>
- Gow, G., Vincy, P. and Waidyanatha, N. (2010). Using Mobile Phones in a Real-time Biosurveillance Program: Lessons from the frontlines in Sri Lanka and India, IEEE International Symposium on Technology and Society (ISTAS 10), June 07 – 09, 2010, Wollongong, Australia, p 366 – 374.
- Kannan, T., Sheebha, R., Vincy, P., and Waidyanatha, N. (2010). Robustness of the mHealthSurvey Midlet for Real-Time Biosurveillance, Intelligent Mobile Computing for Better Medical Services, 4<sup>th</sup> International Symposium on Medical Information and Communication Technology (ISMICT 10), March 22 – 25, 2010, Taipei, Taiwan.
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- Ganesan, M., Prashant, S., Janakiraman, N., and Waidyanatha, N. (2009), Real-Time Bio-Surveillance Program: Field Experience from Tamil Nadu India, 7<sup>th</sup> Indian Association for Social Science and Health (IASSH) Conference, February 13, Varanasi, India
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### **6.11 Lectures & Keynote**

- *Keynote* :: Prof. Artur Dubrawski, *Detection of Informative Disjunctive Patterns in Support of Clinical Informatics*, 2<sup>nd</sup> eHealth Sri Lanka Conference, Health Informatics Society of Sri Lanka, 15 – 16 September 2010; report: <http://lirneasia.net/2010/09/rtbp-hissl-ehealth2010/>
- *Public Lecture* :: Dr. Angelo Ramos (Main Speaker – Molave development foundation, Inc., Philippines), *Form Euphoria to Pragmatism: The experience and potentials of eHealth*; Discussants: Prof. Gordon Gow (University of Alberta, Canada) Dr. Vinya Ariyaratne (General Secretary Sarvodaya, Sri Lanka), and Prof. Jayantha Weerasinghe (University of Peradeniya, Sri Lanka); held on 14 September 2010, Sri Lanka Medical Association; report: <http://lirneasia.net/2010/09/public-lecture-from-euphoria-to-pragmatism/>
- *Seminar* :: Prof. Artur Dubrawski, 21 December 2009, Data Mining and Applications, University of Peradeniya, Department Computer Engineering, Colombo Sri Lanka; report - <http://lirneasia.net/2009/12/rtbp-u-of-pera/>
- *Seminar* :: Prof. Artur Dubrawski, 23 April 2010, Machine Learning in Support of Biomedical Security, University of Colombo School of Computing, Colombo Sri Lanka, report: <http://lirneasia.net/2009/05/autonlab-april-visit/>

### **6.12 Media**

- Sri Lanka media event, 14 September 2010, Cinnamon Lakeside, Colombo; blog and news clippings - <http://lirneasia.net/2010/09/rtbp-news-clippings-from-mobile-health-press-conference/>
- India media event, 07 September 2010, IITM's Technology Park, Chennai; blog and news clippings - <http://lirneasia.net/2010/07/rtbp-in-news/>
- Canadian Broadcasting Corporation News – the Nation Life Lines: <http://lirneasia.net/2010/03/real-time-biosurveillance-program-on-canadian-news/>

## 7 PROJECT OUTCOMES

### 7.1 *Going Beyond the pilot*

#### 7.1.1 **Overcoming the resistance in Sri Lanka**

At the beginning, the Ministry of Health resisted in collaborating; however, changed their opinion after the project showed promising results. The project had developed the proposal in collaboration with the Chief Epidemiologist of the National Epidemiology Unit. At the time the grant was awarded, the Chief Epidemiology seat had changed officials. The new Chief Epidemiologist was not very receptive to the idea, which was mainly a personal bias. As an alternative, the project continued to proceed with the technology developments. Simultaneously, obtaining the ethical clearance from the national ethics review committee of the University of Colombo Faculty of Medicine; the responsible agent for reviewing and approving health related research in Sri Lanka (see Appendix D for letter of approval). Prior to submitting the ethical clearance application, the project Investigator, through their network associates, were able to make the ethics committee members aware of the project objectives, which cleared their doubts of any adverse effects they thought the project might impose.

With the ethics clearance, the Principal Investigator – Dr. Vinya Ariyaratne (General Secretary, Sarvodaya) was able to start the field level evaluation of the project at a provincial level, with the cooperation of the autonomous Wayamba Provincial Director of Health Services. Once the project presented the initial results and the utility of the RTBP, the Provincial Director was keen in the continuation as well as expanding beyond the pilot areas to all areas within his jurisdiction.

#### 7.1.2 **Towards scaling in Sri Lanka**

At the latter stages of the project, to the advantage of the project, the Chief Epidemiologist position, had once again, changed. The new leadership realized the potential and utility of the RTBP and was keen in nationalizing but only after the scalability issues were rectified. The only component that new investments for scaling was the data collection component, which required new mobile devices. The TCWI statistical data mining and Sahana Alerting tools could be used as is. However, CMU's Auton Lab was generous in extending their services beyond the project's obligations, to make several modifications to the software for a more in-situ application.

In order to scale the data collection operations within his province, the Wayamba Provincial Director of Health Services, Dr. Saman Ratnayake (whom we regard as the project Champion), himself approached the Ministry of Health – Sri Lanka to secured funds. The capital investment for the mobile handsets was from a leading mobile operator: Dialog Telekom; with them donating fifty free SIMs and Java-enabled mobile phones. Dialog agreed to the contribution because of its strong relationship with LIRNEasia and their previous goodwill partnerships on similar ICT testing on Disaster and Agriculture related projects. Now the wheels are in motion in scaling the project in two districts: Kurunegla and Puthalam belonging to the Wayamba Province.

### **7.1.3 Early adopter of RTBP - India**

Tamil Nadu Health Ministry in India was quick to support the project right from the beginning. The project was fortunate to have Dr. K. Vijayraghavan (Director, National Center for Biological Sciences) as a co-investigator. His reach into government and established credentials in India was a strong asset for receiving the early consent from the Tamil Nadu Ministry of Health and Family Welfare. The ethical committee clearance took a little longer but the letter of consent from the Health Secretary was adequate to continue the work without any disruptions.

The frontline healthcare workers, in Tamil Nadu, realized the potentials of the mobile phone to aid in their routine reporting duties and were quite assertive in assisting the project with proving the efficiencies and effectiveness of the data digitizing and upstream communication process. On the contrary, the optimistic visage and attitude in the RTBP, by the health department staff and officials, were contradicting from that of the actual behavior. Although they had expressed interest and claimed to realize the importance of rapid epidemiological surveillance and risk information dissemination, the adaptation and acceptance was nonexistent.

### **7.1.4 Weak desire to push forward**

A lot of the enthusiasm and energy, in Tamil Nadu, was on the mobile data collection, with very little or no assertiveness to realize the importance of real-time analytics and dissemination for rapid response and better resource allocation. Collection, detection, and disseminate are integral key complete the early warning chain. The project was unable to identify a project champion or one that realized the potential of the end-to-end revolutionary change, beyond the legacy procedures, the project intended to bring forth.

The scope of the project was not to research the behavior of the principal but to prove the functional capabilities of the integrated technology system as alternative means to complement the labor and paper-based tradition procedures. However, observations may point towards several reasons for the non-adaptive non-acceptance behavior in India. One being the staff was not receptive to change. They were comfortable being inactive and working within the bounds of the assigned routine work. Change happens, if and only if, the order comes from the top. Second, Sivaganga is an underdeveloped rural district. Neglecting their public health status may possibly be perceived to impose very little impact on the State's performance indicators; where more importance is given to bigger cities and towns. The RTBP was able to detect several episodes of gastrointestinal diseases and common cold that naturally hinder the household productivity in Sivaganga. However, given the socio economic class the general population in this district is in, they may not be falling within the focal periphery of the State's decision makers.

Having realized these issues, IITM's Rural Technology and Business Incubator changed the strategy to advocate the project with the State level administrators in Chennai. Meetings were held with officials from the Directorate of Tamil Nadu Public Health and Preventive Medicine. The project also launched a massive media campaign with articles published in popular and prestigious newspapers like the Times of India and The Hindu. Otherwise, the project may have gone unnoticed and the project would have had no impact and gone in vane.

There is reason to believe that the media campaign caught the attention of those decision-makers that needed to know. Following, project researchers were invited to forward thinking strategic planning meetings, not just in Tamil Nadu but also neighboring States Kerala for example, to brief the officials on the outputs and outcomes of the RTBP. The project envisions that the necessary change and scaling may take place at its natural pace.

## 7.2 Needed capacity improvements for future adaptations

There are several uncertainties in the technology, training regime, and procedures that need fixing. The project experimented with an open approach, removing all restrictions and exposing elements of the technology with all possible function to the principal. Anticipating that the openness would trigger their minds to see other opportunities or improvements in which the RTBP could benefit their objectives.

For example, the Deputy Director of Planning at the Wayamba Provincial Director of Health Services seeing the potential of TCWI assisting him with the long term planning and resource allocations to optimize the benefits of the limited working budget and expertise. The Village Health Nurses in India, who had never used the mobile phone beyond voice and were exposed to the text features for the first time, saw the potential of incorporating the bulk of their health information reporting needs. These nurses were improvising the mHealthSurvey, intended for reporting disease information, to also submit immunization information. Public Health Inspectors in Sri Lanka were improvising the SABRO to electronically communicate the H544 infectious disease notification information to replace the process that previously forced the officials to make a bus trip to the MOH department to receive the same information on paper.

Having provided the users with the opportunity to experiment at will without implementing exact function specific technology, the researchers were able to identify elements for improvement and elements that can be further exploited.

### 7.2.1 Discrepancies of data quality impacting analytics

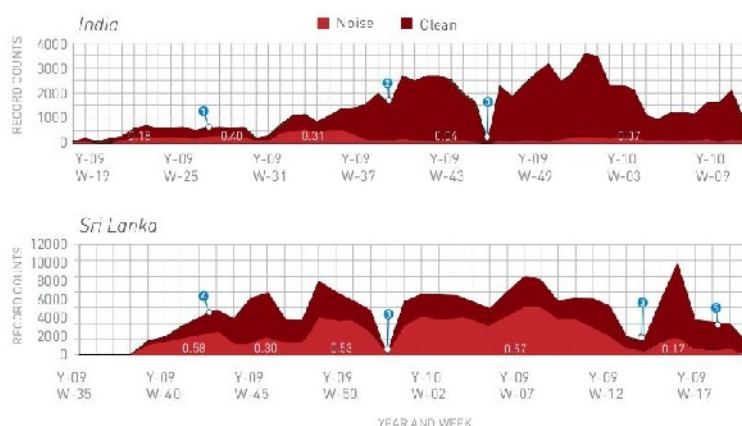


Figure 3: time series ratios of noisy and clean data

There were drawbacks to the approach of opening up the technologies with the mHealthSurvey allowing for the submission of low quality data, TCWI being perceived overly complex to those statistically shy epidemiological staff, and the inability cope with the requirements for message completeness offered through the CAP-enabled SABRO.

Fidelity of digitized data was not promising; especially with the personnel in Sri Lanka with no medical knowledge

but technically capable were producing up to 45% noisy data (Figure 3 bottom graph). On the contrary, Indian nurses, with medical training but less fluent in mobile phone usage were less prone to producing noisy data (Figure 3 top graph). The Indian health workers had an incentive because the erroneous data would produce false alarms that may force them to respond to those inadvertent events or it would portray a bad image of their competencies, accountability, and the health status of their area. The Sri Lanka data digitizing personnel had no incentive or obligations besides picking up a paycheck for the routine work.

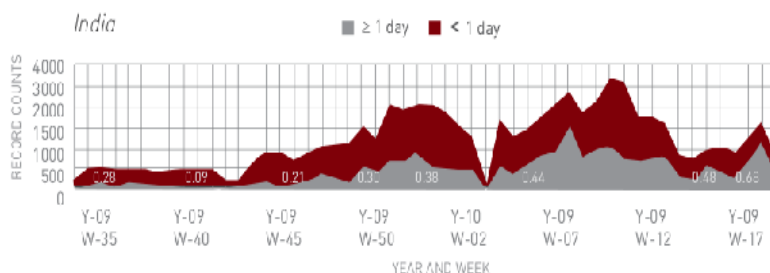


Figure 4: India - data submission delays

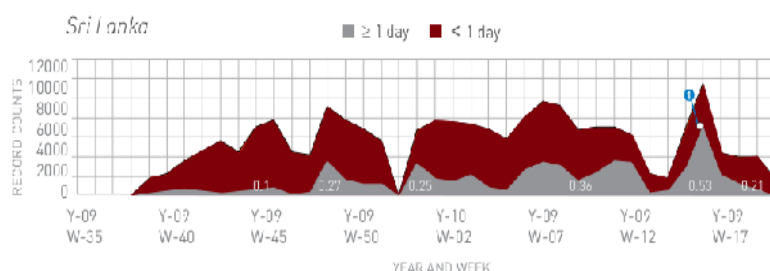


Figure 5: Sri Lanka - data submission delays

The RTBP envisions that hospital data is submitted each day; thus, the real-time expectations. The noticeable latencies of data entry are shown in Figure 4 and Figure 5. There were also irregularities resulting from batch entry of data. This is perfectly fine provided the actual patient visitation time is recorded (case-date). Moreover, they were submitting cases of fever (refer to section 7.2.2.3 in eval-toolkit-n-guide) This can be easily explained with the fact that the recruited data entry personnel were required to submit an average number of records per month and it is possible that they were cheating to meet their quota to receive the full paycheck. The nurses, especially the Village Health Nurses, in India owned up to the fact that they were busy

with their routine work and could attend to the additional project imposed duties only during vacant times such as once a week or every other day. In the analyses, this would depict an unusual escalation of fever cases for that day.

Researchers also observed biases in preliminary diagnosis of certain disease, which manifest in a similar way, for example flu-like symptoms. The Variance in doctors' preference for a similar illness can range from common cold, Cough, Respiratory Tract Infection. This issue of doctor preference may dilute signals and reduce the ability to quickly detect emerging outbreaks (Figure 6).

The effects of low quality data invalidating epidemiological surveillance, is a challenge that the RTBP faces. These could possibly be rectified with changes in policies, procedures, and technology. In addition, if we want doctors, community and health workers' cooperation with accountable and reliable data gathering, which is essential for reliable target-population, based denominator and numerator type data, the doctors from whom the data is derived and health workers or data-entry assistants doing the collecting need to be part of the feedback loop.

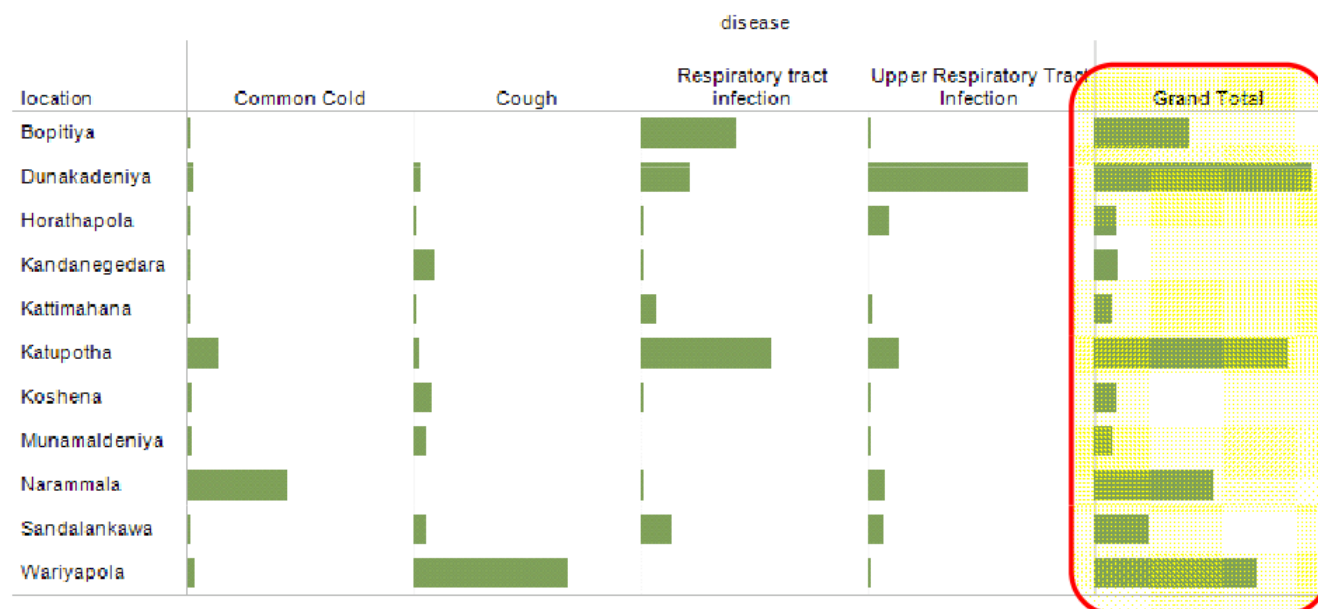


Figure 6: Doctor bias on preference of diagnosis

Drawing from the lessons learned through the RTBP, researchers have realized the importance of building automated systematic data quality checks in to the TCWI software. Health officials can then use these tools to guide in the agile management of health data quality. These techniques would be essential when with implementing TCWI in developing countries with limited resources. One such method would be investigating the uniformity of spatial data to find outliers that may provide indications of miscoding that can be rectified at an early stage with some intervention. Another method would be investigating the biases in preliminary diagnosis over a period of interest.

### 7.2.2 Feedback on the mHealthSurvey technology

The ITU E.161 standard mobile phone numeric keypads is not the most efficient way to digitize text; especially large volumes outpatient data (over 100 records a day). It would work fine with drop down selections but not well with entry of free text. The project detected an outbreak of Whooping Cough, a disease that has been eradicated in Sri Lanka and most parts of the world for several decades. The data-entry operator had accidentally selected the wrong disease for Worm Infestation. Whooping cough cannot be removed from the list because it a listed notifiable disease. There were similar cases of a nurse in India getting her daughter to digitize the data on her behalf that produced a false alarm of a dengue outbreak opposed to diarrhea.

The main dilemma with the free text entry, using multi-tap, is the accidental mistyping when having to press the number 6 key twice for the letter 'n' which is similar in shape as the letter 'm' when spelling a word like *meningitis* that may be misspelled as *menigitis*. The project also researched with the T9 word completion technology that is gaining popularity among all mobile phones; however, did not have the resources to look into adopting it to details. This technology would help remove data quality issues

where one may type “*skin irritation*” and another may type “*irritation of the skin.*” The T9 predictive text should suggest “*skin irritation*” immediately when the application recognizes user typing the word “*skin*” or “*irritation.*”

Given that the combinations of wordings associated with “*skin*” or “*irritation*” may be numerous, it may still force the user to bypass T9 by entering a space and typing their own version. This affect was noticed in the data. Whenever the system administrators found a wrongly typed disease, symptom, or sign name, they would deactivate that record. In the future, if the user tried to submit a similar wording, the database would reject that entry prompting the user with the error. They were bypassing the logic by either replacing a dash or an extra space between words.

The overall intuition of the researchers is that the digitizing should be the responsibility of the medical officer that would improve the accountability. Otherwise, there is tendency to point fingers, if the data is digitized by a data-entry assistant or a second person. The project also came to learn that health workers were under-reporting in the present system to avoid additional work of the numbers went beyond a certain threshold. They also feared that with the electronic health record, the central authorities would be able to monitor their behavior. Such accountability and trust issues can be eliminated if the health records are created by the medical officers. The propagation of errors is bound to trickle as layers are added to the processes.

## 7.2.3 Automated event detection

### 7.2.3.1 Replication study

TCWI was able to detect events of interest in the available datasets. First, TCWI was put through a replication study with semi-synthesized data extracted from the Weekly Epidemiological Return reports published in the public domain ([www.epid.gov.lk/wer/](http://www.epid.gov.lk/wer/)). These tests revealed TCWI's capability to detect events that would go unnoticed to the human eye when applying traditional paper and manual methods. To name a few – food poisoning in several cities around the hill provinces of Sri Lanka (present system reports of only cases in the city of Nuwaraeliya, June 2008), signals of leptospirosis as early as November 2007 (outbreak came to realization in Dec 2007 – Jan 2008), off-season trends of dengue (2007 – 2009), and propagation patterns of dengue (Apr-May 2009).

Once the RTBP collected data had saturated to a desired level, TCWI was regularly applied to the real-time data. We were able to detect events of escalating infectious diseases of common cold and diarrhea. Figure 7 shows the moving average trend of common cold in Thirupathur Block of Sivaganaga District. It seems to be a neglected disease burden that must affect the household productivity. The plot also shows signs of season trends that are correlated with the rainy seasons.



Figure 7: Moving average trend of common cold in Thirupathur Block

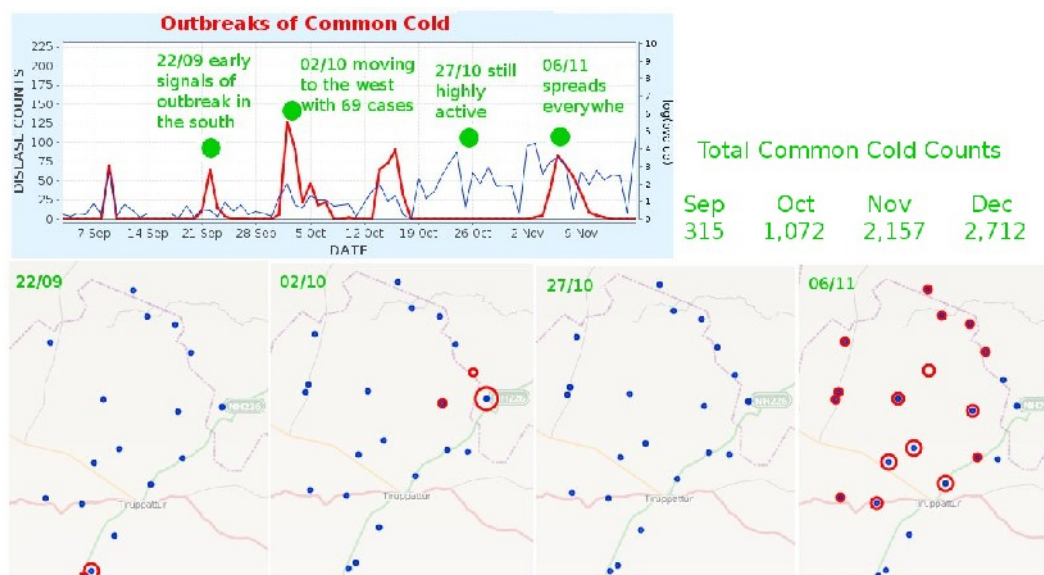


Figure 8: Propagation of common cold in Sivaganga district immediately before and during rainy season

Over a single cycle (Sep – Nov) Figure 8 shows the common cold to emerge at in early September, before the peak monsoon season. Early signals were detected on 09-Sep-2009 and again on 22-Sep-2009. The disease remains dormant, with several hundred people being affected in that region. The outbreak escalates beyond the tipping point in early November, going in to the monsoon season, with a moving average of 50 cases reported each day. Ideally, with the detection of the outbreak as early as September and early intervention could have prevented the large numbers in November and December. Present day systems do not provide the tools and means to inference such events that affect the households periodically.

Similarly, in Sri Lanka we observed several episodes of respiratory tract infection, chicken pox, dysentery, and measles outbreaks. The most of the events were detected by the Public Health Inspectors through TCWI and had issued an alert using SABRO to the targeted health workers and officials. A few cases of dengue and leptospirosis were detected but was not recording cases that reflected the actual high counts of the menace taking place in Kurunegala district. This was because the pilot was submitting data from smaller hospitals; whereas patients with suspected dengue would typically visit larger Base or General Hospital.

#### 7.2.3.2 Relieving the Public Health staff incompetency in statics

The kind of analyses done in the cases of common cold in India (Figure 8) does not have to be at a local level. The project realized that such analytics might be too sophisticated for those staff at the local divisional level health departments. With that in mind a set of simplified pre-screenings, invoked by a push of a button, were developed for them to routinely execute, for example daily. These pre-screenings are for detecting escalating cases of Fever like diseases, Notifiable diseases, other-communicable diseases, and non-communicable diseases. Each click would produce a daily list of

events that are ranked on the statistical significance of the likelihood of an outbreak for that particular disease in the given geographic area for specific age groups and genders will take place. The Public Health Inspectors in Sri Lanka had actually discovered the chicken pox and dengue cases outbreaks by executing the escalating notifiable disease pre-screening. The Tamil Nadu Integrated Disease Surveillance Program and Sri Lanka Weekly Epidemiological Returns reports are also simplified to a click of a button that produces the same results on demand in a manner of seconds, which usually takes a week of more to achieve through the current procedures.

Designers of epidemiological surveillance tools should follow a similar course of development with the sophistication associated with routine executions hidden to the less skilled end user; thus, making the operations very self-intuitive. Also, offer the advance users to custom create drill down queries and run their own statistical estimations for ad-hoc analyses.

## 7.2.4 Disseminating adverse events for early response

### 7.2.4.1 Present day health risk awareness

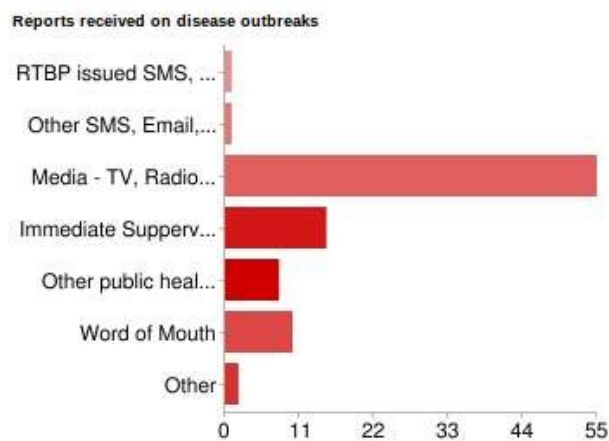


Figure 9: India - way health risk information is received now

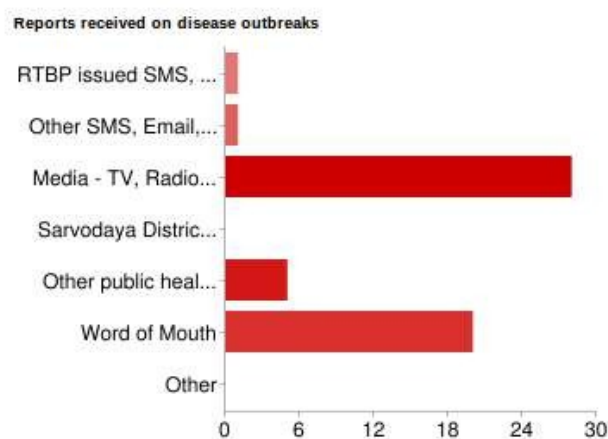


Figure 10: Sri Lanka - way health risk information is received now

At the early stages of the project, the participating health nurses and data-entry operators were asked to maintain a journal. In the journal, one of the observations they had to make was on any news, rumors, etc. they hear of any health risks. The responses from 28 persons in India and 15 persons in Sri Lanka are illustrated in Figure 9 and Figure 10, respectively. Results show that there is no formal way in which they receive health risk information from the government health authorities. Mainstream media seems to be the most common source. However, mainstream media broadcast news stories of disease outbreak only after several deaths had occurred and it thus becomes newsworthy. Word-of-mouth also seems to be a common source, trailing with hearing from peers. The type of information they came to learn was on Swine Flu, Viral Fever, and Chikungunya.

### 7.2.4.2 Notification policies and procedures

The study on the notification or downstream reporting policy and procedures in India and Sri Lanka revealed similar requirements. The health officials and health workers were interested in receiving two types of messages, those termed as action alerts that require early response actions, such as in the case of notifiable diseases that require on site (household) investigations and public awareness. The other type was a situational-awareness message that would alert them of any escalating diseases that do not pose an immediate threat but may escalate to a severe outbreak. Those receiving the situational-awareness message can then be better prepared and be vigilant of similar suspected cases. If there was a discovery of an outbreak in a specific area (e.g. PHI area – Sri Lanka or PHC area – India) this targeted group may receive an action alert; whereas all others in the neighboring areas may receive a situational-awareness message.

A third type of downstream message was another awareness alert that was similar to the Weekly Epidemiological Returns report in Sri Lanka and the Integrated Disease Surveillance Program report in Tamil Nadu, which would share information on the top 5 diseases for that week within their district or Division. This was not one that was requested by the health officials but introduced by the project. The aim of this weekly exercise was twofold. First, disease outbreaks do not happen every day or every week and by issuing these weekly reports using SABRO will ensure the system is always functional as well as for those users issuing the message to regularly use SABRO and not forget the procedures during a rare occasion of a crisis. The second intent was for the health workers and officials to receive the weekly messages as a feedback loop to the upstream communication contributions they have been making. This would create an incentive as well as a mechanism to identify any upstream data reporting errors that may have triggered for a particular disease to show high counts in that targeted area when it was not the real situation.

#### **7.2.4.3 Actual Utilization of SABRO**

As mentioned at the beginning of the discussion on the outcomes, the Indian health officials were not utilizing SABRO. The Integrated Disease Surveillance Unit and the Deputy Director of Health Services district office had been using a free to use portal – [www.way2sms.com](http://www.way2sms.com) - for issuing SMS text to health workers and officials. This tool was used mainly to inform them of any ad-hoc meeting that were summoned to but not for sharing health risk information. It was beyond the comprehension levels of the staff members in realizing the value that the CAP-enabled SABRO had to offer in terms of creating, predefined templates with repopulated content, complete unambiguous messages, availability of the resource segment to provide clear documented response instructions, simultaneous publishing of full email and web alerts, managing the historic account of issued alerts for audits and maintaining recipients lists.

The users in Sri Lanka, predominantly the Public Health Inspectors, were quick to realize the aptitude of SABRO and have been using it throughout the project evaluation period. Some of the alerts issued were in relation to notifiable disease incidences of respiratory tract infection, measles, chicken pox, diarrhea, and dengue. The Public Health Inspectors have requested that SABRO for them to exchange information with patient contact and other details that they can send to the respective officials to conduct the on-site investigations. The project had proposed a work around to use another feature that is part of the greater Sahana Messaging/Alerting Module; thus, utilizing the quick message function. They were improvising this feature to accomplish the request until such time a more user friendly and

integrated system is implemented.

#### **7.2.4.4 Findings from the evaluation exercises**

Message comprehension exercised proved the utility of SABRO and its capability to disseminate alerts that the health workers were able to decipher. Four different messages were issued with and the recipients were given a set of questions to complete based on the messages received. Except for very small proportion of the recipients all performed well. There were certain elements such as the message identifier they could not decipher. This was mainly due to the limitations in the SMS terminating the message at 160 characters. This can easily be fixed by increasing the number of pages a typical message by default should be assigned. Approximately 23 participants in India and 19 participants in Sri Lanka took part in this activity.

In the message issuing exercises, aiming to study the usability of SABRO and the competency in CAP, we had no cooperation from the anticipated users in India. This exercise was conducted with five participants in Sri Lanka. The users of SABRO, in issuing CAP alerts, made very few errors and were able to determine the intended users. A few of them had some confusions but it would naturally rectify if the system was regularly used by those weaker users.

#### **7.2.4.5 Sharing risk information with others**

Cascade messaging is typically a system-to-system delivery of alerts. For example, the health authorities would alert the airport authorities by issuing an alert to the airport authority system. Given the interoperability nature of CAP alerts, the airport authorities would be able to import that message in to their CAP messaging system, make the necessary alterations such as changing the sender information, then relay that message through their networks to the appropriate personnel. In cascade alerting, the health authorities are not required to maintain the recipients list except for in one dedicated channel, thus decentralizing the management. Cross-border alerting or inter-jurisdictional alerting would follow a similar procedure.

Although the project had the intention, it was not able to test this concept to the extent mentioned with the example of alerting airport authorities. However, it did experiment with a similar concept that involved relaying the message to village community-based organization leaders. Messages were relayed to Sarvodaya Suwadana Center volunteers. They in turn transcribed the message into the local language and posted for the public's viewing. Such postings would be effective during a Respiratory Tract Infection outbreak, for example; where the local communities were made aware of the threat. The local bulletin would make recommendations such as refraining from exposing children to public places and transport, also be extra hygienic when returning home from work and embracing children.

The CAP design allows for transmitting alerts in multiple languages; namely, an information segment is allocated for each language. CAP has an attribute assigned to specifying the language using the utf-8 two-letter language codes. These features can be used in cascading the alerts to the last-mile households.

Despite the health sector working language being English, the frontline health workers in India had

requested that downstream messaging be in the local language: Tamil (utf-8 code 'ta'). Observed in the upstream reporting – health workers make notes in their local language, later transcribe that information in to the statistical reporting forms. Hence, given the L10N localization capabilities technology has to offer it may be recommended that the localization be, not just with downstream reporting, but also enable the upstream reporting technologies.

## 7.3 Gender and age specific findings

### 7.3.1 Hospital visitation patterns

“Collecting all data, including private health practitioners, can assist in planning health resources”

Figure 11 – India and Figure 12 – Sri Lanka shows the moving average time series of the overall hospital visitations in the gray plot; below that is the moving average time-series plot, in purple, depicting the difference between Female counts and Male counts (i.e. take time series Female counts and subtract Male counts from). The moving average purple plots, for both India and Sri Lanka, shows to be significantly above the origin (zero count), implying more females visit the Government health facility outpatient clinics.

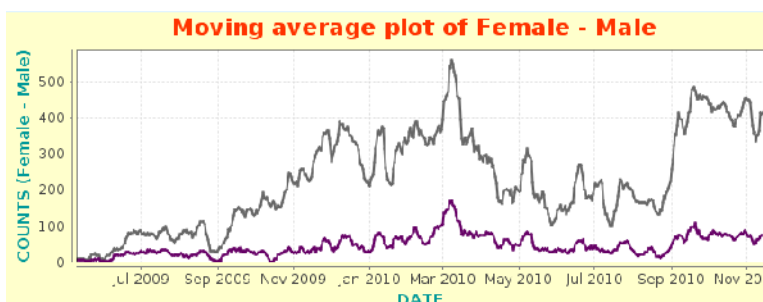


Figure 11: India - female hospital visitations over male (purple plot)

Interviews with health officials and health workers revealed that men who are out working are more likely to visit a private practitioner in the evening at the end of the work day. This hypothesis could be validated if we had private practitioner data from those same areas as well.

The importance of collecting all time-series data is that it can inference other helpful knowledge such as for resource allocation in hospitals by understanding the visitation patterns.

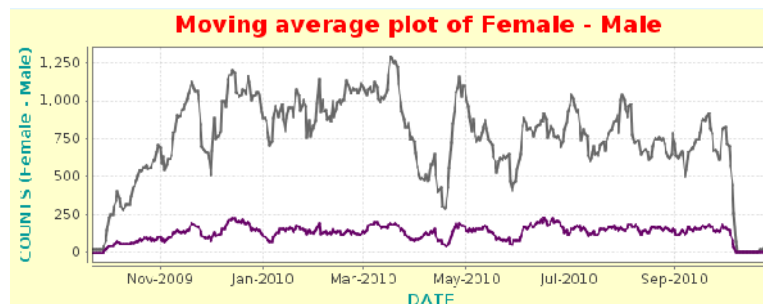


Figure 12: Sri Lanka - female hospital visitation over male (purple plot)

### 7.3.2 Chronic (life-style) diseases

“Benefit of the comprehensive data is the ability to find trends in targeted groups who may be susceptible to chronic diseases, and then implement targeted prevention campaigns; which can help reduce government health budgets allocated for chronic disease clinics.”

We tested the hypothesis that women above the age of 45 were more susceptible to chronic diseases than men in the same age category. We applied the *odds ratio* (specifically the natural logarithmic odds ratio) claiming that the odds of women being affected by the selected chronic diseases are higher than that for men. For both India and Sri Lanka, we examined the hypothesis for a select few, most popular, non-communicable diseases and for all age categories. In Figures 13 and Figure 14, data points on the zero imply that males and females have equal odds; data point  $> 0$  imply females are more susceptible than males, and data point  $< 0$  imply that females are less susceptible than males.

In India, we examined Anemia, Asthma, Cataract, Diabetes, Eczema, Hypertension, Leucorrhoea, Urinary Tract Infection, and Ulcers that had the highest counts from the data collected through the RTBP from the Primacy Health Centers in Thirupathur Block (Figure 13). The hypothesis that women over 45 are more vulnerable to these diseases is not evident from the data; i.e. women and men of the age category are equally affected. However, we observe females in all age groups are more susceptible to Anemia and Leucorrhoea than males; with Urinary Tract Infection more common among schoolgirls in the 6 – 14 age category.

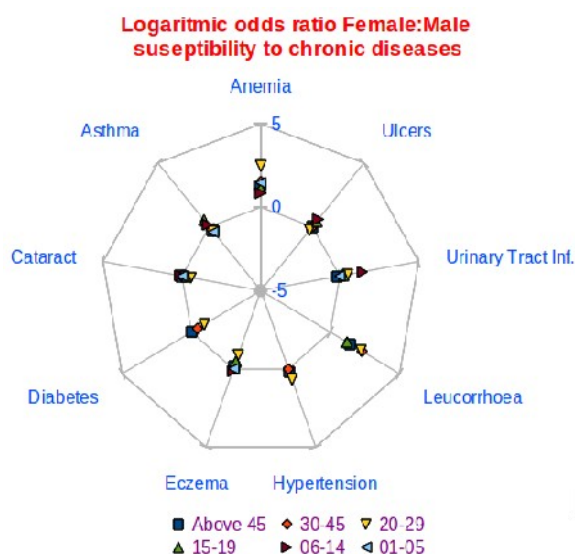


Figure 13: India - logarithmic odds ratio plot for chronic diseases by age groups

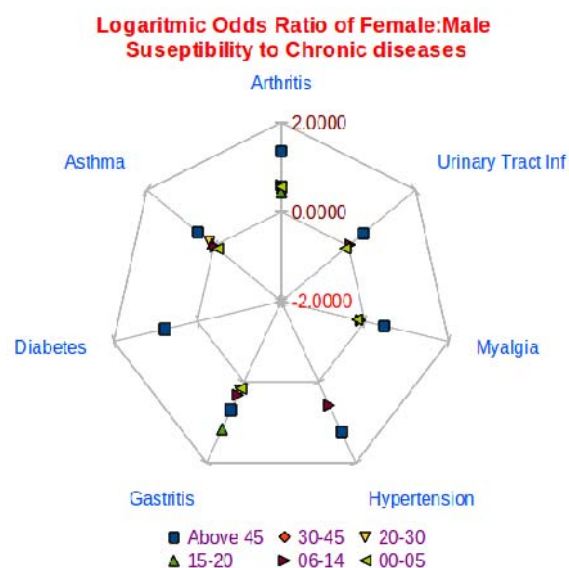


Figure 14: Sri Lanka - logarithmic odds ratio plot for chronic diseases by age groups

In Sri Lanka, we investigated Arthritis (generic, osteoarthritis, and rheumatoid arthritis combined), asthma (normal, bronchi asthma, and wheezing combined), Diabetes, Gastritis, Hypertension, Myalgia, and Urinary Tract Infection. Figure 14 shows that the hypothesis that females over 45 are more susceptible than males is not true with the odds favoring females much higher than males. The data shows that Gastritis and Arthritis to be higher in females in all age groups than males; these two diseases prevailing in children are also termed as Stomach Irritation and Juvenile Rheumatoid Arthritis, respectively.

The example study on life-style disease shows the utility of RTBP beyond simply detecting infectious

disease outbreaks. Thus, collecting a comprehensive and much richer set of information on all patient records opposed to a handful of notifiable diseases with aggregates, as in the present day practices, can reveal knowledge that can assist in systematically and effectively planning the required national health interventions.

### 7.3.3 Empowering the Nurse

The female health workers outnumbered the male health workers in India. The female to male ratio was, approximately, 10:1. The Village Health Nurses who are predominately providing mobile health services with weekly school camps, house-to-house visits, and immunization camps were compelled to maintain the health records in twenty different paper registers and lug these bulky loads around with them. When the RTBP showed the potential of moving all the paperwork to a mobile phone, they were thrilled and were looking forward to it.

Village Health Nurses mentioned that they rarely or never get to see the results or inference outcomes of the aggregates that are communicated up the chain. The inferencing at the state or national level is of a higher level than local level. The Directorate of Public Health and Preventive Medicine web portal does allow for generating a selected set of reports (morbidity, mortality, antenatal care, etc.) filtered by the area; i.e. Primary Health Center and Health Sub Center. However, does not allow for ad-hoc queries and investigations as the TCWI would offer, which they could possibly execute when they visit Primary Health Center or have the Sector Health Nurse run the queries and SMS or Email them the results on to their mobile phone. Given the flexibilities in SABRO, they could arrange for any kind of reports to be sent as email or SMS on to their mobile phones.

We also observed that the female Sector Health Nurses and the female medical officers were more cooperative and willing to accept the technologies than the men were. Particularly the Sector Health Nurses were keen in learning TCWI to conduct their own analysis and generate their report. Ideally, the task of investigating disease outbreaks would be the responsibility of the Health Inspector. However, we did not see much enthusiasm and leadership from these men; whereas the Sector Health Nurses were ready to go beyond their duty to handle those tasks that were neglected by others. It was quite evident that the Sector Health Nurses were the stronger and more proactive leaders in these institutions.

## 7.4 Economic analysis

**“RTBP can save on the total cost of ownership of an epidemiological surveillance and notification program by 49% in Indian and 38% in Sri Lanka.”**

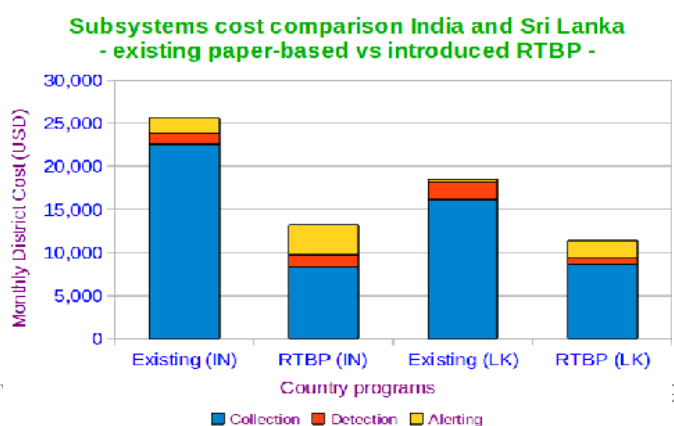


Figure 15: comparison of the present and introduced systems

To perform the cost analyses of the existing paper-based system and the RTBP introduced technology system, the researchers calculated the investments and expenses as whole, in terms of Cost Benefits, Economic Efficiencies, and Cost Sensitivity.

The key outcomes of the economic analysis is that Investments are very little or none on real-

time event detection and alerting. Approximately, 88% of the budgets are for collecting information and consolidating the statistics on the limited set of 25 notifiable diseases (Figure 15). RTBP can reduce Total Cost of Ownership (TCO) by 49% in India and 38% in Sri Lanka. The reductions in cost does not alter the present day practices in any way, instead improves the timeliness for rapid detection and alerting as well as provides a richer set of information on all diseases: communicable and non-communicable ones.

Digitization health records at the point of care removes the bulk of the workload at health department in consolidating the statistics. Figure 16 shows the health departments (red bars) to absorb bulk of the resource as they require high capacity to handle the bulk of the paper work that comes in from all the health facilities and divisional centers. All that overhead can be removed if the digitizing is done at the point-of-care, which is what RTBP has introduced. Figure 16 shows the RTBP introduced resources at the health facilities to be higher than that of the existing systems. That is because the costs were estimated anticipating a worst case of having to introduce a new human resource along with the technology. However, health facility cost increase is less than that of the health department money saved; (i.e. India: health facility cost increment 61% < health department cost savings 86%, Sri Lanka: health facility cost increment 72% < health department cost saving 87%).

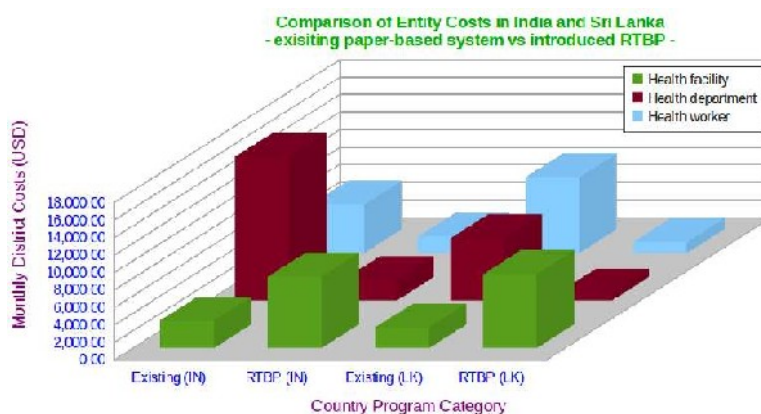


Figure 16: TCO distribution by health facilities, health departments, and health workers

The reasons are - Village Health Nurses travel to their respective Primary Health Centers once a week to spend the day transferring the information from twenty different forms and register to sixteen registers. This information is once again aggregated and hand carried to the District office to have a data-entry operator digitize that information using a web based application. Another procedure that is part of the Integrated Disease Surveillance Program has all Primary Health Centers and Village Health Nurses making a voice call to the district office to share the daily counts of Fever-like cases and Acute Diarrheal Disease. A data-entry operator at the Deputy Director of Health Service's District office notes the statistics on paper, then transfers that to an excel sheet. Weekly aggregates and trend analysis results performed using the spreadsheet is manually entered in to a web-based application that shares those statistics with the State and National bureaus.

In Sri Lanka, the paper forms that come from hospitals to the divisional health departments are recorded in registers, then that information is relayed to the Public Health Inspectors. The Public Health Inspectors perform their investigation duties and provide supply a hand written report back to the divisional health department. All that information is consolidated in to a weekly report that is shared with the Regional and National Epidemiology Units. Each of the individual Epidemiology Units enter that information in to an excel sheet at their own office for their own trend analyses.

## 8 OVERALL ASSESSMENT AND RECOMMENDATIONS

Given that RTBP was an innovation that was aiming to change the present day public health practices in developing countries like India and Sri Lanka, it was able to educate the project designers and researchers of the practicalities of introducing technology in the given environments. It also educates the health sector that there are ways ICTs can help them with changing the self-realized shortcomings of present day practices. Simple mobile phones can play a key role in human centric sensing that can feed information to sophisticated statistical data mining tools for the rapid detection of adverse health events. Similarly, standardized health risk knowledge can be shared with healthcare workers, once again using mobile phones. We do not need expensive super computers or specialized technologies and skilled labor.

### 8.1 *Alternative Digitizing Techniques*

“Investigate other large volume data digitizing technologies using character recognition, touchscreen, or voice that would overcome the digitizing inefficiencies resulting from standard ITU E.161 mobile phone-keypads.”

Low cost standard Java-enabled mobile phones can be used for digitizing health records for disease surveillance. However, the standard International Telecommunications Union (ITU) E.161 numeric keypad is a relatively slow and cumbersome interface for a Medical Officer, physician, or village health nurse entering patient data. This can result in an undesirable interruption to work flow for frontline healthcare workers, who may be required to enter large number of records per hour or per day. Under competing demands for time, frontline health care workers may find it difficult to enter records as required, or may need additional staffing recourses to assist with data entry. Difficulties in using the standard telephone keypad for data entry may also contribute to higher error rates in patient records being entered into the system.

Designers of mHealth data acquisition applications should investigate other data entry methods suitable for low-cost mobile devices. These could include Optical Character Recognition (OCR) methods that capture and digitize handwritten patient records using the camera-equipped mobile phones; QR code methods that allow camera-equipped mobile phones to scan a 2-dimensional barcode containing the patient record and then transmit the data over SMS or other suitable method (e.g. GPRS). More advanced methods such as touch screen capabilities and the development of touch-based mobile applications should be considered. Although this method would require the deployment of more advanced smart phone devices, it is expected that the cost of these devices will decline significantly in coming years and may reach a suitable price point when the system is ready for wider adoption among frontline health care workers. Moreover, a mobile application based on touch screen interface could also be ported to a desktop environment for use in urban hospitals, where electric power and networked desktop computers may be readily available to health care workers.

### 8.2 *Health service specific Graphic User Interfaces*

“Graphic user interfaces must be attuned to the specific health system's service or

program.”

RTBP developed mHealthSurvey application was specific to the project and did not specifically address a particular health service or program such as antenatal, outpatient, inward, immunization, etc. The application's Graphic User Interface should focus on the need of the health service incorporating the proper underlying data standard. Thereafter, the subset of epidemiological data should be extracted from those datasets.

To illustrate the point - Health care providers are legally obliged to report cases of priority diseases to public health authorities, but existing manual, provider-initiated reporting systems generally result in incomplete, error-prone, and tardy information flow. Discussions with the Public Health Inspectors in Sri Lanka stressed that they spend a substantial amount of time deciphering the hand written incomplete information that is required for their investigations. Further, they spend time traveling back and forth between their villages and the health departments to receive their job orders on paper and return the completed jobs with handwritten investigation reports. Also, automated laboratory-based reports are more likely accurate and timely, but lack clinical information and treatment details.

Electronic Support of Public Health application (<http://esphealth.org/trac/ESP>) is a portable public health detection and messaging system for cases of notifiable diseases. The ESP application applies disease specific logic to any complete source of electronic medical data in a fully automated process, and supports an optional case management work flow system for case notification control. All relevant clinical, laboratory and demographic details are securely transferred to the local health authority as an HL7 message.

The Sentinel Surveillance in India and Sri Lanka are programs that can adopt ESP applications or similar ones to help overcome the information sharing and work flow dilemmas. The ESP application is freely available and should be used as a platform to investigate implementing a similar system.

### **8.3 Personal Health Records (PHR)**

“Research the implementation and policy requirements for a centralized or decentralized PHR system.”

A particular PHR carries a person's medical history, which would range from the history of illnesses to prescribed medication to immunization. At present, patients in most developing countries do not have a formal way of maintaining their history. Some systems maintain paper chits that end up in a rubbish bin or a book that gets lost. In either method, efficiently retrieving a patient's information is nearly impossible. It is proposed that PHR should be introduced in to the healthcare systems in developing countries.

PHR do not have an immediate contribution to detecting outbreaks. However, certain disease related procedures require investigative and curative care. This requires knowing the patient's personal details. Therefore, relating the public health information with PHR would provide the added benefit.

One research aspect is investigating the centralized vs. decentralized models or a hybrid for

redundancy. There are phone brand-specific applications like PHR Lite for Android phones but trail versions are limited and full versions require purchase.

Smart Phones are not yet popular in the rural setting and may require alternative simpler mobile applications that would across all standard phones. While Bluetooth is bundled in all phones, a lesser complex method may be the use of QR codes, specifically Secure QR codes (SQRC), as a way to transfer encrypted PHR data on to a standard phone using the simple camera. The PHR data is stored on one's mobile phone (decentralized) with option of retrieving the data from a central repository as well.

#### **8.4 *Ontology for standardizing Epidemiological Data (EpiD)***

“Develop an epidemiological ontology to improve data quality and granularity for reliable and meaningful epidemiological statistical hypotheses testing.”

The RTBP proposal indicated that it would make note of existing data standards but would not incorporate them in this phase. There are several health data standards; to name a few – Health Level 7 (HL7), Logical Observations Identifiers Names & Codes (LOINC), systematized Nomenclature of Medicine--Clinical Terms (SNOMED-CT), Unified Medical Language System (UMLS), Emergency Data Exchange Language Hospital Availability Exchange (EDXL-HAVE). All these standards have some commonality with Public Health informatics. However, requires harmonization and regional specific standardization for epidemiological data exchange.

Despite the health domain working language being English, localized vocabulary should be taken in to consideration. In most cases, the documentation is done in the local language and the statistics are extracted and translated in to English at the time of reporting.

Public health officials are keen in investigating groups of syndromes like variations of pains (body pain, joint pain, muscle pain), respiratory infections (cough, upper respiratory tract, lower respiratory tract), and fevers (fever over 7 days, fever over 3 days). The ontology should have ways to allow for granularity. Not all symptoms or signs are necessary, for example, cuts and scrapes have no correlation with infectious disease outbreaks. Thus, the optimal set of terms and cliques must be derived.

A proper ontology will improve the data quality, which in turn would reduce the false alarm and missed alarm rates. Therefore, it is recommended that the fore mentioned data standards are used as a basis to develop a standard for exchange of epidemiological data for outbreak detection and knowledge sharing.

#### **8.5 *EHR Security, Privacy, and Trust***

“Study the security, privacy, and trust requirements and solutions for institutionalizing EHR systems.”

For the purpose of the RTBP pilot, security, privacy, and trust of electronic health record systems were not addressed. However, would be required before such a system can be implemented at a national scale. Some of the recommendations are protection of information against antitrust with those having access to the information misusing the information for institutional or personal financial gains. Central

EHR repositories will need to be protected with level 4 security. However, Access Control Layer (ACL) will need to be based on the applications, users, and their roles. The ACL will also account for establishing the privacy.

### **8.6 Minimize false and missed alarm rates**

“Research on practical ways to include domain knowledge and machine learning techniques to eliminate Type I and Type II statistical hypothesis testing errors that may lead to costly consequences.”

The generic detection algorithms are producing too many findings, which the RTBP realized was overwhelming for an Epidemiologist to verify each of the long list of incidents. Therefore, the detection algorithms must be integrated with an expert system (or machine learning) that would help train the algorithms to learn in producing the optimal set of results. RTBP also realized that Epidemiologist would rather receive an automated alert of the optimal list of findings on their mobile phone with the necessary and sufficient pieces of information that would provide insight to the health situation for that day. They would further drill down in to the specific event of greater interest using the desktop analytics tools like TCWI.

The accuracy of the detections (or alarms) largely depends on the quality of the data. The detection analysis tools should have some in built intelligence to weed-out or highlight those mistakes. It is recommended that TCWI also build in data quality and miscoding detection tools that public health officials can use to cross check the validity of the alarming results. For example, an alarming number of fever-greater-than-7-days cases concentrated in a single location is highly unlikely. Therefore, the analyst would run a diagnostics test on the uniformity of the data over that period to determine the likelihood of that incident.

### **8.7 Syndromic surveillance**

“Alter the present day passive practice of monitoring a few infectious diseases to a new proactive paradigm of monitoring patient complaints (symptoms), clinical observations (signs), and all diagnoses.”

Syndromic surveillance is an effective technique that can complement the existing systems for discovering early signals of common chief complaints concentrated in a geographical area. This requires introducing the new paradigm to the public health sector in developing countries. RTBP findings are that epidemiologist have the desire to monitor cases with fever, respiratory, gastrointestinal, and pain like syndrome but do not have the means for acquiring the data as well as scientifically analyzing and visualizing the information in a meaningful way. This requires revolutionary data collection and analytical power beyond simply computerizing the paper system. Moreover, some intervention is necessary in changing the mindset of the health officials and health workers to adapt to systems other than the century old narrow fixed list or aggregate based of disease surveillance.

## 8.8 Standardized health risk knowledge share

“Improve downstream and cross-boarder communication with EDXL interoperable data standards.”

Although CAP/EDXL enabled health risk information sharing was proven relevant and effective in the RTBP, there is more work that needs to be done. The EDXL component was not implemented in the SABRO. An important component of EDXL is the Distribution Element (DE) that accounts for tracing the list of recipients in an audit, which is not available in the present release of SABRO. Another important aspect is testing and evaluating the effectiveness of an inter-jurisdictional or cascade alerting method that would enable local health authorities to share information with regional or other agencies, such as transport and immigration authorities or local media. Similarly, the standardization of health alerts and notifications using CAP/EDXL would further enable the sharing of health risk information across international borders and with global portals like *HealthMap* (<http://healthmap.org/en/>) or *Promed* (<http://www.promedmail.org/>) and would support the deployment of multi-agency situational awareness systems.

The detection algorithms in TCWI could be further integrated with SABRO to enable automated notification of potential health incidents to authorized issuers (e.g., a regional Medical Officer of Health) on a 24/7 basis, using SMS, email or other suitable method. On receiving a notification by SMS or other method, the authorized user would further investigate the potential incident by examining the TCWI data and then decide based on professional training and policy if the incident warrants a wide area health alert. TCWI could also be modified to simplify this process by including a simple additional button to its interface that would enable the authorized user to launch the wide area alert to the designated user group of frontline healthcare workers and agencies.

## 8.9 Sustainability Models

“Investigate possible epidemiological surveillance and information sharing business models.”

The RTBP has shown that public health budgets can be reduced with the introduction of technology. However, this would require convincing health ministries to share their budgets with telcos and software service providers, which is not something they have been accustomed to doing. Although open source software can be adopted, it still requires a substantial amount of resources to customize and maintain the implementations. Health departments would never spend the kind of salaries on a skilled software engineer or systems administrator. They would invest in a resource person with adequate technical knowledge to assist with routine upkeep. However, they would still need the expertise to support the internal resource persons. That would require some licensing or support agreement with a software vendor.

To overcome these issues of spending public funds outside of the institutional domain would require some innovative schemes in sustaining these ICT based interventions. Given that these interventions are at their infant stages, the impact is yet to be realized, which may take several years. Once saturated and the mindset has changed then policies will also change towards integrating or allowing the private sector to provide such services.

The type of business schemes are – pure donor model, public private partnerships, or entrepreneurial model. In Sri Lanka, the RTBP was successful in establishing a public-private partnership with a telco providing in-kind services and good. In India, the Integrated Disease Surveillance Program (IDSP) is a service provided by a private company to the National Informatics Center (government entity). It has been proposed that RTBP follow a similar model in providing a third party service to the IDSP initiative, which is an entrepreneurial model. However, in either case, it would require an initial investment from a donor to kick-start and sustain the program for a short duration until such time the alternative sustainability models can take effect.

### **8.10 Policy and legal changes**

“Current paper based procedures are bound by Acts that must be changed before electronics can replace them.”

The current use of paper-based forms and registers is required for legal reasons. Replacing them with EHR will require change in legislation. Moreover, any re-engineering processes with the introduction of ICT and its impact on workflow will also require a review of and possibly changes to hospital policy and procedures. RTBP realized that the parallel work of maintaining the government paper trail requirements and operating the ICTs might be too costly and cumbersome. Without changes to the legal and policy framework, there will likely remain reluctance on the part of frontline healthcare workers to adopt the technology - even if efficiency gains can be demonstrated.

Other policy and legal changes are needed in establishing security, privacy, and trust in relation to the ICT interventions. This may require the involvement of the Ministry of Telecommunications or Information Communication Technology Agencies getting involved with assisting the Health Ministry with establishing these changes. Another organization that can assist with this process is the Health Informatics or eHealth Association of the respective country.

Expanding the RTBP system to a regional or international scope will also require efforts to address policy, legal, and procedural reform to enable data to flow across borders and to ensure standardized methods for collecting and evaluating data, as well as creating and issuing health alerts and notifications.

### **8.11 Practical evaluation techniques**

“Evaluating real-time biosurveillance programs through methodologies described in literature are good guidelines but is impracticable; hence, need other methods that can produce in the same measures.”

RTBP had envisioned a quasi-experimental evaluation method for comparing the RTBP intervention with that of the present system, Activity Monitoring Operator Characteristic or Receiver Operator Characteristic for assessing the reliability of the detection systems, and simulations for assessing the competency of the users but was unsuccessful in achieving them. Therefore, it is important that alternative methodologies are adopted or practical approaches are recommended in attaining the same measurements.

Some of the scientific methodologies recommended in eHealth theory are adopted from medical experiments that are resource intensive and are not quite applicable in a realistic setting given the uncertainties or artifacts in the sampling associated in eHealth experiments. For example, it is impossible to find two hospitals that provide the same level of services. One hospital may be popular for a certain disease, given the level of specialization or experience of the house physicians. Hence, patients would be more inclined to visit that particular physician opposed to the nearest hospital. When comparing the statistics it is difficult to normalize the data based on the geographic population served by a hospital. Future research should focus on refining the methodologies that can be applied to evaluate eHealth interventions.

### ***8.12 eHealth Knowledge sharing***

“Share eHealth program institutionalization knowledge through a network of SAARC, ASEAN, Indochina, and Pacific Island countrys' eHealth Association, eHealth Society, or other national eHealth body advocated through PANACeA.”

There is a need for practitioners and researchers in the Asia Pacific region to share their experiences; especially on the technology developments, implementation strategies, and policy advocacy. Symposiums or Conferences on eHealth in a country tends to attract predominantly resource persons within the hosting country. Moreover, the research discussed at symposiums and conferences are predominantly on laboratory academic research with no field or implementation experience. What is required is a stimulating round-table like discussion; where real implementation and operationalization related problems can be exchanged; especially, given the infancy of eHealth adaptation in the region.

Such a platform can be offered through sharing of knowledge workshops. The effectiveness of invited group discussion was realized through the two sharing of knowledge workshops conducted by RTBP in collaboration with the Aga Khan University (Pakistan) and Molave Development Foundation, Inc. (Philippines). Therefore, we recommend that such face-to-face sharing of knowledge programs be conducted in the region.

PANACeA<sup>13</sup> (Pan Asian Collaboration for Evidence based eHealth Adaptation) is an IDRC funded project. Fifteen countries in region was part of the network that piloted several eHealth programs. Members of this network were a blend of researchers and practitioners. PANACeA can function in the capacity of the umbrella organization to all the eHealth Associations or Informatics Societies in the region; where by PANACeA would facilitate intra-regional small sharing of knowledge workshops.

Assembling all countries around a large round table is impossible. Therefore, the countries can be subdivided in to groups such SAARC, ASEAN, Indochina, or Pacific Islands, etc. Those participating in these workshops should be practitioners and researcher directly involved in establishing eHealth strategies and influencing eHealth policy in their countries. The country representative should then disseminate that knowledge with in their countries through the Health Associations, Health Informatics Societies, or other applicable local assemblies.

<sup>13</sup> PANACeA information can be accessed through here - [http://www.idrc.ca/en/ev-117799-201\\_104161-1-IDRC\\_ADM\\_INFO.html](http://www.idrc.ca/en/ev-117799-201_104161-1-IDRC_ADM_INFO.html)

The aforementioned sharing of knowledge meetings can be followed up with a summarizing meeting where by selected representatives from the regional subdivision groups along with the PANACeA management/monitoring team, specific to this initiative, would produce annual updates to all member countries. The lessons share would be not on the eHealth applications but on how those applications were implemented at a national scale along with the type of policy and strategic work ecology they had to build around it; i.e. outcomes and recommendations.

## 9 GLOSSARY OF ACRONYMS AND TERMS

*	Asterisk with an attribute in a table indicates a mandatory element
ADD	Acute Diarrheal Disease
ANM	Auxiliary Nurse Midwife
API	Application Programmer Interface
BHT	Bed Head Ticket
BMO	Block Medical Officer
BSM	Biosurveillance Module
CAP	Common Alerting Protocol
CDMA	Code Division Multiple Access
CLDC	Connection Limited Device Configuration
CMU	Carnegie Mellon University
DB	Database
DBA	Database Administrator
DD	Deputy Director
DDHS	Deputy Director of Health Services
DE	District Entomologist
DEO	Data Entry Operator
DGHS	Director General of Health Services
DM	Data Manager
EDGE	Enhanced Data Rates for GSM Evolution
EDXL	Emergency Data Exchange Language
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communication
GUI	Graphic User Interface
HI	Health Inspector
HTTP	Hyper Text Transfer Protocol
ICT	Information Communication Technology
IDE	Integrated Development Environment

IDSP	Integrated Disease Surveillance Program
IITM	Indian Institute of Technology Madras
IITM's RTBI	Indian Institute of Technology Madras's Rural Technology and Business Incubator
IO	Input Output
ISP	Internet Service Provider
IT	Information Technology
J2ME	Java 2 Micro Environment
JAD	Java Application Descriptor
JAR	Java Archive
MAM	Messaging/Alerting Module
mHS	mHealthSurvey
MIDP	Mobile Information Device Profile
MO	Medical Officer
MOH	Medical Officer of Health
MOIC	Medical Officer In-Charge
NIDC	National Institute for Disease Control
PERL	Practical Extraction and Report Language
PHC	Primary Health Center
PHI	Public Health Inspector
PHP	Programming for Hypertext Preprocessor
PHS	Public Health Services
RA	Research Assistant
RDBMS	Relational Database Management System
RMS	Record Management Storage
RTBI	Rural Technology and Business Incubator
RTBP	Real-Time Biosurveillance Program
RTI	Respiratory Tract Infections
SARS	Severe Acute Respiratory Syndrome
SHN	Sector Health Nurse
SHN_BSM	Sahana Biosurveillance Module
SMS	Short Message Service
SOP	Standard Operating Procedures

SRS	Software Requirement Specification
Suwacevo	Suwadana Center Volunteers
SysAdmin	System Administrator
TCWI	T-cube Web Interface
UI	User Interface
UoA	University of Alberta
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
URS	User Requirement Specification
UUID	Universal Unique Identifier
VHN	Village Health Nurse
WAP	Wireless Application Protocol
WER	Weekly Epidemiological Report
WRCD	Weekly Return of Communicable Diseases
WTK	Wireless Tool Kit
WWW	World Wide Web

## 10 APPENDIX A – Requirements Analyses

### 10.1 Axiomatic Design Framework

Table 2, 3, 4, and 5 define the *Customer Attributes* (CA), *Constraints* (CS), *Functional Requirements* (FR), and *Design Parameters* (DP), respectively. Figure 17 shows the mapping of CA, FR, DP, and PV domains. Table 6 is a matrix of the FR in the rows, and the corresponding DP are represented in the columns. This assessment does not look at the *Process Variables* but will take the analysis of the process variables in to consideration when the standard operational procedures are in place.

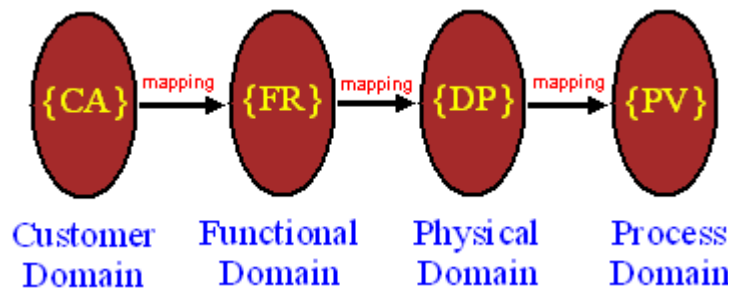


Figure 17: Domain mapping

Table 2: Customer Attributes

CA01 =	frequently and consistently report case information
CA02 =	rapidly detect disease outbreaks
CA03 =	automate weekly disease surveillance reports
CA03 =	Alert health authorities of potential diseases outbreaks

Table 3: Functional Requirements

FR01 =	collect patient visitation information from healthcare facilities	
FR02 =	digitize consolidate statistics of patient “case” information	
	FR021 =	use a mobile hand held computing device
	FR022 =	enter the information in the mobile device
FR03 =	submit consolidated visitation records	
	FR031 =	primary transport method
	FR032 =	secondary transport method
FR04 =	store visitation records in database	
	FR041 =	warehouse records
	FR042 =	fill the data voids

	FR043 =	commit records
FR05 =	update the base line information	
FR06 =	manual detection of disease outbreaks	
	FR061 =	query a subset of data
	FR062 =	view data
FR07 =	automated detection of disease outbreaks	
	FR071 =	initialize dataset and parameters (e.g. detection/decision cut-offs)
	FR072 =	execute data mining algorithms
	FR073 =	verify detected disease outbreaks
FR08 =	make decision to notify disease outbreaks	
FR09 =	communicate notification reports to healthcare workers	
	FR091 =	communications service provider
	FR092 =	disseminate weekly epidemiological report
	FR092 =	disseminate CAP messages

Table 4: Constraints

CS01 =	User must enter each record in less than 1 minute
CS02 =	Application should not be power hungry
CS03 =	Communications costs (terminal device and transmission) must be affordable
CS04 =	Frequency of record submission must adhere to the analysis requirements
CS05 =	notification reports and alerts must contain necessary and sufficient information
CS06 =	community must be notified before disease reaches epidemic states

Table 5: Design Parameters

DP01 =	Patient visitation registry	
DP02 =	Mobile Communication Terminal	
	DP021 =	Java enabled mobile phone
	DP022 =	“RTBI” J2ME application
DP03 =	GSM mobile service platform	
	DP031 =	GRPS primary transport
	DP032 =	SMS secondary transport
DP04 =	“Sahana” BSM MySQL relational database	

	DP041 =	staging tables
	DP042 =	procedures with KB
	DP043 =	transaction tables
DP05 =	Bayesian network	
DP06 =	PHP GUI Query Viewer	
	DP061 =	MYSQL queries analyzer
	DP062 =	Geo Temporal Trend GUIs
DP07 =	“Auton Lab” Statistical data mining algorithms	
	DP071 =	T-Cube
	DP072 =	WSARE, Spatial Scan, and Tipmon
	DP073 =	Healthcare Worker (Human intervention)
DP08 =	Epidemiologist (human intervention)	
DP09 =	“Sahana” Messaging Module	
	DP091 =	Email
	DP092 =	SMS

dependent on the DP. With respect to the independence axiom Table 6 shows characteristics of a lower triangular matrix with very few 'X' in the non-diagonal cells, implying that the system is a “decoupled” design but showing a stronger inclination to a “uncoupled” design. Therefore, we can expect the proposed design to poses less complexities or uncertainties due to interdependencies.

FR03: submission of the visitation records is dependent on DP022: the J2ME application. Thus, failure of the J2ME application will result in the inability to submit the correct information. Just as much as the J2ME application focus is on capturing the data, an equal prominence must be given to the transport of the data via GPRS or SMS. This is one reason for the design to not only rely on a single transport such as GPRS but also have a redundant transport working over an alternate service platform such as SMS. The design is also taking in to consideration the failure of the J2ME application, which will cripple the healthcare worker from submitting data. As a result the data submission process will incorporate an option independent of the J2ME application using an enumerated coding method; where the healthcare worker can text message, via SMS, the enumerated strings.

*Table 6: Incidence matrix of functional requirements and design parameters*

	DP	01	02		03		04			05	06		07			08	09	
FR			021	022	031	032	041	042	043		061	062	071	072	073		091	092
01		X																
02	021		X															

	022		X	X													
03	031			X	X												
	032			X		X											
04	041						X										
	042						x	X									
	043						x	x	X								
05									X	X							
06	061								X		X						
	062								X		X	X					
07	071								X			X	X				
	072								X	X			X	X			
	073								x			X		X	X		
08												X				X	
09	091			x	x											X	
	092			x		x											X

Another strong dependency is the availability of data in the transaction tables, DP043. Without any data, the analysis, FR06 - FR07, cannot take place, and, as a result, detection of disease outbreaks cannot be predicted. Strong emphasis must be given to ensure data integrity and minimize on faulty records. A knowledge base with a series of procedures will be developed to validate the records as well as use intelligence to either flag or correct the faulty records.

DP062: Data visualization is empowered through a browser based (PHP) GUI; where data can be visualized over geographical and temporal dimensions. This GUI has other ways of visualizing the data besides over fore said dimensions such as filtered queries (cross tabs) in table form, which can be exported to generate other types of visual graphs using popular spreadsheets such as Excel. FR062, FR071, FR073, and FR08, which assists the user with system initialization for analysis, detection, and decision processes strongly depend on a good usable GUI based on Human Computer Interface (HCI) principals.

## 10.2 Healthcare worker assessment of the ICT system

As a precursor, a group of healthcare workers was selected from village, divisional, and regional levels to evaluate the preliminary development of the proposed system. They were presented the concepts along with the opportunity to investigate the “demo” ICT system in person. Thereafter, through a questionnaire the healthcare workers provided feedback on the design.

The questionnaire focused on: quantity and frequency of data collection based on demographic information (number of facilities in area, population densities, and weekly visitation statistics), knowledge on disease surveillance (historic epidemiological incidences in area, national disease surveillance protocols, communicable vs. non-communicable disease definitions), technology readiness (frequency of use of mobile phone for personal and business, type of mobile phone technologies and applications used), and strengths and weaknesses of the proposed technology (recommendations in the choice of attributes and functionality).

### **10.3 User Requirement Specifications**

#### **10.3.1 Overview towards a URS**

The Real-Time Biosurveillance Program<sup>14</sup> (RTBP) is an m-Health pilot project aiming to answer the question: “Can software programs that analyze health statistics and mobile phone applications that collect and report health information potentially be effective in the early detection, intervention, and prevention of disease outbreaks?” This project is a pilot aiming to study the technology, human, and policy predicaments in introducing the RTBP to Sri Lanka and India.

The objective of this document is to consolidate the business analysis of the disease surveillance and notification systems in both Sri Lanka and India and derive the user requirements specifications for University of Alberta, University of Colombo School of Computing Lanka Software Foundation, Carnegie Mellon University’s Auton Lab, and Indian Institute of Technology – Madras’s Rural Technology and Business Incubator (RTBI) to use as a guideline to develop the Software Requirement Specifications and go forth with the adaptation, design and development of standards, database, mobile applications, and analytics software programs.

The document is structured in a way to, First, give a brief overview of both Sri Lanka and India’s healthcare system organizational structure and current practice for monitoring, detection, and reporting of diseases in the respective countries with a discussion of the inputs, outputs, and processes of the two individual systems. Second, discuss the expected inputs and outputs of the m-Health ICT system for gathering health information, analyzing, and reporting confined to the domain of disease surveillance and notification. Additional background information is provided in the Appendix for a comprehensive understanding of the details.

#### **10.3.2 Present day disease surveillance and reporting**

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<sup>14</sup> A synopsis of the RTBP including the research proposal can be found here - <http://limeasia.net/projects/2008-2010/evaluating-a-real-time-biosurveillance-program/>. You may also search for other articles related to this project by searching on the key words: m-Health, e-Health, disease, surveillance, biosurveillance, alerting, epidemiology,

### 10.3.2.1 SRI LANKA - epidemiological organizational structure

History of disease surveillance in Sri Lanka dates back to late 19<sup>th</sup> century. The *Quarantine and Prevention of Disease Ordinance* has been introduced in 1890 to implement the notification system on communicable disease in the country. Figure 18 shows the current Government Public Health organizational structure. Table 7 gives a brief description of the personnel and their roles.

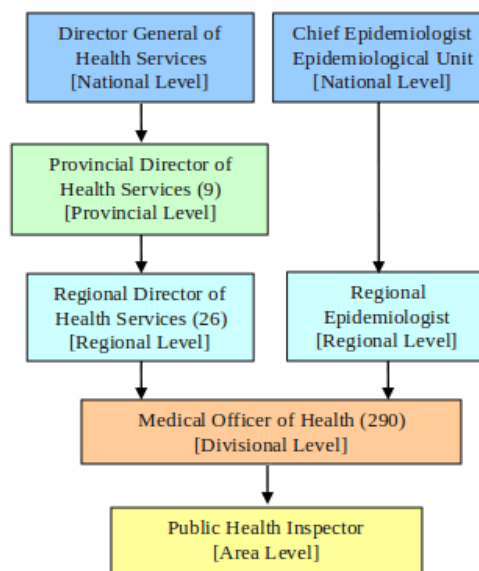


Figure 18: Organizational structure of the Sri Lanka Government Healthcare Officials; integer in parenthesis is the number of each entity in the country

Table 7 Government health organizational structure actors with their roles and responsibilities

<b>Actor</b>	<b>Role and Responsibilities</b>
Director General of Health Services (DGHS)	Policy & decision
Provincial Director of Health Services (PDGS)	Policy & decision
Regional Director of Health Services (RDHS)	Policy & decision making
Chief Epidemiologist (CE)	Analysis of the surveillance data; Policy & decision; Action plans for each situations; Preparation of WER and other reports
Regional Epidemiologist (RE)	Regional level decision making Mediate surveillances
Medical Officer of Health (MOH)	Key role in surveillance and notification; Reporting to the higher levels; Launching the actions prescribed by higher levels
Public Health Inspector (PHI)	Assisting in the reporting; Investigating the cases; Assisting the preventive and curative measures in field level

According to the Quarantine and Prevention of Disease Surveillance Ordinance, all medical practitioners or person professing to treat diseases and attending to patients (In government and private medical institutions – Intern House Officers, Grade Medical Officers, other Medical Officers and Consultants, General Practitioners, Family Physicians) suspected of any “notifiable” disease (see table

2) should notify the case to the relevant public health authorities.

*Group A* diseases should be notified to Director General of Health Services, Deputy Director General (Public Health Services), Epidemiologist, RE, Divisional Director of Health Services/Medical Officer of Health using form I (H-544).

*Group B* diseases should be notified to Divisional Director of Health Services/Medical Officer of Health using form I (H-544).

*Severe Acute Respiratory Syndrome (SARS)* should be notified to Director General of Health Services, Deputy Director General Public Health Services (PHS), Director/Quarantine, Air Port Health Officer, Port Health Officer, Epidemiologist, RE, Divisional Director of Health Services/Medical Officer of Health using form I (H-544).

*Tuberculosis* should be notified to Director/National Program for Tuberculosis, Tuberculosis Control and Chest Diseases using form II (H- 816).

Table 8: List of notifiable diseases in Sri Lanka and the notification mode

<b>Disease</b>	<b>Authority</b>	<b>Mode of notification</b>
<b>Group A :</b> Cholera, Plague, Yellow Fever	DGHS, DDG(PHS) Epidemiologist, RE, MOH	Telephone, Fax, Telegram, H-544
<b>Group B:</b> - AFP /Poliomyelitis      - Enteric Fever      - Tetanus - Chicken pox      - Food Poisoning      - Typhus Fever - DHF/DF      - Human Rabies      - Whooping cough - Diphtheria      - Leptospirosis      - Tuberculosis - Dysentery      - Malaria      - Viral Hepatitis - Encephalitis      - Measles      - Mumps - Rubella /CRS      - Meningitis - Simple cont. Fever > 7 Days - Any other disease occurring in epidemic proportion		MOH by H-544
SARS/Suspected SARS	DGHS, DDG(PHC) Epidemiologist, RE, MOH Director Quarantine Airport/port health officer	Telephone, Fax, Telegram, H-544

Sri Lanka facility types: Teaching Hospital, Provincial General Hospital, District General Hospital, Base Hospital Type A, Base Hospital Type B, District Hospital, Peripheral Unit, Rural Hospital, Prison Hospital, other Hospital (e.g. Police and Army Hospital), Special Campaign Hospital, Central Dispensary & Maternity Homes, Maternity Homes, and Central Dispensary. Table 3 specifies the facilities in Kurunegala District.

New policies are being implemented to rename these facilities. Table 3 introduces the new names of health facilities available in the Kurunegala district and brief descriptions of their services and roles. A

more detailed description of the facilities and their services are in Appendix 7.

Table 9: Healthcare facilities governed by the MOH in Kurunegala District

<b>Healthcare Provider</b>	<b>Brief description</b>
Teaching/Provincial General Hospital	Teaching Hospitals are those hospitals where Professorial Wards are established and are engaged in under-graduate and/or post-graduate training. In provinces, which does not have a teaching Hospital will be developed with similar facilities. (Kurunagala is a Teaching Hospital)
District/Base Hospital	All existing District General Hospitals & Base Hospitals will be renamed as District Base Hospitals. Each District will have 1 District General Hospital & 1-2 District Base Hospitals to fulfill the needs of the population. Kuliyaipitiya and Nikawaretiya have a district/base hospital each.
Divisional Hospital Type A, B, C	All District Hospitals, Rural Hospitals, and Peripheral Units will be re-named as Divisional Hospitals, irrespective of the number of beds. Type A – divisional hospitals with more than 100 patient beds, Type B – divisional hospitals with between 50-100 patient beds, and Type C divisional hospitals with Less than 50 patient beds
Primary Medical Care Units	Central dispensaries and maternity homes will be renamed as primary medical care units and shall provide - out patient care, limited emergency care: facilities for stabilization of patients before referring, to secondary or tertiary care medical institutions, facilities for a poly-clinic including Ante – Natal, Post – Natal, Family Planning, Child Health, Well Women
Suwadana Centers	There are over 450 Sarvodaya initiated Suwadana Centers that are functioning in the Island of which 53 are established in the Kurunergala District. The centers are run by trained volunteers; namely the Suwadana Center Volunteers (abbreviated as Suwacevo). Suwadana Center activities - focal point for health education on an on-going basis, monitoring of health status of the community (community surveillance), liaison with government health services, first-aid and treatment of minor ailments, youth participation in health promotion, focal point for community disaster preparedness and management, organizing periodic health clinics for specific target groups, pre and post maternal care, small scale laboratory tests.

### 10.3.2.2 Disease surveillance and notification processes

#### Document flow and processes

The disease should be notified immediately at the time of first suspicion without waiting for laboratory test results or confirmatory tests. Making the notification at the earliest possible is of paramount importance thus enabling the field public health staff to start the necessary preventive and control measures immediately.

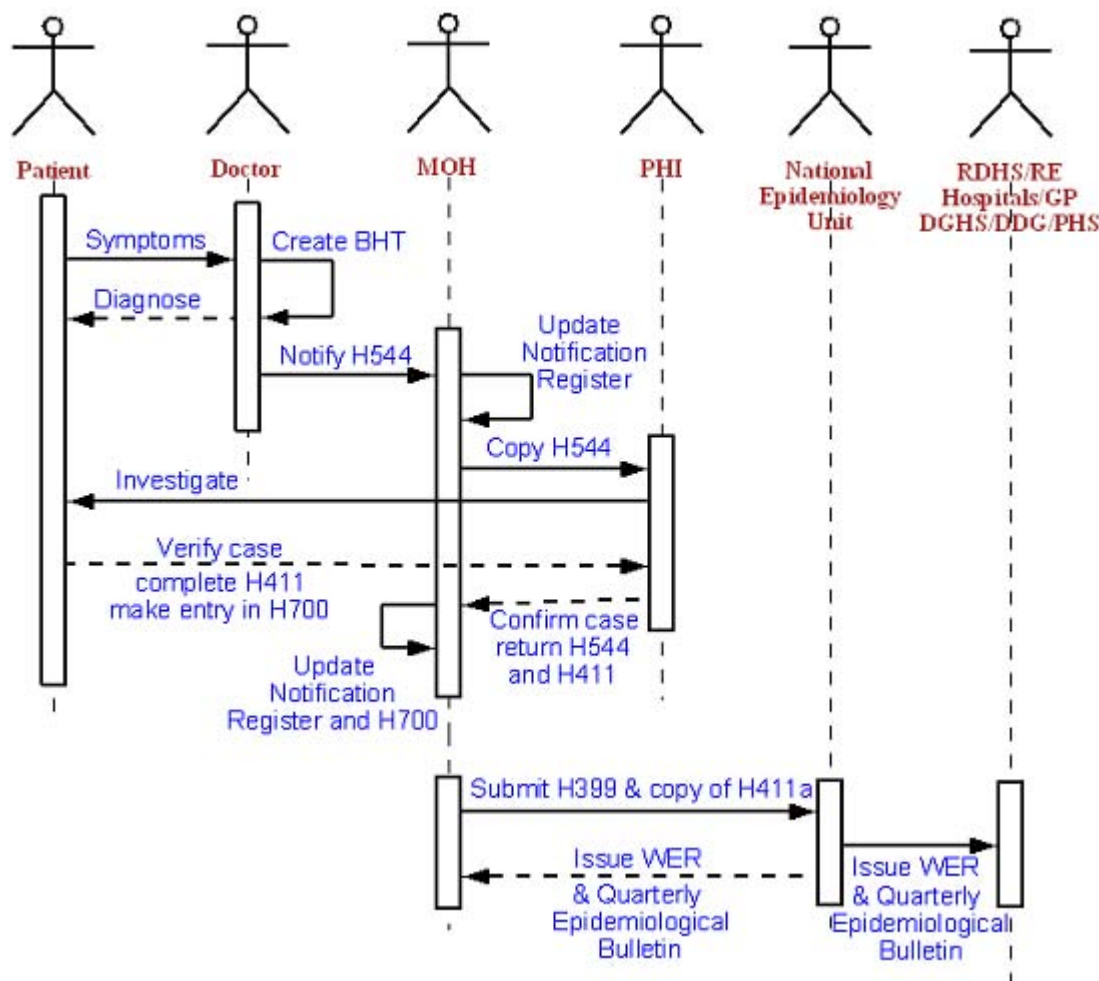


Figure 19: Sri Lanka epidemiological information reporting sequence of functions

As shown in Figure 19, the notification card (Notification of a communicable disease – H-544) should be filled with especial emphasis on writing the patient’s residential address (where it is suspected the patient contacted the disease) so that the range PHI can trace the residence easily. The notification card should be addressed and sent via post to the MOH of the area where the patient is residing in.

A medical officer notifying a case suspected with a notifiable disease should complete a *Notification of a Communicable Disease Form* (H-544). All such cases notified are entered in the *Ward Notification Register*. All wards should have Ward Notification Register. Correct name and address of the patient, age and sex of the patient, the disease suspected, the date of notification, to whom the case is referred and special remarks are included in these ward notification registers.

The completed notifications should be sent to the Director/Medical Superintendent/ District Medical Officer of the institution daily where data are entered in an “Institutional Notification Register” and posted to the MOH of the relevant area.

The MOH on receipt of the Notification will enter the data in “Notification Register” of the MOH office and forward it to the relevant PHI in whose area the patient is a resident presumably contracted the disease. The notification register contains the following data in a table format

- |                         |  |
|-------------------------|--|
| 1. Serial Number        | 8. Notified by whom                          |
| 2. Name of Patient      | 9. Date notification card received           |
| 3. Address              | 10. PHI area                                 |
| 4. Age                  | 11. Date notification card sent to PHI       |
| 5. Sex                  | 12. Date notification card received from PHI |
| 6. Disease              | 13. Remarks                                  |
| 7. Date of Notification |  |

On receipt of H-544, the PHI enters the data in his letter inward register and will visit the household of the patient. During his visit, he carries out a basic public health investigation into the reported case and confirms or refutes the disease. He also carries out necessary and relevant health education and preventive measures aimed at arresting any further cases and spreading of the disease. Then the PHI will complete the form H-411 (communicable disease report part 1) and enter the relevant data in his outward register. The data of all confirmed cases are also entered in the Infectious Diseases register (H-700) at the PHI office. The PHI will then return the completed H- 411 and H-544 to the MOH office.

At the MOH office on receiving the H-544 and H-411 forms from the PHI, the MOH updates the notification register and then enters data of confirmed cases in the Infectious Diseases register – H-700. For each confirmed case the form H-411a is completed using the data on the form H-411 sent by the PHI.

Every week the MOH completes the weekly return of communicable disease (WRCD– H-399) based on notification register and Infectious diseases register. The WRCD and H-411a forms for the particular week are sent to the Epidemiological Unit, Colombo with copy to the Regional Epidemiologist. A third copy should be retained in the MOH office for future reference. This is the most important activity of the MOH in the notification system for which he/she is personally responsible. The MOH has to fill in the WRCD and post it on Saturday, every week.

The MOH/DDHS is also responsible for updating the Maps and Charts in the office according to the instructions given in the divisional circular pub 110 of 1st November 1973.

For selected diseases that are under special surveillance, the MOH has to complete the special investigation forms and send same to the Epidemiology Unit. Every week the Epidemiology Unit prepares a consolidated return of all WRCD. This Weekly Epidemiological Return (WER) is sent to all health institutions in the country including the MOH offices, thus completing the data flow cycle. WER contains the consolidated data on notifications by district, from all reporting 270 MOH areas of the country.

Table 10 Average time taken to complete each leg of the information flow

<b>Functions in Figure 19</b>	<b>Source</b>	<b>Sink</b>	<b>Duration ( days)</b>
Create BHT	Patient	Doctor	1 (Immediate and

			continue till discharge)
Notify H-544	Doctor	MOH	7 (usually weekly)
Update Notification Register	MOH	MOH	1-2 (immediate)
Copy H-544	MOH	PHI	1 to 7 days
Investigate (visit patient to confirm syndrome)	PHI	Patient	1 – 10 days
Verify, complete H-411, make entry in H-700	Patient	PHI	1 to 3
Confirm case, return H-411 & H-544	PHI	MOH	1 to 2
Update Notification Register and H-700	MOH	MOH	1 to 2
Submit H-399 & Copy of H-411a	MOH	EPID Unit	1 -7 (urgent vs. weekly)
Issue WER	EPID Unit	MOH	7 (weekly)
Issue WER	EPID Unit	RDHS, RE, Hospitals, GP, DGHS, DDG, PHI	7 – variable

### 10.3.2.3 Input and Output Documents

This section documents the attributes of the paper base inputs and outputs (forms) that are exchanged between the various healthcare officials for communicating disease information.

Table 11: H-544 from data entry Completed by General Practitioner/House officer/Senior Health Officer/Consultant and sent to MOH

<b>Document Name --&gt;</b>	Notification of a Communicable Disease (H-544)
<b>Attribute Name</b>	<b>Description of attributes</b>
Institute	Name of the institute notification is attached to
Name of Patient	Name of the patient
Name of the Guardian	If it is a pediatric patient
Disease	Tentative diagnosis
Date of Onset	The date patient noticed the ailment
Date of Admission	Date, patient was admitted to the institute
BHT number	Bed Head Ticket Number
Ward	Ward patient was referred to
Age	Age of patient
Sex	Sex of the patient (gender)
Laboratory results	Laboratory results pertaining to the disease (if any)

Home address	Home address of the patient
Telephone number	Phone number of the patient (if available)
Signature of Notifier	Signature of the doctor
Name	Name of the doctor
Status	General Practitioner/House officer/Senior Health Officer/Consultant
Date	data entry date

Table 12: H-411 form data entry completed by PHI and sent to MOH

<b>Document Name --&gt;</b>	Communicable Disease Report – Part I (H-411)
<b><i>Attribute Name</i></b>	<b><i>Description of attributes</i></b>
PHI Reference no	
MOH notification no.	
MOH register no	
PHI range	PHI area
MOH/HO area	
Disease as notified	Disease notified /tentative diagnosis
Date	
Disease confirmed	Definitive diagnosis
Date	
Age	Age of the patient
Sex	Gender: Male/Female
Ethnic group S/T/M/B/Other	Sinhala/Tamil/Muslim/Burger/Other
Patient's movement during three weeks prior to onset	Patient's travel and contacts within last three weeks duration
Date of hospitalization	
Date of discharge	
Name of hospital	
Outcome Recovered/Died	Whether patient was recovered or deceased
Where isolated Home/Hospital/Not isolated	The place patient was kept during the period of isolation

Nature of case Isolated case	Behavior of the patient in isolation
Laboratory findings	Laboratory findings (if any)
Contacts investigated	Details of the contacts of the patient
Name	
Age	
Date seen	
Observation	
Patient's household	
Other contacts	

Table 13: H-411a form data entry completed by MOH/OIC sent to Director of Health Services, with WRCD

<b>Document Name --&gt;</b>	Communicable Disease Report – Part II (H-411a)
<b><i>Attribute Name</i></b>	<b><i>Description of attributes</i></b>
RDHS division	Regional Director of health services division
MOH area	
MOH register no	
Age of patient	
Sex	Gender: Male/Female
Occupation	hospital/ dispensary/ PHI/ Gramasewa niladhari/ school teacher/ private practitioner/ Ayurvedic physician/ estate superintendent/ other
Source of Notification 1-9	
Specify	
Disease as notified	
Disease as confirmed	Hospital MO/ MOH/ Other Gov MO/ RMO/ Practitioner
Confirmed by 1-5	clinical only/ clinical and epidemiological/ clinical and bacteriological/ clinical and serological/ clinical, bacteriological and serological/ clinical and direct microscopy

Nature of confirmation 1-6	
Date of onset	
Date of notification	
Date of confirmation	MOH/ OIC
Signature	

Table 14 Notification registry data entered and maintained by MOH

<b>Document Name --&gt;</b>	Notification Register
<b><i>Attribute Name</i></b>	<b><i>Description of attributes</i></b>
Serial Number	
Name of Patient	
Address	Patient's resident address
Age	Age of patient in years
Sex	Gender: Male/Female
Disease	
Date of Notification	Date H-544 was produced
Notified by whom	Name of GP/Hospital/Clinician who created the H-544
Date notification card received	
PHI area	
Date notification card sent to PHI	
Date notification card received from PHI	
Remarks	

Table 15: H-399 form data entry completed by MOH/OIC and sent to DHS, with Communicable Disease Report

<b>Document Name --&gt;</b>	Weekly Return of Communicable Diseases (H-399) – Part I & II Part I – Cases Notified during the week
<b><i>Attribute Name</i></b>	<b><i>Description of attributes</i></b>

Province	
District	
RDHS Division	Regional Director of Health Services Division
MOH area	
Weekly ending	
PHI area	Space for up to 10 PHI areas
Internationally notifiable diseases	Cholera, Plague, Yellow Fever – counts
Acute Poliomyelitis/Acute flaccid paralysis	Counts
Chicken Pox	Counts (number of cases)
Dengue fever/Dengue hemorrhagic fever	Counts (number of cases)
Diphtheria	Counts (number of cases)
Dysentery	Counts (number of cases)
Encephalitis	Counts (number of cases)
Enteric fever	Counts (number of cases)
Food poisoning	Counts (number of cases)
Rabies	Counts (number of cases)
Leptospirosis	Counts (number of cases)
Malaria	Counts (number of cases)
Measles	Counts (number of cases)
Meningitis	Counts (number of cases)
Mumps	Counts (number of cases)
Rubella	Counts (number of cases)
Congenital Rubella Syndrome	Counts (number of cases)
Simple continued fever	Counts (number of cases)
Tetanus	Counts (number of cases)
Neonatal tetanus	Counts (number of cases)
Typhus fever	Counts (number of cases)
Viral Hepatitis	Counts (number of cases)

Whooping cough	Counts (number of cases)
Tuberculosis	Counts (number of cases)
Total	weekly total of above counts of all the diseases from list above
<b>Document Name --&gt;</b>	Part II – Weekly summary
new cases notified during the week	
cases notified earlier and await investigations at beginning of the week	
cases decided as untraceable during the week	
cases decided as belonging to other MOH areas during the week	
cases confirmed as a non-notifiable disease during the week	
cases confirmed as a notifiable disease during the week	
cases awaiting investigations at the end of the week	
Signature - MOH	
Date	

#### 10.3.2.4 Strengths and weaknesses of current system

##### Strengths

- This provides us the basis for control and prevention of any disease which has a potential to become a threat to the health of the public
- National network covering whole island at all 290 MOH divisions
- Availability of technical experts at each levels
- Close monitoring and evaluation: WRCD screened for clarity, timeliness, and completeness at divisional, regional, and national levels
- Data collection at national level with inbuilt monitoring at divisional, district, and national levels

- Feedback ( WER, Quarterly Bulletin)

Weaknesses

- No active Surveillance: Only Activated-passive and Passive Surveillance
- Timeliness is not very satisfactory, 70% of the WRDC is received within 10 days
- Lack of Laboratory Surveillance
- Limited to inward cases; minimum contribution from OPD / Private sector
- Requires quality review

### 10.3.2.5 INDIA – health sector organizational structure

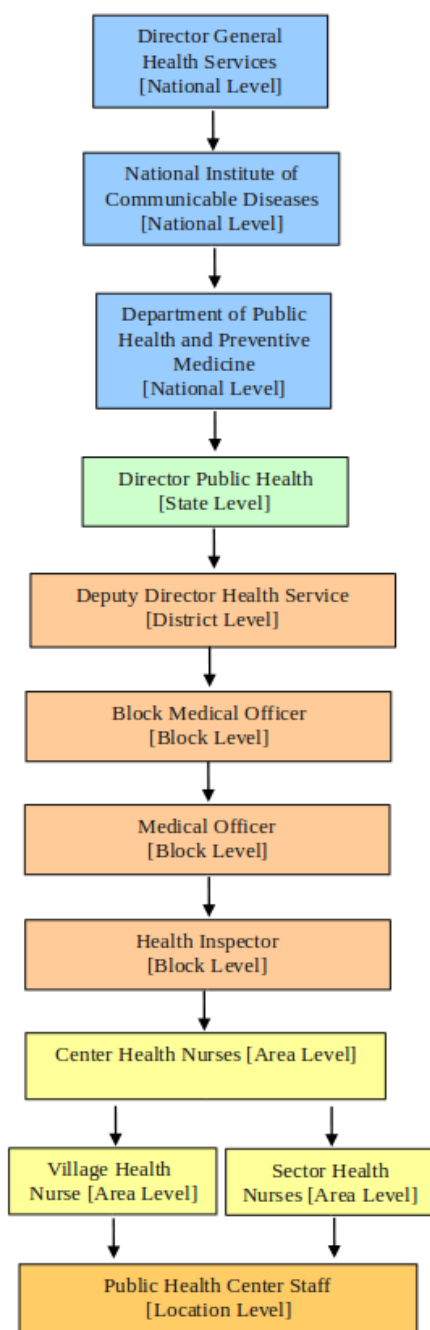


Figure 20: Organizational structure of the Indian Government Healthcare Officials

National Surveillance Program for Communicable Diseases (NSPCD) was initiated in 1998 as a pilot project under the hood of the National Institute for Communicable Diseases<sup>15</sup> (NICD), which is the body that supervises the districts and analyses the data for outbreaks in India. NICD was established on in 1963, to expand and reorganize the activities of the Malaria Institute of India (MII) which remained in existence under different names since its inception in 1909. The reorganized Institute was established to develop a national center for teaching and research in various disciplines of epidemiology and control of communicable diseases. The Institute was envisaged to act as a center par excellence for providing multi-disciplinary and integrated expertise in the control of communicable disease. The Institute was also entrusted the task of developing reliable rapid economic epidemiological tools that could be effectively applied in the field for the control of communicable diseases. The experience from the pilot is subsequently being expanded to build the Integrated Disease Surveillance Program (ISDP) for India.

NSPCD has been launched to strengthen the disease surveillance system so that early warning signals are recognized and appropriate timely follow-up action is initiated. The main objective of the program is capacity building at district and state levels. “WHO is in the process of computerizing the surveillance system in the states of Tamil Nadu and Maharashtra. Computers have been provided to the districts and the relevant staff trained in computer applications vis-à-vis surveillance. This will result in faster transmission of information in both directions and prompt action in the management of outbreaks.”<sup>16</sup>

<sup>15</sup> A full description of the NIDC objectives are discussed here -- <http://nicd.org/NICDOObjectives.asp>

<sup>16</sup> WHO instigated initiative can be found here -- <http://www.whoindia.org/EN/Section3/Section108.htm>

Table 16: Government health system actors with their roles and responsibilities

<b>Actor</b>	<b>Role and Responsibilities</b>
Department of Public Health and Preventive Medicine	Implements of various National and State Health programs. This Department also plans and implements measures to prevent the occurrence of communicable diseases thereby reducing the burden of morbidity mortality and disability in the state. provisions of primary health care, which includes Maternity and Child Health Services, Immunization of children against vaccine preventable diseases, control of communicable diseases, control of malaria, filarial, Japanese encephalitis, elimination of leprosy, iodine deficiency disorder control program, prevention of food adulteration, health checkup of school children, health education of the community and collection of vital statistics under birth and death registration system and environmental sanitation. Prevention and control of waterborne diseases like Acute Diarrhea Diseases, Typhoid, Dysentery prevention and control of sexually transmitted diseases including HIV / AIDS.
Deputy Director Health Service (DDHS)	The DDHS does the groundwork and takes immediate action if necessary, but always keeps the NICD updated on the statistics with periodic reports and seeks help whenever necessary.
Block Medical Officer (BMO)	A lead medical officer who can be consulted at several PHC facilities. This medical officer oversees the PHC medical officers.
Medical Officer (MO)	Each PHC has at least one Medical Doctor who are mostly fresh graduates working as interns.
Health Inspector (HI)	HI who is part of the DDHS assists the VHN in various activities such as conducting school health camps.
Center Health Nurse (CHN)	
Sector Health Nurse (SHN)	The SHN report to the DDHS
Village Health Nurse (VHN)	VHNs report to the DDHS - Any alert with high priority, the VHN will immediately bring it to the notice of the PHC and then health inspector, again after the analysis, the flow will reverse through the Medical officers, CHN, SHN, and ultimate implementation by the VHN.

Table 17: Healthcare facilities governed by the DDHS in Thirupathur Block

<b>Healthcare Provider</b>	<b>Description</b>
Block level Public Health Center (B-PHC)	There are 12 Block PHC; Scans are usually done at block PHC. each block PHC has 3 – 4 Additional PHC; On an average 5 – 7 deliveries are done per month
Additional Public Health Center (A-PHC)	44 Additional PHC; each additional PHC has 3-4 sub centers (SC). Besides the block level PHC in Chembanur there is an additional PHC,

	which has been functional since last 6 years. This PHC has 2 doctors, 3 staff nurses, 1 ANM, 1 pharmacist, 1 Health Worker and 1 Sanitary Worker. The usual conditions observed were upper respiratory tract infections, old age and immunizations. The referral hospital is a GH at Karriakudi. In general, A-PHC conducts tests for hemoglobin, blood sugar, albumin and HIV/AIDS.
Sub Center (SC)	Doctors are required to make field visit to the SCs, provided there is vehicle allocated.

### 10.3.2.6 Rural health data communication processes

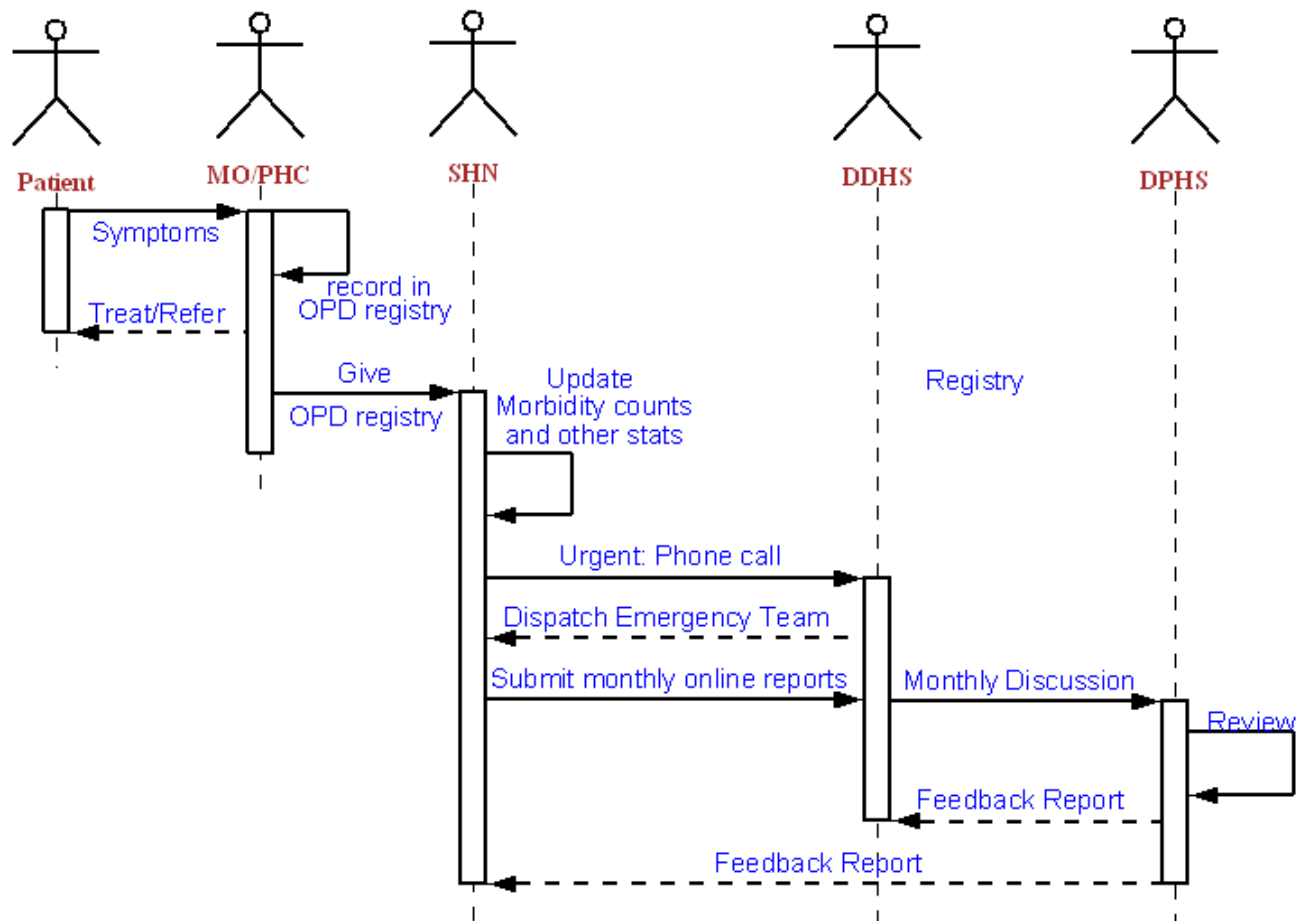


Figure 21: General State level notification process

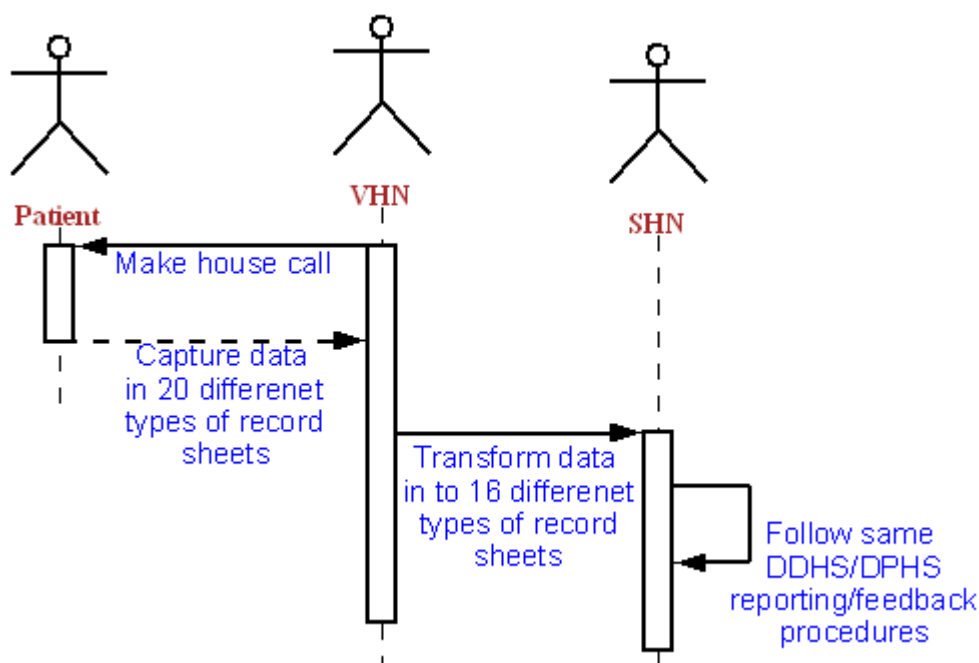


Figure 22: Village health nurse capture of village data

The various reports are - Family Welfare, Morbidity (currently done online), Acute Direct Diseases\*, Fever\*, Immunization Report (by phone), Deliveries, Minor Surgeries and Institution Report. Almost all of them are done by paper and fax except for Morbidity, which was recently launched online.

If a cluster of common symptoms is observed, the PHC notifies its Health Inspector and VHN who in turn does a Survey in the concerned villages. A communicable disease verified by a Government VHN, SHN is informed to the DDHS designated to the area. The DDHS communicates the case to the DPHS designated to the state of Tamil Nadu. The information is then entered in to a computerized database, which is shared with the NICD.

Table 18: Average time taken to complete each leg of the information flow

<b>Functions in Figures 21</b>	<b>Source</b>	<b>Sink</b>	<b>Duration ( days)</b>
Record in OPD registry	Doctor	OPD Registry	Immediate
Give OPD registry	OPD Registry	SHN	1
Update morbidity counts and other stats	SHN	Reports	7
Urgent: Phone call	SHN	DDHS	Immediate
Dispatch emergency team	DDHS	Block	Immediate
Submit monthly online report	SHN	DDHS	30
Monthly discussion	DDHS	DPHS	30
Review	DPHS	DPHS	30
Feedback reports	DPHS	DDHS	30
	DPHS	SHN	30

<b>Functions in Figure 22</b>	<b>Source</b>	<b>Sink</b>	<b>Duration ( days)</b>
Make house call	Doctor	Doctor	7
Capture data	Doctor	PHC	7
Transform data	PHC	PHC	15
Follow functions in figure 21 on feedback	PHC	VHN/SHN/DDHS	30

### 10.3.2.7 Inputs and Outputs

Table 19 Public Health Center morbidity report entry input attributes

<b>Document Name --&gt;</b>	PHC Morbidity Report Entry (on the web)
<b>Attribute Name</b>	<b>Description of attributes</b>
Name of the PHC	A drop down list to select the PHC name
Report Date	Date object to select the date
PHC OP Abstract	Enter the counts for PHC outpatients by Male, Female for Adults, Children, and Total
<b>1. Respiratory System</b>	
Bronchial Asthma	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
COPD	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Allergic Bronchitis	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
LRI including Pneumonia	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
URI	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Tuberculosis	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Other respiratory disease	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
<b>2. Cardiovascular system</b>	
Congenital Heart Disease	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Rheumatic Heart Disease	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Hypertension	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Ischemia including LI	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Other diseases related cardiovascular	PHC OP Morbidity separated by Male Female for Adults, Children, and Total

<i>3. Pyrexia related diseases</i>	
PUO	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Viral Fever	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Typhoid Fever	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Measles	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Chicken Pox	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Malaria	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Others	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
<i>4. Connective Tissue Disorder</i>	
Osteo Arthritis	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Rheumatoid Arthritis	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Other connective tissue disorders	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
<i>5. Pregnancy related disorders</i>	
Pregnancy induced hypertension	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Gestation Diabetes Mellitus	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Malnutrition	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Anemia	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Other related disorders	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
<i>6. Skin</i>	
Eczema	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Tine infection	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Scabies	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Leprosy	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Other related skin diseases	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
<i>7. Insect/Animal Bite</i>	
Dog bite	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Scorpion bite	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Snake bite	PHC OP Morbidity separated by Male Female for Adults, Children, and Total

Other insect and animal bites	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
<i>8. Gastro Intestinal System</i>	
Acute diarrheal disease	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Abdominal colic	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Jaundice	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Worm infection	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Amoebiasis	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Acid peptic disease	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Food poisoning	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Apthus ulcer	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Other related GIT system	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
<i>9. Genito urinary system</i>	
Urinary tract infection	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Menstrual disorder	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
RTI	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Malignancy	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Other related diseases including nephritic disease	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
<i>10. Neurological disorder</i>	
Epilepsy	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
CVA	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Meningitis	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Other neurological disorders	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
<i>11. ENT</i>	
Sinusitis	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
ASOM CSOM- middle ear infections	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Hearing defect	PHC OP Morbidity separated by Male Female for Adults, Children, and Total

Foreign body ear	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Foreign body nose	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Others	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
<i>12. Dental</i>	
Dental carries	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Dental fluorosis	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Other dental problems	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Gingivitis	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
<i>13. Ophthalmic</i>	
Refractive errors	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Conjunctivitis	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Foreign body eye	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Styc	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Other related diseases	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
<i>14. Nutritional disorders</i>	
Nutritional disorder	
Anemia	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Vitamin A deficiency	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Vitamin B deficiency	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Malnutrition	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Other vitamin deficiencies	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
<i>15. Endocrine system</i>	
Diabetes Mellitus	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Goiter	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Others	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
<i>16. All other causes</i>	
Accidents and Injuries	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Burns	PHC OP Morbidity separated by Male Female for Adults, Children, and Total
Surgical related diseases	PHC OP Morbidity separated by Male Female for Adults, Children, and Total

### 10.3.3 Derived requirements

The user requirement derived in this section follow from the close analysis of the current disease surveillance and notification systems in both Sri Lanka and Indian, discussed in the previous sections. The two main weaknesses deduced from the business analysis are -

- 1) The existing system purely thrives on a set of known diseases, labeled as communicable and or notifiable diseases and not on detecting emerging diseases or other adverse health events
- 2) The time taken in delivering the vital health information both upstream and downstream through paper, phone, and fax based system up and down the health system organizational structure is greater than 10 days

Therefore, the summary of the user requirements are –

- 1) design an system to detect all adverse events (including communicable diseases); thus, collect all patient health information for analysis in a timely manner
- 2) design a system that can directly communicate health information from the point of origin to the key decision makers at central levels with provision for the same information to be accessed by all actors at the in between stages in the health organizational structure to execute the required protocols

First, we introduce the key actors, their roles, and the functionality required for the purpose of data collection, analysis, and reporting. Secondly, we introduce the minimal set of attributes required to attain the system requirements for collection of health data, analysis, and reporting.

### 10.3.4 Functions, Actors, and Roles of envisaged RTBP

In general, the users are the healthcare workers, government or non-governmental (private). Although the names (titles) assigned to the healthcare workers for the purpose of disease surveillance and notification is different between Sri Lanka and India the roles and responsibilities are quite similar. Table 9 describes the set of functions, actors and their roles/responsibilities. The columns labeled 'Expected' under both Sri Lankan actors and Indian actors are the healthcare workers entrusted to carry out the prescribed function (protocols) and would be the resource persons expected to carry out the respective functions, namely, the government health officials. The column labeled "Actual" indicates the resource person who will be actually carrying out the respective function for the purpose of the pilot project.

Table 20 RTBP ICT system functions, actors, and roles/responsibilities

<b>Function</b>	<b>Sri Lankan Actors</b>		<b>Indian Actors</b>		<b>Roles and Responsibilities</b>
	<i>Expected</i>	<i>Actual</i>	<i>Expected</i>	<i>Actual</i>	
Data submission	PHI	Suwacevo	VHN/SHN	VHN/SHN	Gather diagnosis, symptom, signs, gender, and age group records with respect to in and out patient visitations from the healthcare providers (hospitals, clinics, PHCs, GPs, community health centers, etc.) in their

					jurisdiction.
Analysis	RE/CE	RA	NICD	DDHS/NIC	Periodically examine datasets from the central repository for a given time period with the use of software tools for manually or automatically detecting adverse events.
Decision Making	MOH, RE, CE	MOH	PHC, DDHS, DPHS, NICD	PHC, DDHS, DPHS, NICD	When an adverse event such as a possible disease outbreak or unusually increase of similar cases is detected through the analysis process a Decision Maker must decide whether or not the event is of significance to be communicated downstream to designated healthcare workers in the vulnerable geographical areas
Publishing -issue reports/alerts	RE or CE	RA	PHC, VHN, HI-DDHS	RA	There are three types of reports: low, high, and urgent priority reports/alerts. <i>Low</i> and <i>High</i> priority reports are generated and disseminated on a weekly (or periodic) basis identifying substantially significant events (e.g. WER). Recipient healthcare workers are not expected to take immediate action but closely monitor those diseases if they are of relevance. <i>Urgent</i> priority alerts are issued as and when a disease outbreak is detected and the healthcare workers in the vulnerable areas must be notified to take immediate action.
Subscribing - receive reports/alerts	MOH, RDHS, RE, Hospitals, GP, DGHS, DDG, and PHI	Suwacevo and MOH	VHN, PHC, HI-DDHS, CHN, SHN	VHN, PHC, HI, DDHS, CHN, SHN	Subscribers can choose to receive either Urgent, High, or Low priority alerts. Based on the individual's responsibilities and the priority level of the alert the recipients will chose the course of action to be taken. If it is a low priority alert, they may choose to be vigilant and

					observe and if it is a high priority alert the individual may choose to apply intervention and prevention actions to safeguard their respective communities
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### 10.3.5 Anticipated problems

- Suwacevo will be playing the role of the PHIs. However, the Suwasevo do not have the same level of training as the PHIs who undergo 3-4 year of training in healthcare associated with their work.
- Although all forms carry all 3 local languages, the Sri Lankan healthcare system functions in English. The Suwacevo will not have the same level of English language competency as the PHIs, at least, not the domain specific language
- VHNs and SHNs are to be entrusted in submitting the disease and syndrome data. However, VHNs and SHNs are informed only if the PHC detect a cluster of common symptoms. Ideally, we would want the VHNs and SHNs to submit all symptoms. How they are to receive or extract information pertaining to all the symptoms reported by patients, is a question.
- Research Assistants (RAs) will be conducting the automated and manual analysis. It is doubtful that they will have the same level of experience as an acute physician or epidemiologist to detect adverse events that are not obvious.

### 10.3.6 Optimal set of Inputs, Outputs, and functionality of ICT system

The partners or teams designing and developing the necessary standards, software, and protocols are expected to use the tables below as a guide to developing the precise specification, which will be documented in the SRS. It is evident that the designers and developers will need to expand on this and introduce more attributes and relationships to build the working solutions.

#### 10.3.6.1 Gathering of Diagnosis and Syndrome data

The Suwacevo and VHN will be providing a minimal set of information, listed in Table 10, for the purpose of analysis and detection of adverse health events. The Suwacevo or VHN will visit the healthcare providers, periodically, or use other means to retrieve in and out patient data from the registries (e.g. BHT) to digitize and send those records to a central database. The Suwacevo and VHN should be able to record the relevant data in digital form in a minimal allotted time such as at a rate of 05 seconds per record, which would amount to roughly 25 minutes to enter and submit 250 records.

Table 21 attributes of visitation data collection from the providers by the Suwacevo and VHN

<b>Attribute</b>	<b>Description</b>	<b>Example</b>
Sender ID	[Single Value]: A unique identifier to	1) Health system assigned unique

	associate the data with the healthcare worker (VHN or Suwacevo) submitting the data	ID 2) Name + National ID number 3) National ID Number
Provider	[Single value]: Healthcare provider: hospital, clinic, GP, community healthcare center, etc., where the data will be collected. This element will help identify location (or source) of the health record. It is anticipated that the patient will be from the nearby area. It is possible that a patient from outside of the area may visit the provider	1) provider name: Kurnegala Base Hospital, provider type: Hospital, provider town/village: Kurunegala 2) provider name: Sivaganga Maternity Hospital, provider type: Hospital; provider town/village: Wariyapola 3) provider name: Asiri Community Healthcare Center, provider type: clinic; provider town/village: Pannala
Diagnosis	[Single value]: Name of the disease the practitioner concludes (diagnoses) based on the patient's symptoms and signs	Dengue, Diarrhea, Parkinson's
Symptoms	[Multiple values]: The complaints made by the patient to the doctor. The same diagnosis for two different patients may not always accompany the same symptoms	1) fever, joint aches, vomit blood, rash (Dengue) 2) fever, joint ache (Dengue) 3) bloody stools (Diarrhea)
Signs	[Multiple values] : The observations made by the practitioner (doctor)	Swelling, Rash, Enlarged retinal, Discoloration of tongue
Gender	[Single value]: Male, Female, or Unknown	
Age Group	[Single value]: Age categories; it is at the discretion of the implementers as to how they wish to define the age categories	1) Adult / Child 2) 0 – 10, 11 – 20, ..., 91 – 100, 3) Infant (0 – 1), Child (2 – 12), Teenager (13 – 19), Youth (20 – 25), Adult (26 – 50), Elder (50 – 100)
No. of Cases	[Single Value]: In a particular reporting period, more than one patient may share the same diagnosis, symptoms, and signs and be of the same gender and age group. In the event an aggregate can be reported instead of having to repeat the record	1) Default value = 1 2) General value = any "Natural" number
Date	[Single Value]: The date the patients or the cases were recorded by the provider; i.e. visitation date or admitted date	

### 10.3.6.2 Relations database for storing gathered data

The relation database must have a record of the attributes defined in Table 11. The table structure will

contain more attributes than described in Table 11 as well as related data and preserve data integrity. The data gathered (health records of patient diagnosis and syndrome) by the healthcare workers from the provider will be stored in this database. The same data will be made available for the purpose of analysis.

Table 22 Information stored in the database

<b>Attribute</b>	<b>Description</b>	<b>Example</b>
Provider	Same as in Table 10	
Diagnosis	Same as in Table 10; can be null. The database will try to resolve (suggest) a diagnosis based on the received symptoms	
Symptoms	Same as in Table 10; cannot be null	
Signs	Same as in Table 10; can be null	
Gender	Same as in Table 10. If the input value is NULL then will default to “Unknown”	
Age Group	Same as in Table 10; cannot be null	
No. of Cases	Same as in Table 10; can be null, if null then will default to 1	
Date	Same as in Table 10; can be null	
ICD-10	[Single value]: International Code for Diseases version 10; the database will resolve the value based on the relationship of the codes associated with the diagnosis (disease). The healthcare workers will not be required to submit this data but the internal processes will fill in the voids.	A01.0 Typhoid fever A90 – Dengue Fever B01 – Varicella (chickenpox) none - some diseases are not classified. So 'none' should be a valid option
Lat/Lon	[Two values]: GIS longitude and latitude will be resolved by the database by looking up the values from the pre-registered GIS location information of the provider village/town or other location identifier.	1) Lon = 8.1414 Lat = 3.4123
Other	[Multiple values]: other attributes the user can set or processes the user can execute to detect adverse events	1) Spatial Scan 2) WSARE 3) Tipmon

### 10.3.6.3 Analysis for detection of events

Periodically, daily, every-other-day, or weekly, the RA (or Epidemiologist) will analyze the data for a given time frame to monitor and detect any emerging health threats. They may also execute other detection algorithms or processes for detection of possible adverse events. The users (detection and monitoring staff) will need to filter the dataset through various combinations of selected parameters identified in Table 12.

Table 23 Analysis done by RAs (or Epidemiologists) of the collected datasets

<b>Attributes</b>	<b>Description</b>	<b>Examples</b>
Period	[Two values]: Start and End date of the series of data to be analyzed. Neither value can be null. Some logic will be used to suggest the start and dates for a period	1) 11-Oct-2006 to 10-Oct-2007 2) 01-Mar-2008 to 31-Mar-2008
Disease (Diagnosis)	[Multiple value]: Same as in Table 10; user should have the option of selecting a single disease for analysis or a collection of disease to analyze the dataset	1) Parkinson's 2) Dengue, Malaria, (mosquito borne diseases) 3) Typhoid, Rubella, Jaundice (Child diseases)
Symptoms	[Multiple value]: Same as in Table 10; user should have the option of selecting a single symptom or a collection of symptoms to analyze the data	1) Cough 2) Fever, Cough 3) Fever, Joint Ache, Rash
Gender	[Multiple value]: Same as in Table 10; user should have the option of selecting Male or Female, Unknown or a subset of the genders such as Male and Unknown to analyze the dataset	1) Male 2) Male, Unknown 3) Male, Female, Unknown
Age group	[Multiple value]: Same as in Table 10; user should have the option of selecting one or a range of age groups	1) Child 2) All (Child & Adult) 3) Age: 10 – 25
Provider	[Multiple value]: Same as in Table 10; user should have the option of selecting one or a collection of providers.	1) Kurunegala base hospital 2) Kurunegala base hospital, Kuliypitiya hospital, Pannala Peripheral Unit
Area	[Multiple values]: user should have the option of selecting a polygon (i.e. GIS area). The locations will be subdivided as Country, Region, State, Province, District, Division, Area, Town/Village	1) Pannal MOH Division 2) Kurunegala District 3) Sivaganga District 4) Tamil Nadu State
Other	[Multiple values]: other attributes the user can set or processes the user can execute to detect adverse events	1) Spatial Scan 2) WSARE 3) Tipmon

#### 10.3.6.4 Alerting and reporting of emerging disease outbreaks

Required attributes to generate weekly disease surveillance reports such as the WER and issuing alerts of potential threats such as emerging disease outbreaks. The RA (or epidemiologist) will extract a summary of the weekly report (e.g. WER) and send the report to the healthcare workers each week. In the event of detecting a significant health threat, the resources associated with detection and monitoring

(e.g. RA or Epidemiology Unit staff) will notify the decision makers (e.g. MOH or CE) of the potential threat. Thereafter, the decision maker will decide the priority level and authorize the detection and monitoring staff to issue a bulletin (alert) to those health officials in the vulnerable areas. The weekly reports are regarded as low or high priority bulletins (reports) and the immediate notifications (alerts) are regarded as urgent priority bulletins.

Table 24 Weekly reports and urgent alerts issued by RA (Epidemiologist) to all healthcare workers

<b>Attributes</b>	<b>Description</b>	<b>Examples</b>
Headline	[Single values]: A head line describing one or more significant event(s)	1) “Rains increase mosquito borne diseases” 2) “Chikungunya appears in North Central province” 3) “Unusual fever like disease emerging among children”
Priority	[Single value]: indicating the urgency, severity, and certainty of the emerging disease with priority levels: high – healthcare worker should access alternate resources to learn more about the emerging disease and be vigilant, perhaps inform community, low – healthcare worker should be vigilant but does not need to take any action, or urgent – if message is intended for the healthcare worker (i.e. affects area healthcare worker is in) then take immediate intervention and prevention actions	1) low 2) high 3) urgent
Area	[Multiple values]: to identify the geographical areas the significant event has emerged in or is affecting	1) Western and Central Provinces 2) Sivaganga, Colombo, Kurunegala Districts 3) Pannal, Wariyapola Divisions 4) Kuliyaipitiya, Nathandiya, Pannala, Towns 5) Sri Lanka
Description	[Single values]: Table of, at most, top 5 diseases and their counts or the most significant urgent priority adverse event and a description of the incident.	1) Dengue (23), Malaria (15), Flue (145), 2) Chikungunya (12) 3) “be advised, 12 cases of Chikungunya identified in Sivaganga district, rapidly spreading, take immediate action”
Resources	[Multiple values]: http link to website with full report for users to access to obtain further information and instructions	1) <a href="http://www.epid.gov.lk/WER/">http://www.epid.gov.lk/WER/</a> 2) <a href="http://www.sahana.lk/DS/GIS/WER">http://www.sahana.lk/DS/GIS/WER</a> 3) IVR: +9198555123123 4) Deputy Director Health Services:

		+914455599889988
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### 10.3.6.5 Description of associated system attributes

This section defines the set of attributes associated with the data elements and database

Table 25 Sample of Diagnosis (diseases), symptoms, and signs

<b>Diagnosis (Disease)</b>	<b>Symptoms</b>	<b>Signs</b>
Cholera	Watery Diarrhea, Nausea, Vomiting, Muscle ramps, Thirst	Dehydration, Tachycardia, Drowsiness
Plague	Fever with Chills, Headache, Fatigue, Diarrhea, Chest pain, Vomiting, Muscle aches, Cough with blood stained sputum	Buboes, Bleeding from mucosal tissues, Gangrenes, Pneumonia, Coma
Yellow Fever	Fever, Headache, Muscle aches, Nausea, Loss of appetite, Dizziness, Abdominal pain	Red eyes, Red tongue, Yellowing of skin, Yellowing of sclera, Bleeding from nose, Heart arrhythmias, Liver failure, Kidney failure, Delirium, Seizures, Coma
Polio Myelitis / Acute Flaccid Paralysis	Fever, Headache, Vomiting, Diarrhea, Fatigue, Constipation, Difficult to swallow, Difficulty in breathing	Neck stiffness, Back stiffness, Muscle spasms, Increase sensitivity to touch, Paralysis of the limbs, Cranial Nerve palsy, Facial muscle paralysis, Features of bulbar palsy
Diphtheria	Sore throat, Painful swallowing, Difficulty in breathing, Fever, Chills, Malaise	Hoarseness, Swollen glands, Grey membrane covering throat, Red infected wound, Wound with gray patchy material, Eye signs
Dysentery	Abdominal cramp, Nausea, Vomiting, Fever, Diarrhea, Blood stained stools, Mucous stained stools	Abdominal tenderness
Pertussis	Runny nose, Sneezing, Mild cough, Low-grade fever, Dry cough	Whooping
Enteric Fever	Fever, Headache, Fatigue, Sore throat, Abdominal pain, Diarrhea, Constipation	Rash, High fever, Distended abdomen, Delirium, Typhoid state

Table 26 Attributes associated with the Healthcare Provider identification

<b>Provider Attribute</b>	<b>Description</b>	<b>Example</b>
Name	Registered name of the healthcare provider or facility	Asiri hospital, Pannala Community Health Center, Dr. Roshan Hewapathirana, MD Chennai Family Clinic
Type	The type of the healthcare provider defined by the country's healthcare system	Hospital, Clinic, Community Health Center, Maternity Home, General Practitioner
State/Province 1)	State or Province within the country the provider operates in or is licensed to operate	Tamil Nadu, Rajasthan, Western Central
District 1)	District within the State or Province the provider operates in or is licensed to operate	Sivaganga, Kurunegala, Kandy
Village/Town 1)	Village or town within the District the provider operates in or is licensed to operate	Kuilyapitiya, Kurunegala, Pannala
Street Address	Postal street address the provider operates in or the facility is established	12 Colombo road, 42-12 Kiribathhena road
GIS coordinates 1)	GIS Long & Lat coordinates of the location of the provider facility	Long: 10.1234 Lat:7.0987 Long: 34.1234 Lat: 23.1122

Table 27 Geographical coverage definitions with hierarchy

<b>Parent</b>	<b>Child</b>	<b>Examples of Parent</b>
Country	Province, State	Sri Lanka, India
Province	District	Western, Sabaragamuwa, Central
State	District	Tamil Nadu, Rajasthan, Maharashtra
District	Division, Block	Kurunegala, Sivaganaga
Block	--	Thirupathur
Division	Area	Pannala, Kuliypitiya, Wariyapola, Udubeddewa
Area	--	PHI area, VHN area

### 10.3.7 Inventory of Health Facilities

#### 10.3.7.1 Kurunegala District, Sri Lanka

Table 28 Kurunegala district, Sri Lanka health facility inventory

<b>Facility Type</b>	<b>Facility Name</b>
Provincial General	TH-Kurunegala (Line Ministry Inst.)

Hospital	
Base Hospital Type A	BH-Kuliyapitiya
Base Hospital Type B	BH-Nikaweratiya, DH-Polpitiyagama, DH-Galgamuwa
District Hospital	DH-Alawwa, DH-Dambadeniya, DH-Maho, DH-Mawathagama, DH-Polgahawela, DH-Ridigama, DH-Sandalankawa, DH-Wariyapola, DH-Hettipola, DH-Hiripitiya, DH-Gokarella, DH-Bingiriya, DH-Katupotha, DH-Narammala
Peripheral Unit	PU-Ambanpola, PU-Dunakadeniya, PU-Kandanegedara, PU-Mahagiriella, PU-Mahananneriya, PU-Megalewa, PU-Muwanhela, PU-Nikawewa, PU-Pahalagiribawa, PU-Thalampitiya, PU-Kotawehera, PU-Kobeigane, Rural Hospital, RH-Ehetuwewa, RH-Delwita, RH-Gonigoda, RH-Mahamukalanyaya, RH-Wellawa, RH-Koshena, RH-Karambe, RH-Indulgoda, RH-Nawatalwatta, RH-Rajanganaya,
Central Dispensary & Maternity Homes	CM-Munamaldeniya, CM-Madahapola, CM-Rasanayakepura (Pahala Mawathagama)
Central Dispensary	CD-Boraluwewa, CD-Buluwala, CD-Dodangaslanda, CD-Divurunpola, CD-Diganpitiya, CD-Elabadagama, CD-Gonawa, CD-Hiruwalpola, CD-Bihalpola, CD-Bopitiya, CD-Batalagoda, CD-Balalla, CD-Bandara koswatte, CD-Udumulla, CD-Mothuwagoda, CD-Netiya, CD-Welikare, CD-Ataragalle, CD-Divullegoda, CD-Uhumeeya, CD-Dothalla, CD-Kadigawa, CD-Horathapola, CD-Kudagalgamuwa, CD-Minuwangette, CD-Tisogama, CD-Taranauduweela, CD-Talawa-Moragollagama, CD-Kalugalle, CD-Udubaddawa, CD-Kimbulwanaoya, CD-Weerapokuna, CD-Weuda, CD-Usgala Siyambalagomuwa, CD-Kattimahana, , CD-Wadakada, CD-Kosdeniya, CD-Kumbukwewa, CD-Inguruwatte, CD-Makulpota, CD-Ethanawatta, CD-Potuhara, CD-Boyawalana, CD-Nagollagama, CD-Narangoda, CD-Melsiripura, CD-Kolambagama, CD-Maspotha, CD-Wewagama, CD-Udapolawatta, CD-Thambarombuwa, CD-Gonagama

### 10.3.7.2 Kurunegala District, Sri Lanka

Table 29 Kurunegala district, Sri Lanka health facility inventory

<b>Facility Type</b>	<b>Facility Name</b>
Provincial General Hospital	TH-Kurunegala (Line Ministry Inst.)
Base Hospital Type A	BH-Kuliyapitiya
Base Hospital Type B	BH-Nikaweratiya, DH-Polpitiyagama, DH-Galgamuwa
District Hospital	DH-Alawwa, DH-Dambadeniya, DH-Maho, DH-Mawathagama, DH-Polgahawela, DH-Ridigama, DH-Sandalankawa, DH-Wariyapola, DH-Hettipola, DH-Hiripitiya, DH-Gokarella, DH-Bingiriya, DH-Katupotha, DH-Narammala
Peripheral Unit	PU-Ambanpola, PU-Dunakadeniya, PU-Kandanegedara, PU-Mahagiriella, PU-Mahananneriya, PU-Megalewa, PU-Muwanhela, PU-Nikawewa, PU-

	Pahalagiribawa, PU-Thalampitiya, PU-Kotawehera, PU-Kobeigane, Rural Hospital, RH-Ehetuwewa, RH-Delwita, RH-Gonigoda, RH-Mahamukalanyaya, RH-Wellawa, RH-Koshena, RH-Karambe, RH-Indulgoda, RH-Nawatalwatta, RH-Rajanganaya,
Central Dispensary & Maternity Homes	CM-Munamaldeniya, CM-Madahapola, CM-Rasanayakepura (Pahala Mawathagama)
Central Dispensary	CD-Boraluwewa, CD-Buluwala, CD-Dodangaslanda, CD-Divurunpola, CD-Diganpitiya, CD-Elabadagama, CD-Gonawa, CD-Hiruwalpola, CD-Bihalpola, CD-Bopitiya, CD-Batalagoda, CD-Balalla, CD-Bandara koswatte, CD-Udumulla, CD-Mothuwagoda, CD-Netiya, CD-Welikare, CD-Ataragalle, CD-Divullegoda, CD-Uhumeeya, CD-Dothalla, CD-Kadigawa, CD-Horathapola, CD-Kudagalgamuwa, CD-Minuwangette, CD-Tisogama, CD-Taranauduwela, CD-Talawa-Moragollagama, CD-Kalugalle, CD-Udubaddawa, CD-Kimbulwanaoya, CD-Weerapokuna, CD-Weuda, CD-Usgala Siyambalagomuwa, CD-Kattimahana, , CD-Wadakada, CD-Kosdeniya, CD-Kumbukwewa, CD-Inguruwatte, CD-Makulpota, CD-Ethanawatta, CD-Potuhara, CD-Boyawalana, CD-Nagollagama, CD-Narangoda, CD-Melsiripura, CD-Kolambagama, CD-Maspotha, CD-Wewagama, CD-Udapolawatta, CD-Thambarombuwa, CD-Gonagama

### 10.3.7.3 SRI LANKA disease communication paper documents

<p>සෞඛ්‍ය රෝග පිළිබඳ නිවේදනය</p> <p>නොහැරුණු හා අනිවාර්ය</p> <p>NOTIFICATION OF A COMMUNICABLE DISEASE</p>		<p>සෞඛ්‍ය / සෞඛ්‍ය / Health - 544</p>	
<p>ආයතනය / ආයතනය / Institute .....</p>		<p>රෝගය / රෝගය / Disease .....</p>	
<p>පෝෂිතයාගේ නම*                      රෝගාගාරයේ නම                      Name of Patient</p>		<p>පැමිණි දිනය                      ඇතුළත් වූ දිනය                      Date of Onset</p>	
<p>* ළමා රෝගීන්ගේ මව/පියා/පාලකයාගේ නම සහතික කරන්න                      රෝගාගාරයේ නම                      Paediatric Patients-Name of Mother/Father/Guardian</p>		<p>ඇතුළත් වූ දිනය                      ඇතුළත් වූ දිනය                      Date of admission</p>	
<p>රුග් අංකය                      B.H.T. No.</p>		<p>වයස                      වයස                      Age</p>	
<p>රුග් අංකය                      B.H.T. No.</p>		<p>ස්ත්‍රී/පුරුෂ භාවය                      Sex</p>	
<p>රුග් අංකය (සෞඛ්‍ය සේවකයාගේ සහතිකය)                      Laboratory Results (If available)</p>			
<p>රෝගියාගේ නිවෙස් ලිපිනය (සෞඛ්‍ය සේවකයාට නිවස සොයා ගැනීමට භාවිත කරයි)                      රෝගාගාරයේ නම                      Home address of Patient (for the Public Health Inspector to trace the patient's residence)</p>			
<p>රෝගියාගේ නිවෙස් දුරකථන අංකය                      රෝගාගාරයේ නම                      Patient's Home Telephone No.</p>			
<p>අනුමත කරන්නාගේ අත්සන                      අත්සන                      Signature of Notifier</p>		<p>නම                      Name</p>	
<p>නම                      Name</p>		<p>ස්තියාව                      Status</p>	
<p>දිනය                      Date</p>		<p>දිනය                      Date</p>	
<p>සෞඛ්‍ය රෝග පිළිබඳ ලැයිස්තුව සඳහා සෞඛ්‍ය සේවකයාට පිටපතක්                      Please see overleaf for the list of Notifiable Diseases.</p>			

Figure 23: H-544 Form for communicating disease from MOH to PHI (Sri Lanka)

ஹெல்த் டீபார்ட்மென்டில் / சுகாதார சேவைகள் திணைக்களம் / DEPARTMENT OF HEALTH SERVICES

ஸாமி  
 கருதாரம் } H 399  
 Health

ജില്ല / மாவட்டம் / Province: .....

000000 / WTA.LUB / District:

மொழி / மொழிபெயர்ப்பு / M.O.H. Area: 2022-23

பு.ரா.மா.மா.மா. / பி.க.செ.ப.பி.பி. / R.D.H.S. Div.

... വീ ആഴ്ച / ഞായറാഴ്ച / Week ending:

[illegible]

අත්සන / 0 ஸ்தலத்தி / க.வை.அ.கையொப்பம் / Signature of M.O.H.

உரை / திகதி / Date

Figure 1 *H-399 Form for communicating diseases by MOH to the national and regional levels (Sri Lanka)*

Figure 24: H-411 form prepared by PHI and communicated to MOH (Sri Lanka)

සෞඛ්‍ය දෙපාර්තමේන්තුව DEPARTMENT OF HEALTH		සෞඛ්‍ය 411 අ Health 411a (F* 4 S. & E.) 12/87	
<b>බෝවෙන රෝග වාර්තාව - II කොටස</b> <b>COMMUNICABLE DISEASE REPORT PART II</b>			
(සතිපතා බෝවන රෝග වාර්තාව සමග සෞ. සේ. අ. ට එවිය යුතුයි) (To be sent with Weekly Return of Communicable Diseases to D. H. S.)			
<p>(1) සෞ. සේ. අ. කො. R. D. H. S. Div. _____</p> <p>(2) සෞ. වෛ. නි. කො. M.O.H. Area: _____</p> <p>(3) සෞ. වෛ. නි. ලේ. අංකය M.O.H. Register No.: _____</p> <p>(4) රෝගියාගේ වයස Age of Patient: _____</p> <p>1 ජාති/පුරුෂ භාවය Sex of Patient: --- Male _____ Female _____</p> <p>(5) රැකියාව Occupation _____</p> <p>(7) දැනුම් දුන් ස්ථානය Source of notification: _____</p> <div style="display: flex; justify-content: space-between;"> <div style="width: 40%;"> <p>Hospital .. 1</p> <p>Dispensary .. 2</p> <p>P.H.I. .. 3</p> <p>Grama Sevaka .. 4</p> <p>School Teacher .. 5</p> <p>Private Practitioner .. 6</p> <p>Ayurvedic Physician .. 7</p> <p>Estate Superintendent .. 8</p> <p>Other .. 9</p> </div> <div style="width: 5%; text-align: center;"> <p>1</p><p>2</p><p>3</p><p>4</p><p>5</p><p>6</p><p>7</p><p>8</p><p>9</p> </div> </div> <p>විස්තර කරන්න Specify _____</p> <p>(8) රෝගය දැනුම් දුන් පරිදි Disease as notified _____</p> <p>(9) රෝගය ස්ථිර කළ පරිදි Disease as confirmed _____</p>	<p>(10) ස්ථිර කළේ: ආරෝග්‍යශාලා වෛද්‍ය නිලධාරී Confirmed by: Hospital M.O. _____</p> <p>සෞ. වෛ. නි. M. O. H. _____</p> <p>අනිකුත් රජයේ වෛ. නි. Other Govt. M. O. _____</p> <p>දැවැන්තිකර් Apothecary _____</p> <p>පුහුණු වෛද්‍ය Practitioner _____</p> <p>(11) ස්ථිර කිරීමේ ස්වභාවය Nature of confirmation: _____</p> <div style="display: flex; justify-content: space-between;"> <div style="width: 40%;"> <p>Clinical only .. 1</p> <p>Clinical and Epidemiological .. 2</p> <p>Clinical and Bacteriological .. 3</p> <p>Clinical and Serological .. 4</p> <p>Clinical, Bacteriological and Serological .. 5</p> <p>Clinical and direct Microscopy .. 6</p> </div> <div style="width: 5%; text-align: center;"> <p>1</p><p>2</p><p>3</p><p>4</p><p>5</p><p>6</p> </div> </div> <p>(12) රෝගය පටන් ගත් දිනය Date of onset _____</p> <p>(13) දැනුම් දුන් දිනය Date of notification _____</p> <p>(14) ස්ථිර කළ දිනය Date of confirmation _____</p> <p style="text-align: center;">අත්සන/සෞ.වෛ.නි/කා.භා.නි/ Signature of M.O.H/O. I. C.</p> <p style="text-align: center;">*කාර්යාලීය ප්‍රයෝජනය සඳහා පමණක් *Office Use Only</p>		

පැලකිය යුතුයි. — (1) 5, 7, 10, සහ 11 කුරුණු අදාළ කොටුවට x හැසිරවීමෙන් සම්පූර්ණ කළ යුතුයි. අනිකුත් කුරුණු සලකා ඇති ඉඩ ප්‍රමාණයට සම්පූර්ණ කළ යුතුයි. කාර්යාලීය ප්‍රයෝජනය සඳහා වෙන් කර ඇති කොටුවට නිසියම් සටහනක් නොකරන්න.

(2) 9 වැනි විෂය හැකි පමණ විස්තර සහිතව සම්පූර්ණ කළ යුතුය. උදා. "පැරා උණ සන්නිවාර උණ ව" — මෙය "ආන්ත්‍රික උණ" නොවේ.

Notes.—(1) Items 5, 7, 10 and 11 should be completed by placing a x in the appropriate box. Other items should be entered in the space provided. Please do not enter anything in space for office use.

(2) Items 9 should be completed in as much detail as possible, e.g., "Paratyphoid A" and NOT "Enteric fever".

ජ 100793—100,000 (87/12) ශ්‍රී ලංකා රජයේ මුද්‍රණ දෙපාර්තමේන්තුව

Figure 25: H-411a form communicated by MOH to regional and national levels (Sri Lanka)

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02<sup>nd</sup> - 08<sup>th</sup> December 2006

**Table 4: Selected notifiable diseases reported by Medical Officers of Health**  
**25<sup>th</sup> Nov - 1<sup>st</sup> Dec 2006 (48<sup>th</sup> Week)**

DPDHS Division	Dengue Fever / DHF*		Dysentery		Encephalitis		Enteric Fever		Food Poisoning		Leptospirosis		Typhus Fever		Viral Hepatitis		Returns Received Timely**
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	%
Colombo	86	3112	04	336	00	07	03	78	00	45	02	131	00	04	01	67	86
Gampaha	25	1673	03	300	00	10	00	57	00	147	03	200	00	11	05	143	64
Kalutara	11	886	11	472	00	07	00	77	00	59	07	114	00	06	02	44	70
Kandy	90	1265	04	425	00	09	03	112	01	35	07	90	02	96	00	129	82
Matale	16	325	09	297	00	06	00	18	00	21	03	26	00	02	03	19	67
Nuwara Eliya	02	37	04	331	00	00	02	182	00	18	00	11	00	38	14	251	86
Galle	06	218	06	182	00	03	00	13	00	12	07	59	01	16	00	04	94
Hambantota	04	210	01	93	00	09	01	32	00	32	02	49	00	83	01	57	90
Matara	15	494	03	176	00	10	03	75	00	34	07	155	08	225	02	14	100
Jaffna	00	48	00	134	00	03	00	158	00	27	00	03	00	129	00	75	00
Kilinochchi	00	01	00	23	00	00	00	06	00	24	00	00	00	00	00	08	00
Mannar	00	01	04	51	00	00	00	135	00	03	00	01	00	00	00	10	40
Vavuniya	02	12	20	140	00	04	00	91	07	79	00	02	00	00	00	08	75
Mullaitivu	00	02	01	24	00	01	00	36	00	09	00	00	00	00	01	10	50
Batticaloa	00	62	06	215	00	03	01	38	00	16	00	06	00	00	06	196	50
Ampara	00	27	00	209	00	00	00	12	00	00	00	10	00	03	00	17	14

Figure 26: Weekly Epidemiological Report (WER) published on the web by the Epidemiology Unit (Sri Lanka)

### 10.3.7.4 INDIA present disease communication web document

PHC OP Morbidity Report - Entry						
HUD : Sivaganga		Report Date : <input type="text" value="Select Date"/>				
Name of the PHC : <input type="text" value="Click here to Select PHC"/>						
PHC OP Abstract						
		Adult		Children		Tot
		Male	Female	Male	Female	Male
		<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
		<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
PHC OP Morbidity						
Description	Disease	Adult		Children		Tot
		Male	Female	Male	Female	Male
1. Respiratory System	1. Bronchial asthma	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	2. COPD	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	3. Allergic Bronchitis	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	4. LRI including Pneumonia	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	5. URI	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	6. Tuberculosis	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	7. Other Respiratory diseases	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
2. Cardiovascular System	1. Congenital heart diseases	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	2. Rheumatic heart disease	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	3. Hypertension	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	4. Ischemia including MI	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	5. Other disease related to cardiovascular system	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
3. Pyrexia related diseases	1. PUO	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	2. Viral fever	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	3. Typhoid fever	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	4. Measles	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	5. Chicken pox	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	6. Malaria	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	7. Others	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
4. Connective Tissue Disorders	1. Osteo Arthritis	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	2. Rheumatoid Arthritis	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	3. Other connective tissue disorder	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	1. Pregnancy induced hypertension	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	2. Gestational Diabetes Mellitus	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Figure 27: PART I - Public Health Center Morbidity Report Entry report (entered through the web)

Pregnancy related disorder	3. Malnutrition						
	4. Anaemia						
	5. Other related disorder						
6. Skin	1. Eczema						
	2. Tinea infection						
	3. Scabies						
	4. Leprosy						
	5. Other related skin disease						
7. Insect/animal bite	1. Dog bite						
	2. Scorpion sting						
	3. Snake bite						
	4. Other insect and animal bite						
8. Gastro Intestinal system	1. Acute diarrhoeal disease						
	2. Abdominal colic						
	3. Jaundice						
	4. Worm infestation						
	5. Amoebiasis						
	6. Acid Peptic diseases						
	7. Food poisoning						
	8. Aphthous ulcer						
	9. Other related GIT system						
9. Genito urinary system	1. Urinary tract infection						
	2. Menstrual disorder						
	3. RTI						
	4. Malignancy						
	5. Other related disease including septicemic syndrome						
10. Neurological Disorder	1. Epilepsy						
	2. CVA						
	3. Meningitis						
	4. Other neurological diseases						
	1. Sinusitis						
	2. Otitis Pharyngitis						
	3. ASOM CSOM-Middle ear infection						

Figure 28: PART II - Public Health Center Morbidity Report Entry report (entered through the web)

<b>11. ENT</b>	4. Hearing defect	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	5. Foreign body ear	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	6. Foreign body nose	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	7. Others	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<b>12. Dental</b>	1. Dental caries	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	2. Dental flurosis	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	3. Other dental problems	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	4. Gingivitis	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<b>13. Ophthalmic</b>	1. Refractive errors	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	2. Conjunctivitis	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	3. Foreign body eye	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	4. Stye	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	5. Other related disease	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<b>14. Nutritional disorder</b>	1. Anaemia	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	2. Vitamin A deficiency	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	3. Viamin B deficiency	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	4. Malnutrition	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	5. Other Vitamin deficiency	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<b>15. Endocrine system</b>	1. Diabetes Mellitus	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	2. Goitre	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	3. Others	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<b>16. All other causes</b>	1. Accidents and Injuries	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	2. Burns	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	3. Surgical related Diseases	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

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Figure 29: PART III - Public Health Center Morbidity Report Entry report (entered through the web)

### **10.3.8 The proposed hospital re-categorization**

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The network of government hospitals is primarily responsible for carrying out the curative health care delivery system. The range of hospitals includes sophisticated teaching hospitals to maternity homes and central dispensaries, which are scattered in the rural areas. Teaching hospitals, base hospitals, District general hospitals, District hospitals, peripheral units, rural hospitals, and maternity homes provide in-patient care facilities for over 95% of the patients who seek admission.

Keeping in line with the health policy of Sri Lanka it is essential that these hospitals be developed in order to ensure equity of health care delivery system. It has been stipulated in the National Health Policy developed in 1996 and the 1998 Presidential Task Force report on Health Policy Implementation that one District Hospital in every District will be upgraded in to a District General Hospital. Presently hospitals are selected for development when funds are available. Sometimes opinion based, unorganized hospital development has caused problems such as unavailability of Human Resources and logistical problems leading to under utilization of these developed hospitals.

The door to successful user-friendly hospital system hinges on evidence based, planned hospital development system. Therefore, it is proposed that a comprehensive need-based, bottom-up, hospital development plan to be developed using a participatory approach. This concept paper described the detailed steps in developing a National Hospital Development Plan.

As the first phase of the activity, it is proposed to re-categorize the hospitals into four categories, which will provide the foundation for decision making in the hospital developmental process. Once approved it is proposed to workout finer details, the infrastructure, human resources, equipment, drugs and supplies, and other logistics which will enable hospitals to be developed in a uniform manner. This proposal explicitly describes the proposed re-categorization of hospitals.

### **10.3.9 The nomenclature of hospital to be changed**

#### **Teaching Hospital/Provincial Hospital (Kurunagala)**

Teaching hospitals are those hospitals where professorial wards are established and are engaged in under-graduate and/or post-graduate training. In provinces that do not have a teaching hospital, will be developed with similar facilities. (Kurunagala is a teaching hospital)

List of Services offered:

1. Outpatient department (OPD) with separate Preliminary Care Unit, Emergency Care Unit and Screening Facilities.
2. Clinic Facilities
3. In-ward Facilities

three Medical units  
 three Surgical units  
 three Gynecology and Obstetrics units  
 three Pediatric units  
 one Neurology unit  
 one Cardiology unit  
 one Dermatology unit  
 one Psychiatry unit  
 one Rheumatology unit  
 one Oncology unit  
 one STD/AIDS unit

one Neuro-surgical unit  
 two Orthopedic surgical unit  
 two ENT surgical unit  
 two Eye surgical unit  
 one Genito-urinary surgical unit  
 one Paediatric surgical unit  
 one Nephrology unit  
 one Neo-natology unit  
 Chest Medicine  
 Transfusion Medicine

#### 4. Intensive Care Units

- Medical Intensive Care Unit (MICU)
- Surgical Intensive Care Unit (SICU)
- Cardiac Intensive Care Unit (CICU)
- Coronary Care Unit (CCU)

#### 5. Operation Theatres

#### 6. Diagnostic services

- Radiology Dept.
- Pathology Dept. with Histopathology, Hematology and Microbiology units

#### 7. Accident service/Trauma Surgery unit

#### 8. Medico-legal Department

#### 9. Maxcillo Facial Surgical Unit

#### 10. Orthodontic Unit

#### 11. Public Health Unit

#### 12. Medical Statistic Unit

#### 13. Dept. of Anesthesia

### **District General / District Base Hospitals (Kuliyapitiya, Nikaweratiya)**

All existing District general hospitals and base hospitals will be renamed as District base hospitals. Each District will have one District general hospital and one or two District base hospitals to fulfill the needs of the population.

**List of Services offered:**

1. Outpatient Department (OPD) with separate Preliminary Care Unit, Emergency Care Unit and Screening Facilities.
2. Clinic Facilities
3. In-ward Facilities

Two Medical units  
 Two Surgical units  
 Two Gynecology and Obstetrics units  
 Two Pediatric units  
 one Psychiatry unit  
 one Dermatology unit  
 one Orthopedic surgical unit  
 one ENT surgical unit  
 one Eye surgical unit  
 two Anesthesia Units

4. Intensive Care Unit
5. Operation Theaters
6. Diagnostic services
  - Radiology Dept.
  - Pathology Dept.
7. Medico-legal Dept.
8. Maxillo facial Surgical Unit
9. Public Health Unit
10. Medical Records Unit

**Divisional Hospitals**

All District hospitals, rural hospitals, and peripheral units Will be re-named as Divisional hospitals (DH) irrespective of the number of beds.

Type A DH – More than 100 patient beds  
 Type B DH – Between 50-100 patient beds  
 Type C DH – Fewer than 50 patient beds

Each DDHS area is to be served by one divisional hospital according to availability of resources.

**List of Service offered:**

1. Outpatient care with a ETU for limited emergency and screening
2. Basic laboratory facilities

3. Minor operation facilities
4. Lab our room
5. Wards:
  - one Maternity ward
  - one male and one female Medical and Surgical ward
  - One children's ward
6. Dental unit
7. Facilities for continuation of treatment of patient referred by secondary and tertiary medical institutions for a limited period of time
8. Facilities for a polyclinic including Ante-Natal, Post Natal, Family Planning, Child Health, Well Women clinic etc.
9. Ambulance

(Services of visiting consultants will be available in some of these hospitals through outreach clinics)

### **Primary Medical Care Units**

Central Dispensaries &

- Maternity Homes will be renamed as PUC

List of Services offered:

1. Outpatient care
2. Limited emergency care: facilities for stabilization of patients before referring to secondary or tertiary care medical institutions.
3. Facilities for a poly-clinic including ante-natal, post-natal, family planning, child health, and well-women.

## **Acknowledgement**

The information on this topic was obtained with the assistance of Mr. P.V. Ariyawansa, Executive Assistant/District Coordinator, Sarvodaya, Kurunegala District Office, Kuliyaipitiya, Sri Lanka and Mr. Neil Sirisena, District Health Education Officer, Medical Officer of Health Office, Kuliyaipitiya, Sri Lanka.

### **10.3.10 ICD 10 Examples**

B01 Chickenpox (Varicella)	diffuse papulovesicular rash; vesiculopustular rash appearing on the trunk and face; Detection of viral antigen; Isolation of the virus from skin scraping Demonstration of specific IgM in a serum
A00 Cholera	severe dehydration, acute watery diarrhea, vomiting; isolation of <i>Vibrio cholera</i> O1 or O139 from stools
A90 Dengue Fever	An acute febrile illness of 2-7 days duration with 2 or more; of the following: headache, retro-orbital pain, myalgia, arthralgia, flushed

	<p>extremities, tender hepatomegaly, rash, eucopenia, thrombocytopenia and hemorrhagic manifestations</p> <p>Isolation of the dengue virus from serum, plasma, leukocytes, or autopsy samples. Detection of viral genomic sequences serum, CSF or autopsy tissues by polymerase chain reaction (PCR).</p> <p>Demonstration of a fourfold or greater rise in IgG titer to one or more dengue virus antigens in paired serum samples by ELISA or HI assay.</p>
A91 Dengue Hemorrhagic Fever / Dengue Shock Syndrome	<p>Rapid and weak pulse, narrow pulse pressure (- 20 mmHg) or hypotension for age, cold clammy extremities and restlessness. Positive tourniquet test Petechiae, ecchymosis or purpura Bleeding: mucosa, gastrointestinal tract, injection sites or other Hematemesis or melaena and thrombocytopenia (100,000 cells or less per mm<sup>3</sup>) and evidence of plasma leakage due to increased vascular permeability, manifested by <math>\geq 20\%</math> rise in average hematocrit for age and sex <math>\geq 20\%</math> drop in hematocrit following volume replacement treatment compared to baseline signs of plasma leakage (pleural effusion, ascites, hypoproteinaemia)</p> <p>Isolation of the dengue virus from serum, plasma, leukocytes, or autopsy samples Detection of viral genomic sequences in autopsy tissue, serum or CSF samples by polymerase chain reaction (PCR) Demonstration of a fourfold or greater change in IgG titer to one or more dengue virus antigens in paired serum samples by ELISA or HI assay</p>
A 36 Diphtheria	<p>stridor characterized by laryngitis, pharyngitis or tonsillitis, and adherent membranes of tonsils, pharynx and/or nose. Isolation of toxigenic <i>Corynebacterium diphtheria</i> from a clinical specimen. A rise in serum antibody (fourfold or greater)</p>
02, A 03, A 04, A 06, A 09 Dysentery	<p>diarrhea with blood and or mucus and with or without fever, nausea, abdominal cramps, and tenesmus. Stool culture and ABST for sensitivity pattern.</p>
G04 Encephalitis	<p>A febrile illness of variable severity associated with neurological features ranging from headache to alteration of level of consciousness and signs and symptoms suggestive of meningitis and encephalitis. Symptoms can include headache, fever, meningeal signs, seizures, stupor, disorientation, coma, tremors, paresis (generalized), hypertonia, loss of coordination.</p> <p>Fourfold or greater rise in JE virus-specific IgG antibody in paired sera (acute and convalescent phases), ELISA, haemagglutination inhibition test or virus neutralization test, in a patient with no history of recent yellow fever vaccination and where cross-reactions to other flaviviruses have been excluded JE virus specific IgM antibody in a single blood sample in late acute phase or early convalescence</p>

	JE virus-specific IgM antibody in the CSF by IgM capture ELISA or Detection of the JE virus, antigen or genome in brain, spinal cord by immunochemistry or immunofluorescence or PCR
A01 Enteric Fever (Typhoid Fever)	<p>insidious onset of sustained fever, headache, malaise, anorexia, in children coated tongue, relative bradycardia, splenomegaly, constipation or diarrhea, nonproductive cough and may have a skin rash.</p> <p>Enteric fever – Isolation of <i>Salmonella typhi</i> from blood, stool or other clinical specimen. Serological tests based on agglutination antibodies (SAT) are of little diagnostic value because of limited sensitivity and specificity. However, the demonstration of a fourfold rise in antibody titre is confirmatory of salmonella infection.</p>
A02, A05, T61, T 62 Food Poisoning	<p>Acute gastroenteritis in a person linked to an ingested food or liquid: or an outbreak of acute gastroenteritis in two or more persons linked by common exposure to a food or liquid ingested</p> <p>Isolation of certain food borne organism (e.g. <i>Salmonella</i>) or toxins from relevant clinical samples. Isolation of suspected organism in sufficient quantities from incriminated food samples or detection of toxins from food samples.</p>
A82 Human Rabies	<p>Acute neurological syndrome (encephalomyelitis) characterized by forms of hyperactivity in the majority of subjects (furious rabies) or paralytic syndromes seen less often (dumb rabies) which progresses towards coma and death usually by respiratory failure, within 10 to 14 days after developing the first symptom, if no intensive care is instituted. An exposure could be bites, scratches, contamination of mucous membranes or contamination of an open wound with saliva from a suspected rabid animal, which usually should be obtained from the patient's medical history. The incubation period may vary from less than 1 week to more than 1 year, but usually falls between 30-90 days.</p> <p>Detection of rabies viral antigens by direct fluorescent antibody (FA) in clinical specimens, preferably brain tissue (collected at post mortem)</p> <p>Detection by FA on skin or corneal smear (collected ante mortem)</p> <p>FA positive after inoculation of brain tissue, saliva or CSF in cell culture, or in mice by intracerebral inoculation</p> <p>Detectable rabies-neutralizing antibody titre in the CSF of an unvaccinated person</p> <p>Identification of viral antigens by PCR on fixed tissue collected post mortem or in a clinical specimen (brain tissue or skin, cornea or saliva)</p> <p>Isolation of rabies virus from clinical specimens and confirmation of rabies viral antigens by direct fluorescent antibody FA testing</p>

A27 Leptospirosis	<p>Acute febrile illness with headache, myalgia and prostration associated with any of the following symptoms: conjunctival suffusion / conjunctival hemorrhage meningeal irritation anuria or oliguria / proteinuria / hematuria jaundice hemorrhages (from the intestines; lung bleeding is notorious in some areas), purpuric skin rash cardiac arrhythmia or failure and a history of exposure to infected animals or an environment contaminated with animal urine; commonly as an occupational hazard.</p> <p>Other common symptoms include nausea, vomiting, abdominal pain, diarrhea, and arthralgia.</p> <p>Direct microscopy (dark ground) of blood and urine Isolation from blood or other clinical materials through culture of pathogenic leptospirosis Positive serology, preferably Microscopic Agglutination Test (MAT), using a range of Leptospira strains for antigens that should be representative of local strains or using a non-pathogenic leptospira strain to detect genus specific antibodies with a 4 fold rise.</p>
B50 - 54 Malaria	<p>A patient residing in malaria endemic area or having a history of visiting a malaria endemic area, presenting with fever or history of fever with chills &amp; rigors and headache. ( Nonspecific symptoms otherwise unexplained, includes – Myalgia, backache and joint pain)</p> <p>Demonstration of malaria parasites in blood films (mainly asexual forms) by Microscopy or Antigen detection by Rapid Detection Test.</p>
B05 Measles	<p>Fever and Maculopapular (i.e. non-vesicular) rash and at least one of the following: Cough, Coryza (i.e. runny nose), Conjunctivitis (i.e. red eyes)</p> <p>Detection of measles specific IgM antibodies in blood collected within 3-28, days of onset of rash</p> <p>Isolation of measles virus from urine, naso-pharyngeal aspirates or peripheral blood lymphocytes during the prodrome or rash stages of the disease</p>
G00, A87 Meningitis	<p>Fever of acute onset with one or more of the following signs of meningeal, irritation/inflammation, Neck stiffness, Irritability, Poor sucking (in infants), Seizures, Bulging fontanel (in infants), Other signs of meningeal irritation/inflammation, Altered consciousness</p> <p>Culture: Isolation of a causal organism by culturing CSF and/or blood. Antigen Detection: Demonstration of an antigen of a causal organism by methods such as latex agglutination or counter-immunoelectrophoresis, in CSF and/or blood.</p>
B26 Mumps (Infectious Parotitis)	<p>An illness with acute onset of unilateral or bilateral tender, self-limited swelling of the parotid or other salivary gland, lasting more than or equal to 2 days, and without other apparent cause.</p>

	Demonstration of mumps specific IgM antibody in a single serum sample.
A20 Plague	<p>Rapid onset of fever, chills, headache, severe malaise, prostration, with bubonic form*- extreme painful swelling of lymph nodes (buboes) in axilla or groin, pneumonic form*- cough with blood-stained sputum, chest pain, difficulty in breathing</p> <p>*Both forms can progress to septicemic form with toxemia; characterized by disseminated intravascular coagulation, hypotension and cardiac failure.</p> <p>Isolation of Yersinia pestis in cultures from buboes, blood, CSF or sputum or Passive haemagglutination (PHA) test, demonstrating an at least fourfold rise in antibody titre, specific for F1 antigen of Y. pestis, as determined by the haemagglutination inhibition test (HI) in paired sera.</p>
B06 Rubella	<p>An illness that has following characteristics: Acute onset of generalized maculopapular rash Temperature greater than 99.00F (greater than 37.20C), Arthralgia/arthritis, lymphadenopathy (Usually sub occipital, post auricular and cervical) or conjunctivitis</p> <p>Detection of Rubella specific IgM in blood specimen obtained within 28 days of onset of the rash. Either seroconversion or four fold rise of IgG antibody between acute and convalescence samples.</p>
P35 Congenital Rubella Syndrome (CRS)	<p>Surveillance case definition An illness usually manifesting in infancy resulting from rubella infection in utero and characterized by signs or symptoms from the following categories*: Cataracts/congenital glaucoma, pigmentary retinopathy, congenital heart disease (most commonly patent ductus arteriosus, or peripheral pulmonary artery stenosis), loss of hearing, purpura, splenomegaly, jaundice, meningoencephalitis, microcephaly, mental retardation, radiolucent bone disease, laboratory data consistent with congenital rubella infection</p> <p>*Some children may have only one symptom</p> <p>Demonstration of a rubella specific IgM antibody in the infant. Almost all infants with CRS will have a positive rubella specific IgM in the 1st 6 months of life and 50-60% will be positive during the 2nd 6 months of life. Demonstration of a significant rise in Rubella specific IgG antibody in the infant during follow up or IgG rubella antibody level that persists at a higher level and for a longer time period than expected from positive transfer of maternal antibody (Maternal IgG antibody persists up to six months of age and then gradually disappears).</p>

Not classified - Severe Acute Respiratory Syndrome (SARS)	<p>Fever (<math>\geq 38^{\circ}\text{C}</math>) and One or more symptoms of lower respiratory tract illness (cough, difficulty in breathing, shortness of breath) and Radiographic evidence of lung infiltrates consistent with pneumonia or Respiratory Distress Syndrome (RDS) or autopsy findings consistent with the pathology of pneumonia or RDS without an identifiable cause. And No alternative diagnosis can fully explain the illness and History of visit to an affected area or close contact with a patient suspected to have SARS; within 10 days of the onset of the illness</p> <p>Isolation of SARS virus from nasopharyngeal aspirate, blood or stools.</p> <p>Detection of rising titres of SARS viral antibody between acute and convalescence samples.</p>
Not classified – Simple Continued Fever of 7 days or more	A febrile illness lasting 7 days or more where no cause is found even after seven days provided basic investigations have been carried out.
A35, A34 -	<p>Clinical picture compatible with Tetanus: Acute onset of hypertonia and/or painful muscular contractions (usually of the muscles of the jaw and neck) and generalized muscle spasms without other apparent medical cause.</p> <p>Diagnosis is mainly dependent on the clinical criteria.</p> <p>Detection of tetanus toxoid antibody in an unvaccinated and untreated patient and demonstration of a specific tetanus toxoid antibody response in a laboratory where appropriate laboratory facilities are available.</p>
A33 - Neonatal Tetanus	Any neonatal death between 3 – 28 days of age in which the cause of death is unknown or Any neonate reported as having suffered from neonatal tetanus between 3 – 28 days of age and not investigated.
A15 – A19 Tuberculosis (Pulmonary)	Signs and symptoms suggestive of tuberculosis particularly cough of three weeks duration or more. Symptoms suggestive of Tuberculosis: Hemoptysis Loss of appetite Shortness of Breath Loss of weight Fever and night sweats Tiredness. Smear positive patient: Two sputum smears are positive for Acid Fast Bacilli (AFB), One sputum smear positive for AFB and radiological abnormalities consistent with active pulmonary tuberculosis, One sputum smear positive for AFB and culture positive for Mycobacterium tuberculosis Smear negative patient with positive culture.
A75 Typhus Fever	An acute febrile illness associated with an eschar, headache, macular popular skin rash conjunctival injection, lymphadenopathy and profuse sweating and cough. Defervescence within 48 hours following Tetracycline therapy strongly suggestive of Rickettsial

	<p>infection. Eschar may or may not be present History of tick bite or travel to scrub areas Rash may be overlooked in patients with dark skin</p> <p>Demonstration of a fourfold rise in antibody titre by Weil-Felix test or IF test. The Weil-Felix test is less specific and less sensitive than the IF test. The Weil-Felix test is currently available at the Medial Research Institute and the IF test will be available in the future.</p>
B15 – B19 Viral Hepatitis	<p>Acute illness including acute jaundice, dark urine, anorexia, malaise, extreme fatigue, and right upper quadrant tenderness.</p> <p>Hepatitis A: Demonstration of Hepatitis A IgM Antibody in a serum sample.</p> <p>Hepatitis B: Demonstration of Hepatitis B surface antigen (HBsAg) or HBc antigen IgM in a serum sample. 38</p> <p>Note 1: The anti-HBc IgM test, specific for acute infection, is not available in most countries. HBsAg, often available, cannot distinguish between acute new infections and exacerbations of chronic hepatitis B, although continued HBsAg seropositivity (&gt;6 months) is an indicator of carrier stage.</p> <p>Note 2: For patients negative for hepatitis A or B, further testing for a diagnosis of acute hepatitis C, D, or E is recommended. anti-HCV positivity in a previously negative person</p> <p>Hepatitis C: (seroconversion)</p> <p>Hepatitis D: Anti-HDV positive HBsAg positive or IgM anti-HBc positive (only as co-infection or super-infection of hepatitis B)</p> <p>Hepatitis E: IgM anti-HEV positive</p>
A37 Pertussis / Whooping Cough	<p>A person with a paroxysmal cough* with at least one of the following**: inspiratory 'whooping', post-tussive vomiting (i.e. vomiting immediately after coughing), Subconjunctival hemorrhage without other apparent cause, *In older children if cough lasts more than two weeks **In neonates apneic attacks may be present</p> <p>Isolation of Bordetella pertussis or Bordetella parapertussis Detection of genomic sequences by polymerase chain reaction (PCR).</p>
A95 Yellow Fever	<p>A disease characterized by acute onset of fever followed by jaundice within 2 weeks of onset of first symptoms. Hemorrhagic manifestations and signs of renal failure may occur; and a history of travel to a Yellow fever affected area within the last six days (longest incubation period for yellow fever)</p> <p>Isolation of yellow fever virus, or Detection of yellow fever specific IgM or a four-fold or greater rise in serum IgG levels in paired sera (acute and convalescent) or Positive post-mortem liver histopathology or Detection of yellow fever antigen in tissues by immunohistochemistry</p>

	Detection of yellow fever virus genomic sequences in blood or organs by PCR
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# 11 APPENDIX B – Software Requirement Specification

## 11.1 *Shana Biosurveillance Case Management Module and Database*

### 11.1.1 Overview

The Sahana Disease Surveillance Module (abbreviated as SHN BSM) intends to capture human health records, analyze the data, and report on the data. The Real-Time Biosurveillance Program (RTBP) will be field-testing the software in India and Sri Lanka with the assistance of actual healthcare workers in the rural setting.

The main functional components are – mobile phone j2me application for capturing health records, a database housing the health records, a PHP front end browser application for managing the database information, a browser based C/C++ statistical data mining software for detecting adverse events, and PHP applications for issuing reports to a personal computers and mobile phones via Email, HTTP/WAP posts, and SMS.

This document describes the functional requirements of the GUI components for capturing and reporting the data through desktop web applications. The GUIs will follow a web based structure developed using PHP with control objects to capture person, location, service, facility, and case (disease, symptoms, and signs) information.

The information captured will be stored in a backend MySQL DB with all relevant components named with the prefix “BSM.” In general, the transactional data is gathered via the mobile application; however, the SHN BSM GUIs will provide an alternate computer interfaces for managing the data.

### 11.1.2 Network Architecture

The software architecture will strongly consider the network capabilities and capacities when designing the software. The RTBP software is for the developing world and designed to be accessible via “bottom of the pyramid” affordable ubiquitous terminal devices such as around United States Dollar One Hundred mobile phones. Another aspect to bear in mind is the reliability (coverage and certainty) and affordability of network connectivity. Although GPRS is assumed to solve the internet connectivity problem or EDGE to solve the broadband problem the availability or reliability of these technologies are questionable in the rural settings. However, SMS that functions on the mobile voice service platform is far more reliable but is a lot more expensive than transporting data over GPRS. Developers should investigate the possibility of using alternate technologies such as SMS for exchanging data for redundancy in applications that depend on real time data exchange. Figure 30 shows possible combinations of communication infrastructure required to communicate between remote sites and central servers.

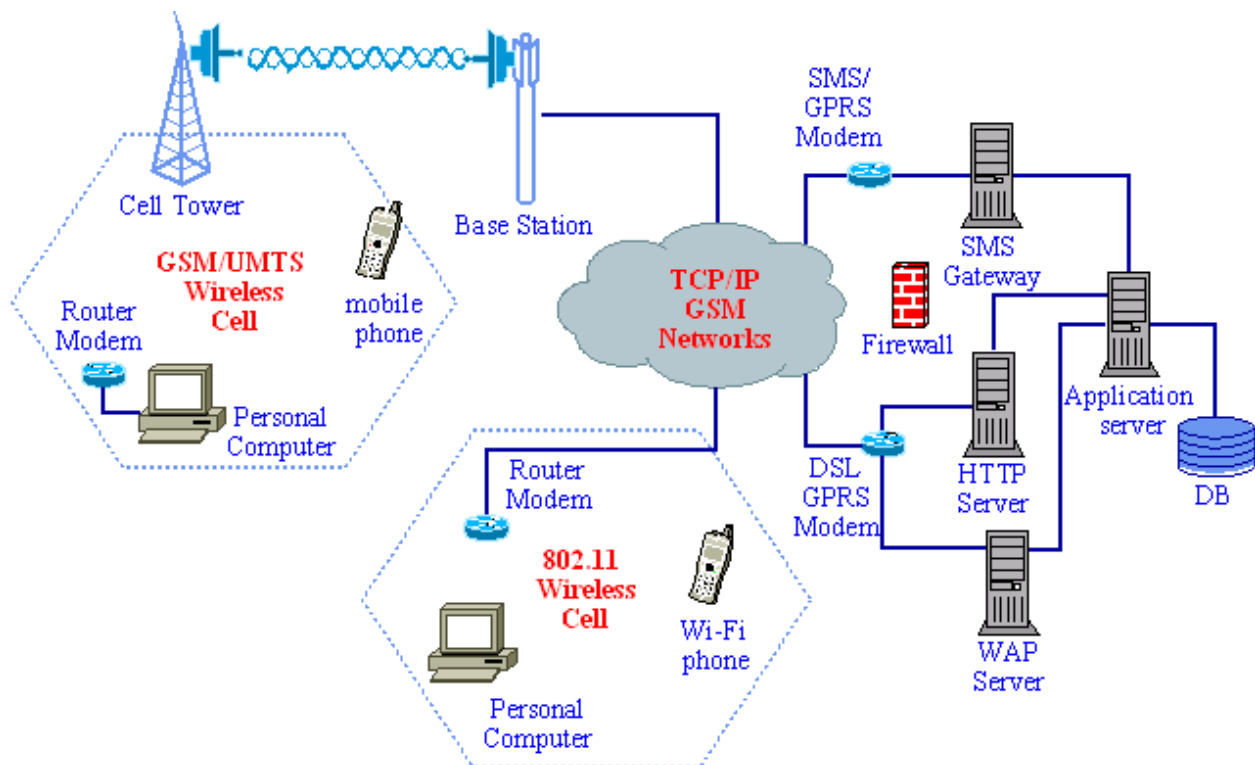


Figure 30: SHN-BSM Communication Architecture

It is important to design the software such that it does not cost the data throughputs or communication overheads. It is easy to get carried away with “all you can eat” DSL networking packages and avoid optimizing the data payloads across the networks. While there may be not much flexibility in optimizing the free text strings, dates, and time it is possible to enumerate fixed list values often used in drop down lists and pass the integer value that takes less capacity than the entire string would. Optimization strategies of this sort will also maximize the throughputs or efficiencies in ever

congesting networks.

The network may experience reliability issues; especially with weak wireless signals for communicating data via GSM networks. Therefore, terminals devices must have methods to buffer the data, especially on the client side. This applies not only to mobile phones but also to PCs connected via GPRS/SMS modems.

Very thin client and heavy server based WAP accessible applications for mobile terminal devices may be perceived as an effective way to deploy scalable solutions. Establishing poorly available connectivity may cause disappointment with the users with frustrations of connecting and downloading bits from the server. Therefore, the user perceived performance problem could be eliminated by providing hand held device resident applets that provide the functionality for data manipulation and use network connectivity purely to exchange the data between the server and client and not have to burden the network with exchanging GUI specific data as in the case of web pages.

The software components should be reused when scaling for different uses and any new configurations should be backward compatible and not affect any deployed components. For example, mobile phones equipped with WAP 2.0, MIDP 2.0 and CLDC 1.1 should be able to accommodate WAP 1.0, MIDP 1.0 and CLDC 1.0. PHP code must be backward compatible thus run on PHP4.0 inherent browser applications as well as PHP5.0 inherent browser applications.

The DB and UIs should be portable, even though first designed to run on MySQL database and PHP front end programming language the DB will be ported to run on any SQL based DB. Thus, the connection component will be independent of the vendor specific connection and shall use ADODB or OLEDB connections generic to most popular DBs.

Ability to add components in the future without having to commit to expensive software architectural or structural changes; i.e. scaling is yet another feature. The data and the components must be independent of the transport protocols or network transport layers. Any parsers or translators that process data received via various transport technologies should be generic and should not be affected by scaling the back end objects to provide additional functionality.

Allocation of abstract functionality within components simplifies extending the functionality via various terminal devices and networks. However, the individual components must be less complex. All actors including users and programmers should be able to understand and verify the concepts and functionality with utmost certainty (i.e. near zero complexity).

Any new additions to the code should not negatively affect the rest of the code (i.e. address evolvability). For example, the entity “service” (see section 7.2) is a bare minimal design at the moment which can be extended to fulfill requirements of Inventory services. Extending the service entity to address the Inventory component should not compromise the case, person, or facility services used in the Biosurveillance module. Some customization is required to address the terminal device specific UIs such as mobile phone WAP interface, mobile phone SMS interface, PC based HTTP interfaces.

### 11.1.3 Software Architecture

Figure 31 provides a very high-level network based client-server layered architecture of the RTBP software components. The communication between components is through messaging passing by “requests,” “posts,” and “gets.”

Layered architecture is designed such that the layers to the left in Figure 31 does not have to know the mechanics of the layer to the right unless in the case the object specific to that layer and provides similar functions as an object in a layer to the right; e.g. the Module SITREP contains an objects called EDXL/CAP, which is a stand-alone object specific to this module but will inherit some of the core objects but if needed will bypass the core layer and associated or inherit with the Database objects.

The levels of abstraction are encapsulated within each of the layers to minimize the complexity of the overall architecture. Figure 31 provides a Domain Specific Software Architecture (DSSA); however, provides the flexibility to reuse most of the objects to address alternate domain requirements; to give an example – Facilities, Person, and Location objects can be applied to generate a Camp Registry Module for managing internally displaced persons after a disaster or the SITREP module can be used to communicate pre and post situation reports of any disaster.

The remote session style architecture allows client side processing to a certain extent as in the case of data capture through the mobile phones using a J2ME applet. Minimizing on the remote data access accept for the occasional case of updating the static datasets in the mobile application. This minimizes the number of server calls and reduces complexity in terms of issues related to unreliable connectivity.

Although WAP as a gateway parser and PDA as a terminal device are included in the diagram (Figure 31) during this phase of the RTBP pilot, these components will not be developed but illustrated to highlight the flexibility of the architecture.

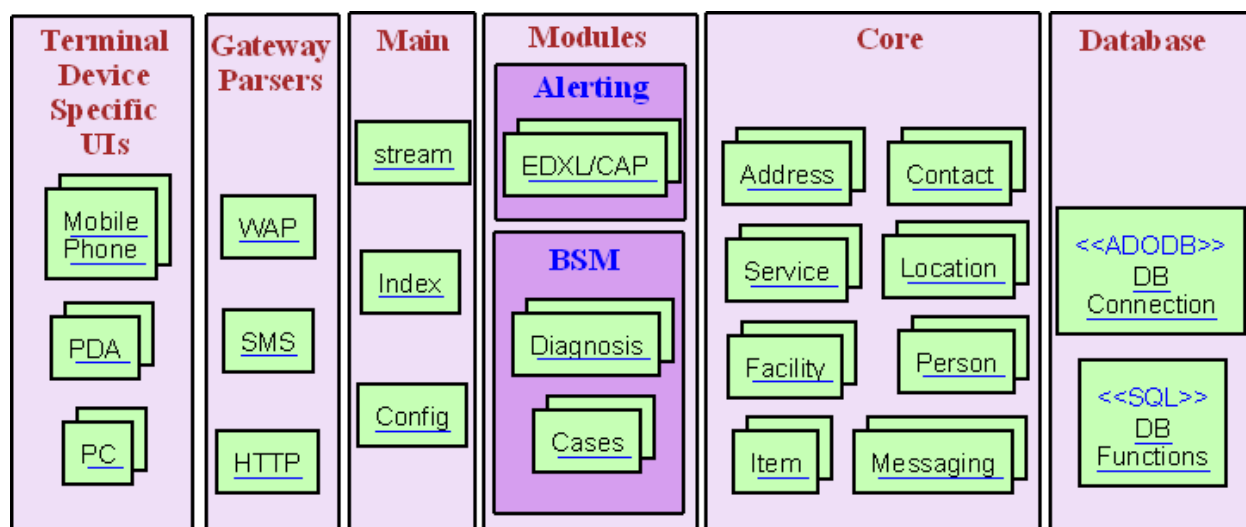


Figure 31: Layers and objects of the complete Biosurveillance product software architecture

Table 30 Layers, objects, and descriptions of elements in the layers in Figure 31

<b>Object</b>	<b>Brief description</b>
<b>Layer: Database</b>	
DB Connection	Uses the PHP ADODB to provide the connectivity to the database for accessing data
DB Functions	Standard set of Sahana functions based on: SELECT, UPDATE, DELETE, INSERT, SHOW, CREATE TABLE, etc. to provide the Sahana specific logic is provided by this object (handler-db.inc)
<b>Layer: Core (reusable abstract classes)</b>	
Item	Basic element that describes a physical object in relation to “inventory management”; i.e. management of matter in time and space.
Person	Person inherits the core classes: <<contact>> and <<address>> to identify a person’s communication and habitat information.
Location	This may be an abstract class with respect to Sahana but inherits the <<GIS>> class to provide GIS features, especially with Google Maps. A location may be take on any geometric shape: point, line, circle, rectangle, polygon,
Facility	Facilities in relation to Health disease surveillance are mostly hospitals, clinics, etc. but can be extended to accommodate any building, property, or infrastructure. Even a camp to house internally displaced people is regarded as a facility. The shape or position of a facility is defined by a location; hence inherits the <<location>> class.
Contact	A contact is a “mode” or “method” to communicate with a person or facility. It is an abstract class.
Address	Address is an abstract class that is related to the postal address of a person or facility.
Service	A service defines a process carried out at a location on a set of items by a processor (e.g. person or machine) on another object such as a person, facility, case, etc. Therefore, a service inherits <<person>>, <<location>>, and <<item>> classes.
Messaging	A message is information sent by a “sender” to one or more “recipients” in the form of voice, text, graphic mediums. This class inherits <<person>>, <<location>> and <<contact>> classes
<b>Layer: Modules</b>	
BSM: Diagnosis	Diagnosis is an abstract class that constructs the relationships between disease, symptoms, sign, and causality factor. These objects will be inherited by the cases class.
BSM: Cases	Module inherits <<person>>, <<location>>, <<facility>>, <<service>>, <<address>>, and <<contact>> core objects along with the module specific health object: <<cases>> to produce the Disease Surveillance (Biosurveillance) functional module.
Alert: EDXL/CAP	Module inherits <<person>>, <<messaging>>, <<location>>, and <<contact>> core objects along with the module specific emergency communication standards based object: <<EDXL/CAP>> to produce the

	SITuation REPort functional module.
<b>Layer: Main</b>	
Config	“Configuration” (config.inc) file contains the DB (e.g. MySQL), Web service (e.g. Apache), and other installation specific information
Index	Sahana uses a REST like architecture with the index.php as the main API two main parameters: module and action to specify the module containing the object and the action specifying the function to call in the module.
Stream	The method in which data is streamed depends on the terminal device specific application. The desktop web Sahana application uses normal HTTP streaming to apply CSS with banners and theme to provide a uniform look and feel; while J2ME mobile phone application uses pure TEXT streaming to avoid overhead in the data transmitted from server to mobile phone.
<b>Layer: Gateway Parser</b>	
WAP	WAP UIs accessing the Sahana objects, such as mobile phones with GPRS, will use this object, which will parse the function to interpret and present in a way understood by the Module, Core, and Main classes.
HTTP	HTTP UIs accessing the Sahana objects, such as PCs through a browser and DSL/UMTS connections, will use this object, which will parse the function to interpret and present in a form understood by the Module, Core, and Main classes. If the Module, Core, and Main classes are developed in PHP, parsing will not be required, since they are written in PHP as well. However, a JSP or ASP function will need to be parsed to transform the function call to be recognized by PHP code.
SMS	UIs exchanging data via SMS the transport with the Sahana object will use this object, which will parse the function to interpret and present in a way understood by the Module, Core, and Main classes.
<b>Layer: Terminal device specific UIs</b>	
Mobile Phone	The miniaturization aspect of the mobile phone and J2ME specific application development restricts the flexibility in adopting this terminal device for data communication. Network efficiencies also constraints transporting data over GPRS/EDGE or SMS transports. WAP gateway allows connecting to a server to exchange information. On board applet can use HTTP, WAP, or SMS gateway for connectivity and communicate information with the DB.
Personal Digital Assistant	PDAs will act in the same manner as desktop web application, where the modules can be accessed via GPRS. Given PDA is J2ME compliant, can execute the same applications developed for the mobile phones.
Personal Computer	PCs provide the best in terms of flexibility and comprehensive functionality; however, does not provide the mobility relative to mobile phones or PDAs. Connectivity can be provided through DSL, UMTS, or GPRS/SMS modems with browser based or desktop applications connecting via the HTTP gateway.

#### **11.1.3.1 External Interfaces**

- Public IP address with ISP to access the web server
- DSL or GPRS/SMS modem to with cables (serial or UTP) to connect to internet
- Intel or Sun server to install the database and web server
- Web server (IIS or Apache) with alias directory system
- Database (MySQL) to install the tables
- Operating system (Windows or Linux) for the RDBMS and Web server to run on
- Browser (Firefox or Explore) to access the application

#### **11.1.3.2 Design Constraints**

The design constraints are the same for all DB, Core, Main, Module, and Gateway Parser components; therefore, this section provides a general set of design constraints for all.

- Programming language must be a web browser executable code base like PHP, Python, ASP, etc.
- The GUI should be independent of the available databases such as MySQL, MS SQL, Oracle, DB2, etc.
- Accessing the software is independent of the network connectivity
- Usability of the GUIs will vary upon the terminal device; e.g. PC with Firefox browser will not have the same restrictions as a mobile phone with WAP
- Software development tools should not violate open source standards; i.e. if another programmer wants to change the source code the source code should be independent of the tool used to write the source code
- If using dependent module such as GIS or other the installation and implementation should not be cumbersome and force too many system changes
- The main functions should be written such that they can be used by other GUIs such as a desktop GUI or mobile phone GUI.
- Super user and users must be able to access the information directly from the main menus
- Navigate through the search result set 20 records at a time

#### **11.1.4 Main Scenarios**

The main scenarios are identical for the entire set of Core and Module objects, which are the search, edit, add, delete, and associate (lookup) sequences. The generalized version of the scenarios will be discussed in this section and any deviations will be discussed in the relevant sections.

##### Edit records

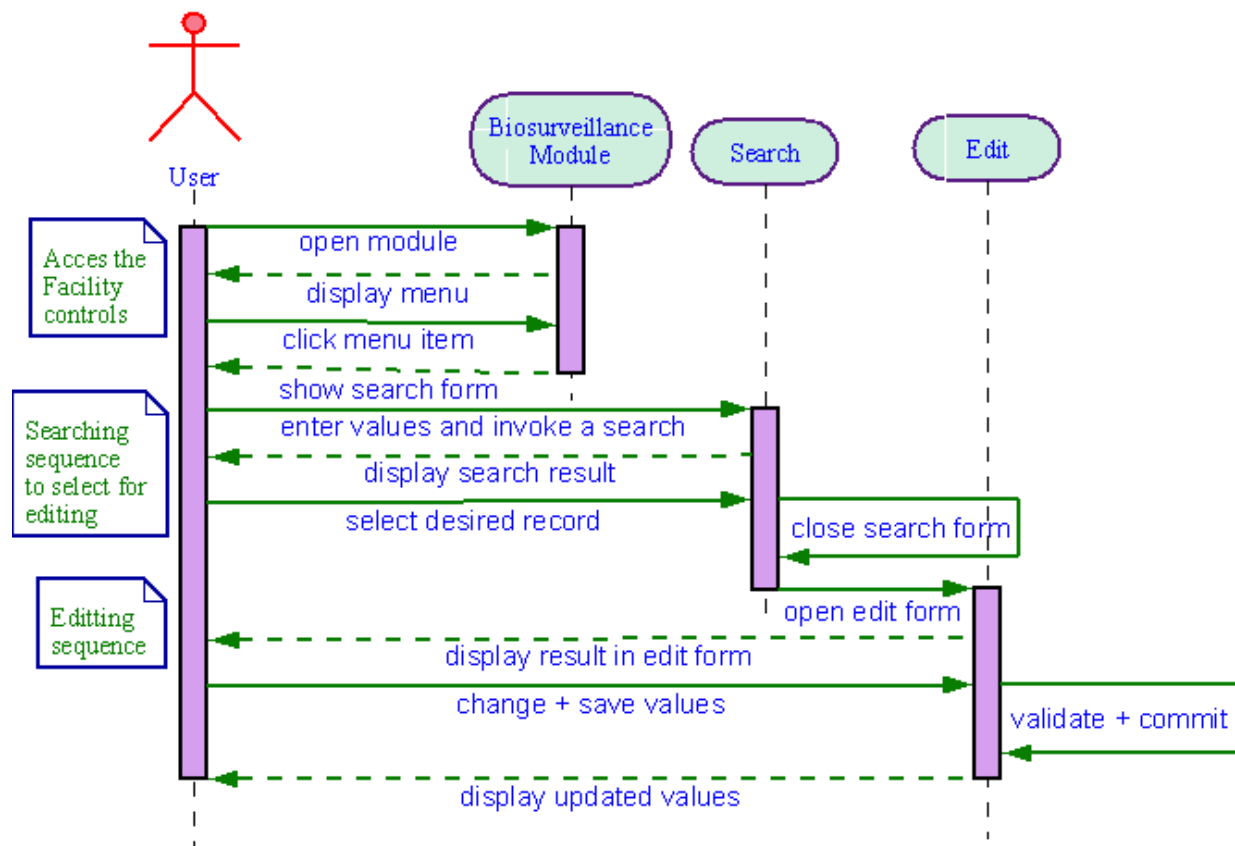


Figure 32: Edit sequence diagram

- Select the desired entity object controls through the main menu by clicking the menu item
- The search form is presented to the user with attributes to filter the search
- User will select values from presented lists and enter partial or full text in free text controls and invoke the process to retrieve records from database
- The returned result set, based on search criteria, is presented in tabulated form giving the user the option to select a desired record for editing or search again with new set of filter values (or criteria)
- Upon selection of record from presented list, the record is displayed in the edit control form to change values and save to update record in database.
- Updated record is displayed in same edit form

### Add records

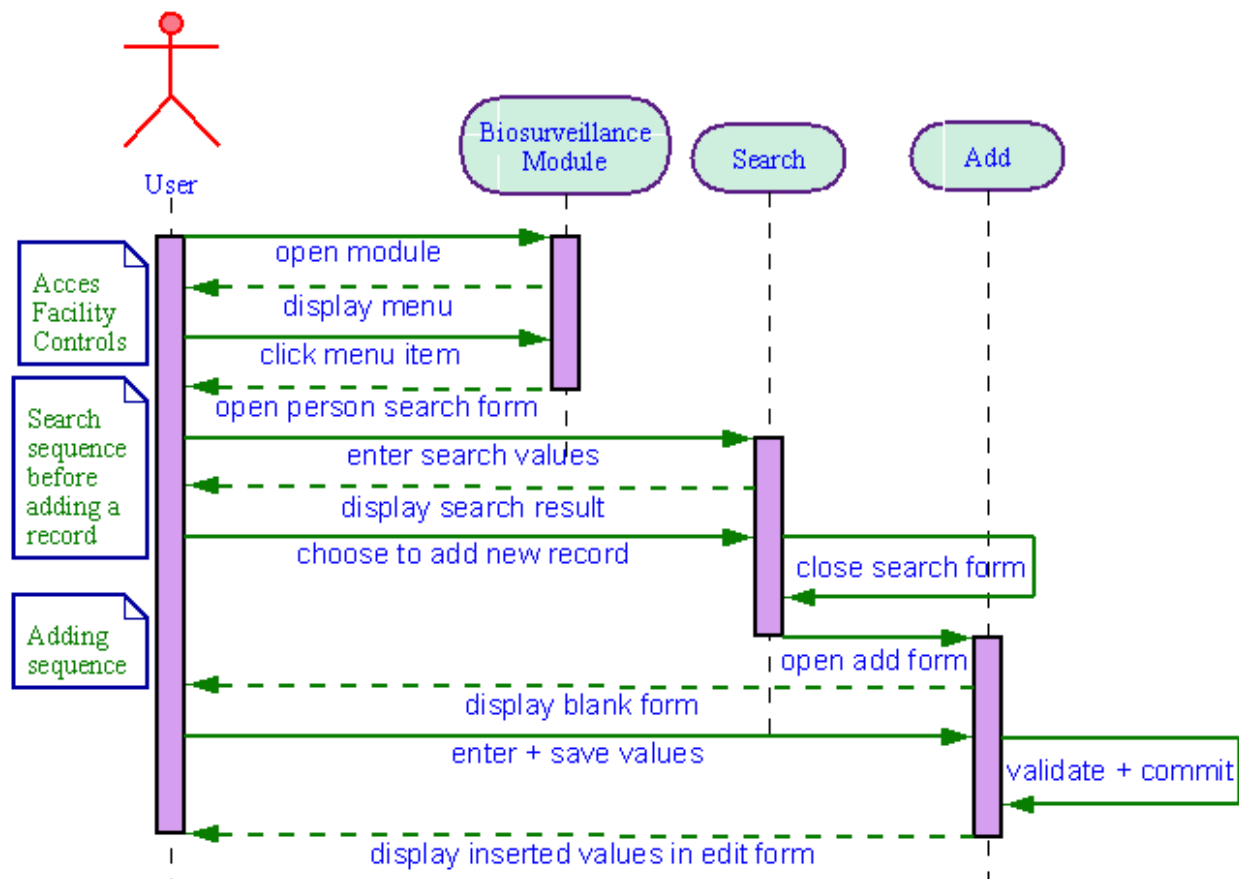


Figure 33: Add sequence diagram

- Select the desired entity object controls through the main menu by clicking the menu item
- The search form is presented to the user with attributes to filter the search
- User will select values from presented lists and enter partial or full text in free text controls and invoke the process to retrieve records from database
- The returned result set, based on search criteria, is presented in tabulated form giving the user the option to select a desired record for editing or search again with new set of filter values (or criteria)
- If search does not return the desired value then the user has the option of adding a new record by clicking the “add” record control.
- The user is presented with a blank form with the preset list values to select from and cleared text and date controls to set the values.
- Upon completion the form values are save by invoking the save control and also committing the record to the DB.
- The committed record is repainted or displayed in the edit control form with options to edit the values and also set the associated information. These related entities (or objects) are not accessible until the primary details are committed to database and a uuid is available to make the relationships with associated entities.

### Delete records

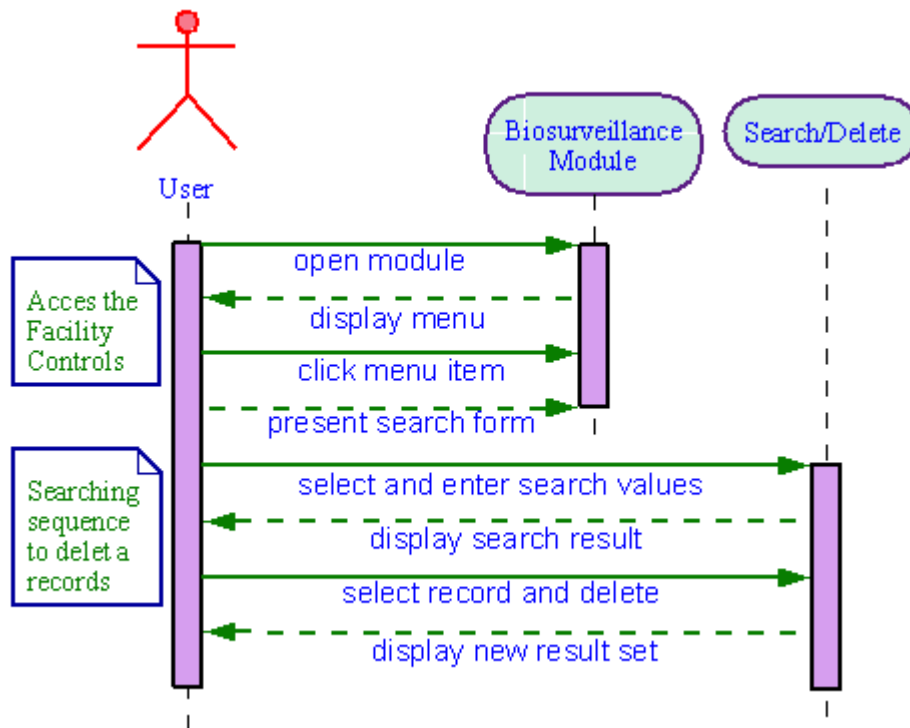


Figure 34: Delete sequence diagram

- Select the desired entity object controls through the main menu by clicking the menu item
- The search form is presented to the user with attributes to filter the search
- User will select values from presented lists and enter partial or full text in free text controls and invoke the process to retrieve records from database
- The returned result set, based on search criteria, is presented in tabulated form giving the user the option to select a desired record for editing or search again with new set of filter values (or criteria)
- The user has the option of selecting one or more records and invoking the delete control button to deactivate the records in the database.
- The records are removed by setting the deactivate date to indicate that the record is invalid from that day on; maintaining the referential integrity without harming any relationships that are in the DB
- Either the deleted records are highlighted in red or simply eliminated from the display

### Access external records relating information

A diagram is shown only for “Cases” but the concept of the sequence flow is identical for the other

entities. Therefore, this document will only discuss the Cases entity, leaving it for the readers to make the analogy for the service, contact, and address entities.

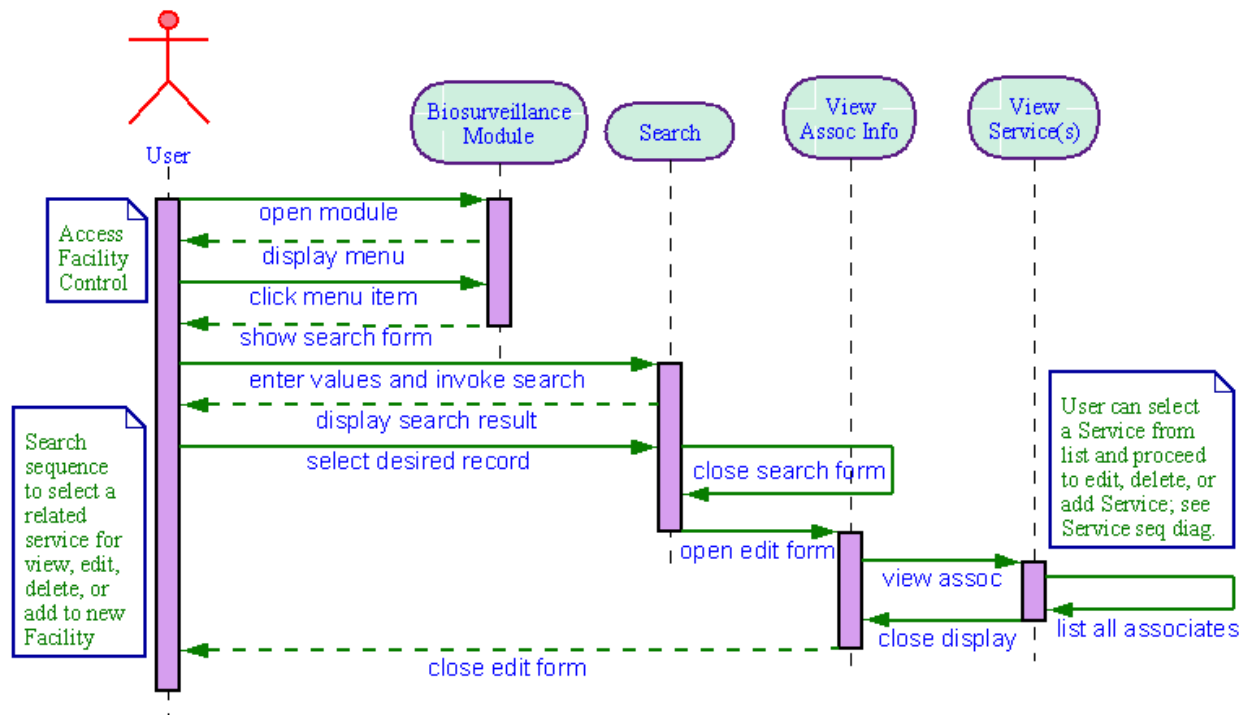


Figure 35: View associated information to add, edit, or delete

- Select the facility controls through the main menu by selecting or clicking the “Facility” menu item
- The search form is presented to the user with attributes to filter the search
- User will select values from presented lists and enter partial or full text in free text controls and invoke the process to retrieve records from database
- The returned result set, based on search criteria, is presented in tabulated form giving the user the option to select a desired record for editing or search again with new set of filter values (or criteria)
- In the Edit control form a section will be designated to display information on the related entities contact, address, service, and cases; in this section necessary and sufficient information or records will be displayed in tabular form or <href> links or button controls will provide access to the full set of information in the respective entity’s edit form or access to search form to related a new record or to the add control form to add a new record and relate to the facility. See the respective entity’s use case and sequence diagrams to learn about the functions.
- Upon completion of viewing, the record or adding a new record the handle is returned to the Facility edit form control.

### 11.1.5 General guidelines to GUI controls design

This section will set out some basic guidelines to designing the GUIs. The elements of the GUIs will be classified as the following objects: forms, reports, text, date, lists, buttons, and links.

- Each core and module object should provide a set of forms to search, edit, add, and delete records per the sequence described in section 5.1. In order to reuse the same form for viewing, editing, and adding records the form will take on the modes: *view*, *edit*, and *add* respectively with embedded functionality.
- A search form is different from the view, edit, and add forms, which does not contain all the attributes of a record but only to the necessary and sufficient attributes to filter the search of desired record(s). A search form will have two modes: *result* and *lookup*. The result mode is simply displaying the filtered search results for the purpose of selecting a record for editing.
- Second mode is a search form acting as a lookup form when relating records. For example, when patient (person) needs to be assigned to a health case the case edit form invokes the person search form to fetch for the results. When an available person record is selected from the list, that particular person is related to the health case record through the person uuid.
- Text, List, Date, and Button control modes are – *enabled* or *disabled*; where only enabled controls are active and can be used; while disabled controls cannot. For example, a disabled text control can be used to simply display the value but not allow the user to alter the value.
- Reports should provide the user with attributes to set the criteria; i.e. filter. Also, provide the option to view all results or sets of results. Another option should be to save the results as a CSV or PDF.

### 11.1.6 Guidelines for database

- Create date, create by, and create process – these attributes appear in all transactional tables. This is for audit and mainly for research purposes. They are mandatory and must be set during an INSERT. Create date tells us when the record was created; create by tells us who created the record (i.e. user name), and create process tells us the process or how it was created (i.e. via mobile phone over GPRS or SMS, PC browser over GPRS or DSL, external bulk load interface)
- Modify date, modify by, and modify process – these attributes are similar to the create date, create by, and create process attributes except they are set every time during an UPDATE. This gives us the same set of information of the last update.
- Deactivate date – is seen in all tables. To ensure associations are not broken by removing the record from the table during a DELETE the deactivate date is set to deactivate the record. This maintains the old relationships and does not affect past reports or queries. All select statements should contain the statement “WHERE deactivate\_dt IS NULL or deactivate\_dt < today()”; the function today() being the present date or it can be replaced with a specific date to exclude all

records deactivated before the indicated date.

- Select – when querying the database to retrieve records the statement should only select the necessary and sufficient attributes to minimize the payload.
- Update – when updating an attribute, if the attribute is not nullable and the process is trying to replace a valid value (i.e. not null value) with a null value then that is not allowed.
- Insert – prior to an insert the process should check if the record already exists in the database. If it is a 90% match then the user should be prompted to search for the record again to avoid duplication.
- Delete – the SQL DELETE function is not used instead the record deactivation process is implemented; see above on “deactivate date”

### **11.1.7 Usability of software components**

#### **11.1.7.1 Software developers**

- Software developers enhancing or adding on functionality must be able complete their tasks in minimal time without having to read through code to understand the function of the entire code base
- Good documentation of the functions must in place for evaluators and future developers to understand the processes invoked by the components
- Ideally all inputs and outputs of data should use a standard such as XML to avoid the software components being dependent on a single programming language such as PHP; thereby, future components developed using other programming languages can still communicate with the predecessor components
- The instructions and guidelines will be made available through the web as well as a printed document. The on line web version will have more literature than the printed version.

#### **11.1.7.2 System Administrators**

- Setting up of public IP to access the web server will be no more than a ½-day task. This is a standard process done in collaboration with the ISP but the application should not complicate the standard process.
- Installation of web server, database, and application, inclusive of downloading the software, will be no more than a 1 – 2 hour task; thus, clear and precise, self-training, instruction must be provided
- Self-learning training material with instruction set will be provided for installing the application, which should not take any longer than an hour, inclusive of reading the instructions
- Configuring the application is guided through the step-by-step installation process itself.

However, alternate approaches, such as directly writing the values in to the “cong.ini” file will be provided. This process includes setting up the administrative user account.

- Using the administrative user account one can begin assigning other user roles, accounts and grant user permissions. The procedure is self-explanatory but additional written instructions will also be provided. Given, the administrator has preplanned the user roles, with the set of users, and permissions, the setup should not take any more than an hour (approximately 20 users); time will vary depending on the number of users.
- A “test” and “live” database will be made available to the implementer for testing implementation concepts and then transferring that to a live version used by all users. Setting up a test version of the application is done through setting the “Incidence” attribute in the conf.ini file and creating a separate database with a different name. This process should not take any longer than a fresh installation of the application.

#### **11.1.7.3 Implementers**

- Implementer must first write the static values such as the location category, location types, person roles, person types, diseases, symptoms, signs, etc. Since this is a onetime process with minor updates, it is considered a DBA task. The DBA will use standard SQL language such as INSERT, UPDATE, SELECT, DELETE to write the preplanned values in to the database. Depending on the implementation, this process may take from one to 2 days, inclusive of a verification process.
- Testing the implementation will be on the “test” version of the installation. Transferring of the implementation to the live version is as easy as repeating the process carried out on the test version or copying the tables, view, and procedures to the live database.
- The instructions and guidelines will be made available through the web as well as a printed document. The on line web version will have more literature than the printed version.

#### **11.1.7.4 Users**

- A one-day training workshop should provide the necessary hands on training to use the application in creating, editing, deleting, searching, and associating records of all the objects.
- Training and reference manuals will be provided for trained users to refer to when in doubt. These manuals will have examples of how to conduct each task made available through a series of controls in the application
- The instructions and guidelines will be made available through the web as well as a printed document. The on line web version will have more literature than the printed version.

### **11.1.8 Core Object Functionality**

The core objects will function as abstract classes with APIs to request, get, and post records sets in

relation to the individual objects. They will also contain a set of GUIs interface for reading, selecting, and writing data. The following sections describe the specifications for each of the abstract objects.

### **11.1.9 Location**

Location is a self-contained independent object used not only by the BSM but also by other Sahana modules such as Victim Management and SITREP. The other objects - person, address, facility, case, and service use the concept of locations.

Location category defines the hierarchy of the ontology and taxonomy of the specific location classification. For the purpose of health and Biosurveillance, the category defined will be labeled as “Health.” Examples of alternate location categories are be the Governance structure, Disaster Management structure or Water management structure.

Location Type is the subcategory but has the structure to be defined in a hierarchical order. For example, Sri Lanka health sector hierarchy of locations, in ascending order, are – National, Regional, Provincial, District, MOH divisions, and PHI areas; similarly in India – National, State, District, Block, and Village; which are classified as location types.

#### **11.1.9.1 Real Need**

- Identify the location the case originated such as the village health worker recorded the data or facility the patient reported the illness to
- Define hierarchical areas (or boundaries) based on the health sector governance structure
- Identify clusters of diseases or disease densities by locations
- Target reports and alerts by locations

#### **11.1.9.2 User Goals**

- Search locations by category, type, or name
- Edit location details including assigning the parent location (i.e. wider area location belongs to)
- Add a new location
- Delete one or more locations by deactivating the record
- Assign standard location descriptors such as GIS coordinate or ISO code systems to the records

#### **11.1.9.3 Actors & Roles**

- *Super User (Implementer/DBA):*
  1. Define location categories and types
  2. Add, Edit, & Remove location categories and types
- *User (Health Worker)*

## 1. Add, Edit, and Remove specific locations

### 11.1.9.4 Use-Case Diagrams

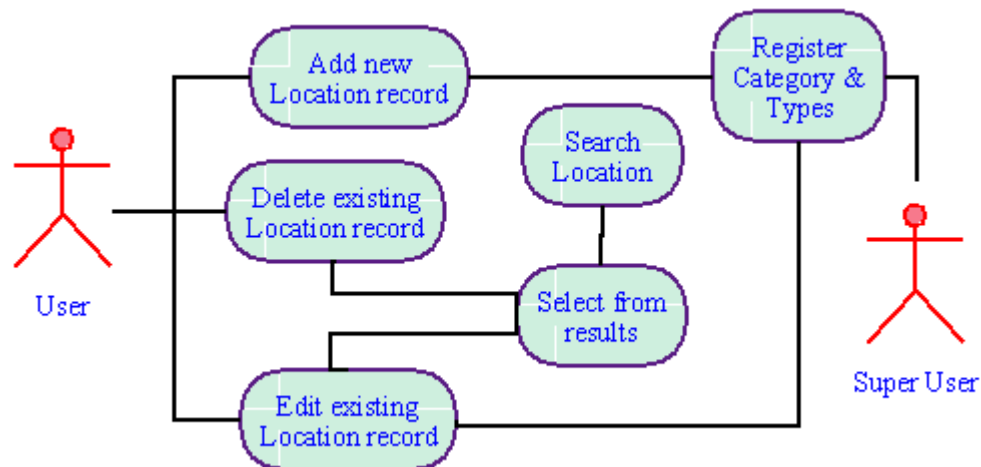


Figure 36: location use case diagram

Table 31 description of use cases in Figure 36

Search record	Provide necessary and sufficient set of attributes for user to enter full or partial information; then apply search function to retrieve relevant dataset from database to be displayed in tabular for user to select one or more records
Select from result	Tabulated results should be presented with options to select one record for editing and one or several desired records for deleting. Also, provide the option to add a record if desired. Tabulation mandatory elements are display the location name, parent location, category, and type; while other values are optional but displayed if they are necessary for user to distinguish between two similarly named locations
Edit record	First search for the record and select the desired record from result set; then make changes to the values and save
Add new record	By default the user should be forced to search for the record and if not in result then allow to add a new location record; the record will select a location category and type from registered list
Delete record	First search for the record and select the desired record from result set; then apply delete function

### 11.1.9.5 Main Scenarios

- Create facility categories
- Create facility types and assign a category
- Create facility status

- Create a facility and assign a category, type, and status
- Lookup and associate a location to the facility <<location>>
- Assign an address to a facility
- Edit facility details
- Deactivate facility from database
- Search a facility record

#### 11.1.9.6 Data Storage (files and databases)

Table 32 Location category information

<b>Attribute</b>	<b>Data Type</b>	<b>Comment</b>
Location Category	Varchar	Health, Governance, etc. the location classification
Enumeration	Integer	Value to communicate instead of sending string to optimize bytes as in mobile phones
Description	Varchar	Detailed explanation of the category to be used in reports, help or other human readable explanations
Deactivate date time	Date Time	Records will not be deleted from database only deactivated to maintain referential integrity

Table 33 Location detail information

<b>Attribute</b>	<b>Data Type</b>	<b>Comment</b>
Location Type	Varchar	Subcategories with hierarchical structure
Location Category	Varchar	Type should be associated with a category
Description	Varchar	Detailed explanation of the category
Type	Varchar	Health location types: MOH, PHI,
Deactivate date time	Date Time	To deactivate the record instead of deleting

Table 34 Location detail information

<b>Attribute</b>	<b>Data Type</b>	<b>Comment</b>
Universal Unique ID (uuid)	Integer/Varchar	Unique identifier for the record
Parent uuid	Integer/Varchar	Identifier pointing to the parent location
Location Name	Varchar	Human readable name to id the location
Location Category	Varchar	Health, Governance,
Location Type	Varchar	Health location types: MOH, PHI,
Description	Varchar	Additional human readable info
ISO Code	Varchar	ISO 3116 country codes or 8440 international trade location code
Coordinate System	Varchar	Name of the vector coordinate system such as GIS lat/lon, GIS utm, that gives meaning to the X, Y, Z, coordinates

Shape	Varchar	Geometric shape of the location e.g. circle, polygon, line, point
X vector	Varchar	A polygon will have a set of x coordinates $X = (x1, x2, \dots, xn)$ e.g. latitudes
Y vector	Varchar	The same polygon will have equal number of y coordinates $Y = (y1, y2, \dots, yn)$ ; e.g. longitudes
Z vector	Varchar	If 2 dimensional then a set of Z coordinates representing the height else zero $Z=(0, 0, \dots, 0)$
Create date time	Date Time	To identify when the record was created
Create by	Varchar	User or System creating the record
Create process	Varchar	How the record was created; e.g. web, mobile phone, the application, external
Modify date time	Date Time	Identify when record was last modified
Modify by	Varchar	User or System modifying the record
Modify process	Varchar	The method the record was modified
Deactivate date time	Date Time	Records will not be deleted from database only deactivated to maintain referential integrity

#### 11.1.9.7 Associations

II. Location is inherited by objects such as person, facility, address, person, and service.

Table 35 Other object controls quasi modally accessing the location object

<b>Interface Name</b>	<b>Remarks</b>
Person add and edit controls	A health worker is associated with a location; e.g. a Public Health Inspector is assigned a jurisdiction.
Facility add and edit controls	A hospital is associated with a location; e.g. Kuliypitya base hospital is situated in the Kuliypitiya MOH division
Service add and edit controls	A service such as investigating a patient can be carried out in a particular Public Health Inspector area.
Case add and edit controls	A case has to be identified with a location to calculate the disease densities.
Address add and edit controls	An address may belong to a particular governance area such as a tribunal or village or a district

#### 11.1.9.8 Implementation Notes

- Identify and add set of location categories and related types with hierarchy in database
- Set user permissions as to who can add, edit, delete, search, and associate location records

#### 11.1.10 Service

Service, similar to the location, is a self-contained independent object of that is, mainly, used by the health cases object but also can be used by other classes such as inventory, person, or facilities.

Service category defines the specific class of services and the type specifies the sub category of services. For example, the category: Health Worker Services may have several types: investigate a case, follow up case, or notify village.

Service is driven by state transitions that are recorded as the state according to a given sequence. The date and time stamp tells when the state transition occurred.

A service may have inputs outputs such as a set of items; in the context of health, we may regard an input as a blank set of document and the output as the filled set of document (reports).

A person (or system or machine), termed as the provider must carry out the service and a person (or system or machine), termed as the recipient, will receive the benefits of the service. For example, the Public Health Inspector will “provide” the service of investigating a case by visiting the patient’s (recipient) home.

#### **11.1.10.1 Real Need**

- Provide a method to define, record, and track services in relation to health cases carried out by health workers such as investigating a case
- Provide a method for the laboratories to carry out their work in relation to a health case and record the procedures and outcomes (or results)
- Facilities provide services such as quarantine, maternity, cardiac health services. The mechanism should define the services provided by the facilities for the purpose of referrals
- In the event of intervention and prevention procedures, the health officials should have a method to define the services to be carried out specific persons or facilities in given locations.

#### **11.1.10.2 User Goals**

- Create service categories, types, and states
- Associate a service to the entities: Person, Facility, and Case by creating a new service instance
- Track the progress or to edit the content in the service
- Set the status of the service along with a timestamp indicating the state transition of the service
- View service progress reports based on the status and time period

#### **11.1.10.3 Actors & Roles**

- *Super User (Implementer/DBA):*
  1. Define the category and type of services
  2. defines the type of person that provides the service and the type of person that may

- receive the service
- define the input and output items associated with the service type

- User (Health Worker):**
  - Add, Edit, and Remove specific services associated with person, case, or facility
  - Set the status of the service
  - View aggregated service progress reports

#### 11.1.10.4 Use-Case Diagrams

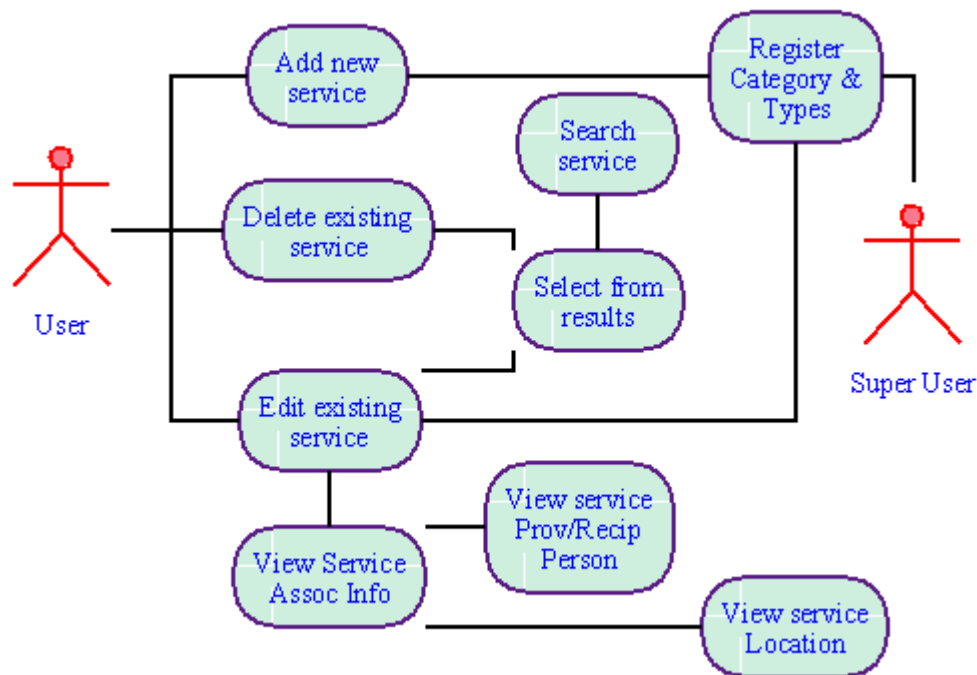


Figure 37: service use case diagram

Table 36 description of use cases in Figure 37

Search record	Provide necessary and sufficient set of attributes for user to enter full or partial information; then apply search function to retrieve relevant dataset from database to be displayed in tabular for user to select one or more records
Select from result	Tabulated results should be presented with options to select one record for editing and one or several desired records for deleting. Also, provide the option to add a record if desired. Tabulation mandatory elements are display the service id, category, type, state; while other values are optional but displayed if they are necessary for user to distinguish between two similarly named locations
Add new record	By default the user should be forced to search for the record and if not in result then allow to add a new service record
Edit record	First search for the record and select the desired record from result set; then

	make changes to the values and save
Delete record	First search for the record and select the desired record from result set; then apply delete function

#### 11.1.10.5 Data Storage (files and databases)

Table 37 Service category information

<i>Attribute</i>	<i>Data Type</i>	<i>Comment</i>
Service Category*	Varchar	Define if Health Service or other based on implementation
Enumeration	Integer	Value to communicate instead of sending string to optimize bytes as in mobile phones
Description	Varchar	Detailed explanation of the category to be used in reports, help or other human readable explanations
Deactivate date time	Date Time	Records will not be deleted from database only deactivated to maintain referential integrity

Table 38 Service type information

<i>Attribute</i>	<i>Data Type</i>	<i>Comment</i>
Service Type*	Varchar	Subcategories with hierarchical structure
Service Category*	Varchar	Type should be associated with a service category in Table 8
Enumeration	Integer	Value to communicate instead of sending string to optimize bytes as in mobile phones
Description	Varchar	Detailed explanation of the category
Process Notes	Varchar	Provide instructions on conducting the type of service
Expected Result	Varchar	Explanation on the expected result of the service outcome
Expected Time	Time	Number of days or hours the service should be processed or completed in; i.e. the start data and end date of the service will be set as a function of this values
Provider Type	Varchar	Person type providing the service; e.g. Public Health Inspector
Recipient Type	Varchar	Person type receiving the service e.g. Patient
Deactivate date time	Date Time	Records will not be deleted from database only deactivated to maintain referential integrity

Table 39 Service status information

<i>Attribute</i>	<i>Data Type</i>	<i>Comment</i>
Service State*	Varchar	Name to identify the transitional state of the service
Service State Sequence	Integer	A number to indicate the service transitional sequence

		order for a given type and category
Service Category*	Varchar	State should be associated with a Category in Table 8
Service Type*	Varchar	State should be associated with a Category in Table 9
Enumeration	Integer	Value to communicate instead of sending string to optimize bytes as in mobile phones
Description	Varchar	Detailed explanation of the status to be used in reports, help or other human readable explanations
Deactivate date time	Date Time	Records will not be deleted from database only deactivated to maintain referential integrity

Table 40 Service type item information

<b>Attribute</b>	<b>Data Type</b>	<b>Comment</b>
Item Name*	Varchar	Name to identify the item
Item Category*	Varchar	Status should be associated with a Category in Table 8
Item Type*	Varchar	Status should be associated with a Category in Table 9
Item State	Varchar	Indicate whether item is an input to or output of the service process; by default will be considered an output
Enumeration	Integer	Value to communicate instead of sending string to optimize bytes as in mobile phones
Description	Varchar	Detailed explanation of the item to be used in reports, help or other human readable explanations
Deactivate date time	Date Time	Records will not be deleted from database only deactivated to maintain referential integrity

*Table Comment:* to define the set of inputs and outputs necessary for carrying out each service type

Table 41 Service item detail information

<b>Attribute</b>	<b>Data Type</b>	<b>Comment</b>
Service Universal Unique ID (uuid)*	Integer/Varchar	Unique identifier for the record same as the service uuid in Table 11 with the option of adding additional items specific to the instance
Item Name*	Varchar	Same name as defined in Table 11
Item State	Varchar	Indicate whether item is an input to or output of the service process; by default be considered an output item
Deactivate date time	Date Time	Records will not be deleted from database only deactivated to maintain referential integrity

*Table Comment:* table will store all instances of services created through functional processes such as by case, facility, or person

Table 42 Service item detail information

<b>Attribute</b>	<b>Data Type</b>	<b>Comment</b>
Service Universal Unique ID (uuid)*	Integer/Varchar	Unique identifier for the record same as the service uuid in Table 11 with the option of adding additional items

		specific to the instance
Service Category	Varchar	Same Service Category in Table 8
Service Type	Varchar	Same Service Type as in Table 9
Service Status	Varchar	Same as in Service Status as in Table 11
Status Date	Date Time	Date and Time stamp the status was set
Provider	Varchar	Actual name of the Provider carrying out the service, obtained from Person entity
Recipient	Varchar	Actual name of the Recipient receiving the service, obtained from Person entity
Start Date	Date Time	The date and time the service is scheduled to be carried out or the date and time the service actually began; choice of the implementers to set the policy
End Date	Date Time	The date and time the service is scheduled to be completed by or the date and time the service actually was completed; choice of the implementers to set the policy
Notes	Varchar	For additional notes, remarks, comments such as to record the outcome or results and any changes in the procedures
Create date time	Date Time	To identify when the record was created
Create by	Varchar	User or System creating the record
Create process	Varchar	How the record was created; e.g. web, mobile phone, the application, external
Modify date time	Date Time	Identify when record was last modified
Modify by	Varchar	User or System modifying the record
Modify process	Varchar	The method the record was modified
Deactivate date time	Date Time	Records will not be deleted from database only deactivated to maintain referential integrity

*Table Comment:* table will store all instances of services created through functional processes such as by case, facility, or person

#### 11.1.10.6 Main Scenarios

- Create facility categories
- Create facility types and assign a category
- Create facility status
- Create a facility and assign a category, type, and status
- Lookup and associate a location to the facility <<location>>
- Assign an address to a facility
- Edit facility details
- Deactivate facility from database
- Search a facility record

### 11.1.10.7 Associations

- Service is inherited by objects such as person, facility, and cases.

Table 43 Other GUIs quasi modally accessing the service controls: forms & reports

<b>Interface Name</b>	<b>Remarks</b>
Person add and edit controls	A patient or health worker can be assigned a series of services such as test reports to be completed by a certain date.
Facility add and edit controls	A hospital will be required to setup a quarantine service or a special vaccination campaign
Case add and edit controls	A case will have investigative services, follow up services, reporting services

### 11.1.10.8 Implementation Notes

- Identify and add set of service categories and related types with hierarchy in database
- Define the execution times, procedures and expected results in the type entity
- Identify and add set of states for a given type and setup the transitional sequence
- Set user permissions as to who can add, edit, delete, search, and associate location records

### 11.1.11 Person

Person is an abstract object used in Biosurveillance. In disease surveillance the main actors: health worker and patient will be defined as a person. The services will identify the service provider and service recipient from the person entity. Person is also used by other Sahana modules.

Persons are classified by their role and each role creates a unique instance where typical roles can be “health worker,” “patient,” “field worker,” and “governor” with the freedom for implementers to define.

Within a given role, there could be many sub roles, which shall be regarded as types. Some examples of person types for the role of health worker are Health Inspector, Deputy Director Health Services, and General Practitioner.

The state of a person can be regarded as the entropy of the person at a given time and can be labeled accordingly. In the existing Sahana system, people states are labeled as missing, victim, or dead and in the proposed Biosurveillance module the patients may be labeled as sick, well, dead, active, inactive, etc. per the implementers’ policy.

Although the database may have several instances of a person based on the role different roles can be mapped to a single person through their passport, national identification, or driving license.

Personal details will be the date of birth, vital statistics (height weight), gender, ethnicity (race and

religion), marital status, and country of birth (or origin); the list is not exhaustive.

#### **11.1.11.1 Real Need**

- Person is central to the module as preliminary work on Biosurveillance surrounds human diseases
- The intervention and prevention services are carried out by health workers; i.e. a class of persons that play the role of health workers
- The users are another class of people engaging in managing the information system
- The person entity is used by case and service entities

#### **11.1.11.2 User Goals**

- Manage person details
- Associate a person to a case or service
- Associate addresses and contact details of a person
- View case history reports on a person and the status
- View a person's service history reports and the progress

#### **11.1.11.3 Actors & Roles**

- *Super User (Implementer/DBA):*
  1. Define the roles, types, and states of a person
  2. Assign system user roles and rights
  3. Setup the person related services
- *User (Health Worker):*
  1. Add, Edit, and Remove specific services associated with person, case, or facility
  2. Set the status of the service
  3. View aggregated progress reports

#### **11.1.11.4 Use-Case Diagrams**

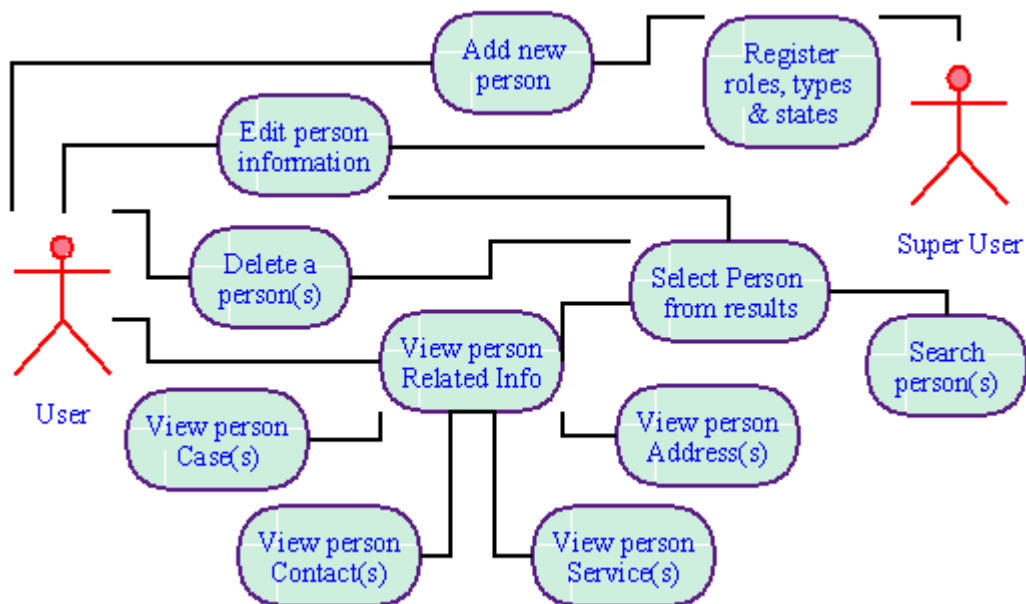


Figure 38: person use case diagram

Table 44 description of use cases in Figure 38

Search record	Provide necessary and sufficient set of attributes for user to enter full or partial information; then apply search function to retrieve relevant dataset from database to be displayed in tabular for user to select one or more records
Select from result	Tabulated results should be presented with options to select one record for editing and one or several desired records for deleting. Also provide the option to add a record if desired. Tabulation mandatory elements are display the person name, identifications, role, and type; while other values are optional but displayed if they are necessary for user to distinguish between two similarly named locations
Edit record	Search for the record and select the desired record from result set; display selected record in edit form, then make changes to the values and save. User is allowed to change the role and type of the person provided another instance of the same person with same role does not exist. <b>Question: if, role or type is changes, do we save the new instance as a new record under an alternate person uuid or do we change the values and save under the same person uuid?</b>
Delete record	First search for the record and select the desired records from result set; then apply delete function; followed by a confirmation and display of new result set. Note record is deactivated and not physically removed from database.
Add new person	By default, the user should be forced to search for the person, to avoid duplication, with known attributes such as name and identification information. If anticipated name not in result then allow to add a new person record; only one instance of a person with same name and identification may be allowed for a given role and type; check this criteria before committing record to DB.

View person cases	A control should be provided from the person edit form to the person's related cases with provision to edit, add, and delete cases; functions which will be inherited through the Case object.
View person services	A control should be provided from the person edit form to the person's related services with provision to edit, add, and delete service information; functions which will be inherited through the service object.
View person address	A control should be provided from the person edit form to the person's related addresses with provision to edit, add, and delete address information; functions that will be inherited through the address object.
View person Contacts	A control should be provided from the person edit form to the person's related contacts with provision to edit, add, and delete contact information; functions which will be inherited through the Contact object.

When collaborating with other objects such case or service the entry point for associating a location with these objects is through the search use case.

#### 11.1.11.5 Main Scenarios

- Create person roles
- Create person types for each role
- Create a set of person states for each type and role
- Search a person record
- Edit a person record
- Add a person record
- Delete a person record
- Lookup and associate person addresses <<Address>>
- Look up and associate person contact details <<Contact>>
- Lookup and associate person services <<Service>>

#### 11.1.11.6 Data Storage (files and databases)

Table 45 Person role information

<i>Attribute</i>	<i>Data Type</i>	<i>Comment</i>
Person role*	Varchar	Roles can range from health worker, field worker, patient, user, etc. providing the freedom for implementers to define as seen fit
Description	Varchar	Detailed explanation of the role to be used in reports, help or other human readable explanations
Enumeration	Integer	Value to communicate instead of sending string to optimize bytes as in mobile phones
Deactivate date time	Date Time	Records will not be deleted from database only deactivated to maintain referential integrity

Table 46 Person type information

<b>Attribute</b>	<b>Data Type</b>	<b>Comment</b>
Person type*	Varchar	Different type of roles within a main role; e.g. role = health worker, types = nurse, doctor, village health nurse, medical officer of health
Person role*	Varchar	Same as in Table 16; one role with many types
Description	Varchar	Detailed explanation of the type to be used in reports, help or other human readable explanations
Enumeration	Integer	Value to communicate instead of sending string to optimize bytes as in mobile phones
Deactivate date time	Date Time	Records will not be deleted from database only deactivated to maintain referential integrity

Table 47 Person state information

<b>Attribute</b>	<b>Data Type</b>	<b>Comment</b>
Person state*	Varchar	States can range from active, inactive, missing, dead, victim
Person role*	Varchar	Same as in Table 16; a person's state can be role specific; e.g. deceased is only applicable to patients and active/inactive is only applicable to health workers
Description	Varchar	Detailed explanation of the status to be used in reports, help or other human readable explanations
Enumeration	Integer	Number to communicate instead of sending string to optimize bytes as in mobile phones
Deactivate date time	Date Time	Records will not be deleted from database only deactivated to maintain referential integrity

Table 48 Person information

<b>Attribute</b>	<b>Data Type</b>	<b>Comment</b>
Person UUID*	Varchar	Name to identify the item
Person Role*	Varchar	Status should be associated with a Category in Table 16
Person Type*	Varchar	Status should be associated with a Category in Table 16
Person State*	Varchar	Indicate whether item is an input to or output of the service process
Passport	Integer	Value to communicate instead of sending string to optimize bytes as in mobile phones
National ID	Varchar	Detailed explanation of the item to be used in reports, help or other human readable explanations
Driving License	Date Time	Records will not be deleted from database only deactivated to maintain referential integrity

Last Name*	Varchar	Surname or family name
First Name	Varchar	Given name
Middle Name	Varchar	Other given names
Alias	Varchar	Other names or alternate names used
Gender	Varchar	Male, Female, or Unknown
Designation	Varchar	Reverend, Minister, President, Lawyer
Dependent Person UUID	Varchar	Mother, Father, or other dependent person or relative; the dependent person must be registered in the database and related via person uuid
Age	Decimal	Numeric value with 2 decimal places
Age Group	Varchar	Infant ( < 1), child (1 – 12), Teen (12 – 19), Youth (20 – 30), Adult (30 – 55), Elder (> 55)
Date of Birth	Varchar	Year / Month / Day
Height	Decimal	Person's height
Height unit	Varchar	Inches, Feet, Meters, Centimeters
Weight	Decimal	Person's weight
Weight unit	Varchar	Kg, lb, gr,
Religion	Varchar	Christian, Hindu, Buddhist, Islam,
Race	Varchar	Han, Nazi, Sinhala, Tamil, Muslim
Marital status	Varchar	Single, Married, Divorced, Separated
Skin color	Varchar	Black, White, Yellow, Brown
Eye color	Varchar	Green, Blue, Brown, Black
Hair color	Varchar	Blue, Blond, Black, White
Body Markings	Varchar	Scar above left eyebrow, birthmark on chest
Blood Type	Varchar	O, O-, A, A+, AB
Notes		For any additional remarks about the person
Create date time*	Date Time	To identify when the record was created
Create by*	Varchar	User or System creating the record
Create process*	Varchar	How the record was created; e.g. web, mobile phone, the application, external
Modify date time	Date Time	Identify when record was last modified
Modify by	Varchar	User or System modifying the record
Modify process	Varchar	The method the record was modified
Deactivate date time	Date Time	Records will not be deleted from database only deactivated to maintain referential integrity

#### 11.1.11.7 Associations

- Person is inherited by objects such as service and cases.
- Person inherits services, address, and contact

Table 49 Other GUIs quasi modally accessing the Person controls: forms & reports

<b>Interface Name</b>	<b>Remarks</b>
-----------------------	----------------

Service add and edit controls	A service contains a record of the person providing the service and the person receiving the service
Cases add and edit controls	A health case record will contain the patient and health worker information

#### **11.1.11.8 Implementation Notes**

- Identify and add the set of person roles and related types with hierarchy in database
- Define the set of person states to the implementer's liking

#### **11.1.12 Facility**

A Facility is a building, property or infrastructure. Facility is an abstract object that can be used in many business cases and one being health facilities in relation to the disease surveillance.

Facility entity is inherited by the health Cases object and the facility inherits the service, location and address objects.

Facilities are categorized and type classified along with a name to create unique instance. A typical category can be a "health care" facility, "medical storage" facility, or "quarantine" facility. For a given category, there are many sub categories termed as types; e.g. set of types for category: health facilities are hospital, clinic, maternity home, general practitioner.

The status of a facility describes the functional state of the facility independent of the category or type. The status can easily be confined to the set – designed, building, opened, closed, operational, occupied, unknown, etc.

Another vital piece of information is the location of the facility, which can be defined by a point in space, which may be the most common but also by a geometric shape.

##### **11.1.12.1 Real Need**

- Patients will be reporting their health cases in health facilities and the system should be able to trace back a health record to the facility
- Aggregate health cases by facilities they are reported from
- Different types (or classes) of facilities provide different sets of services and identifying the service by facility may provide benefits in containing diseases by referring patients to the correct facility

##### **11.1.12.2 User Goals**

- Create, edit, delete a facility
- Relate a facility to a case

- Assign a location or address to facility
- Maintain up to date details on the facility
- View case history and aggregate reports by a facility or collection of facilities
- View a facility service history reports and the progress

### 11.1.12.3 Actors & Roles

- *Super User (Implementer/DBA):*
  1. Define the categories and types
  2. Assign system user roles and rights
  3. Setup the facility related services
- *User (Health Worker):*
  1. Add, Edit, and Remove specific facilities
  2. Add, Edit, and Remove associated health cases, services, addresses, or location from a facility
  3. Set the status of the facility
  4. View aggregated reports

### 11.1.12.4 Use-Case Diagrams

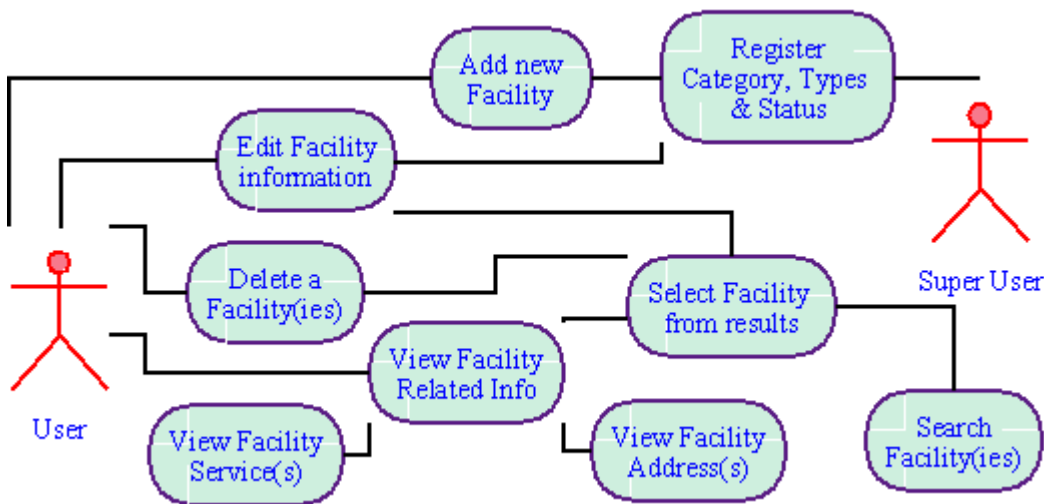


Figure 39: Facility use case diagram

Table 50 description of use cases in Figure 39

Search Facility(ies)	Provide necessary and sufficient set of attributes for user to enter full or partial information; then apply search function to retrieve relevant dataset from database to be displayed in table for user to select one or more records
Select Facility from result	Tabulated results should be presented with options to select one record for editing and one or several desired records for deleting. Also, provide the option

	to add a record if desired. Tabulation mandatory elements are facility name, category, and type; while other values are optional but displayed if they are necessary for user to distinguish between two similarly named facilities
Edit Facility Information	Search for the record and select the desired record from result set; display selected record in edit form, then make changes to the values and save. User is allowed to change the category and type of the facility provided another instance with same name category, and type does not exist. <a href="#">Question: if, category or type is changes, do we save the new instance as a new record under an alternate facility uuid or do we change the values and save under the same facility uuid?</a>
Delete Facility(ies)	First search for the record(s) and select the desired record(s) from result set; then apply delete function through the available control (e.g. button); followed by a confirmation. Upon completion of the delete-function display new result set. Note record is deactivated and not physically removed from database.
Add new Facility	By default, the user should be forced to search for the facility, to avoid duplication, with known attributes such as the name, category, and type information. If user determines anticipated facility record is not in result set then provide a control to add a new facility record; only one instance of a facility with same name, category, and type may be allowed for a given role and type; check this criteria when validating before committing record to DB.
View Facility Service(s)	A control should be provided from the facility edit form to the facility's related services with provision to edit, add, and delete service information, functions which will be inherited through the service object.
View Facility address	A control should be provided from the facility edit form to the facility's related addresses with provision to edit, add, and delete address information; functions which will be inherited through the address object.

When collaborating with other objects such case or service the entry point for associating a location with these objects is through the search use case.

#### 11.1.12.5 Main Scenarios

- Create facility categories
- Create facility types and assign a category
- Create facility status
- Create a facility and assign a category, type, and status
- Lookup and associate a location to the facility <<location>>
- Assign an address to a facility
- Edit facility details
- Deactivate facility from database
- Search a facility record

#### 11.1.12.6 Data Storage (files and databases)

Table 51 Facility category information

<b>Attribute</b>	<b>Data Type</b>	<b>Comment</b>
Facility category*	Varchar	Categories can range from health, storage, government, etc.; user
Description	Varchar	Detailed explanation of the category to be used in reports, help or other human readable explanations
Enumeration	Integer	Value to communicate instead of sending string to optimize bytes as in mobile phones
Deactivate date time	Date Time	Records will not be deleted from database only deactivated to maintain referential integrity

Table 52 Facility type information

<b>Attribute</b>	<b>Data Type</b>	<b>Comment</b>
Facility type*	Varchar	Different type of facilities within a category; e.g. health facility type = hospital, clinic,
Facility Category*	Varchar	Same as in Table 22;
Description	Varchar	Detailed explanation of the type to be used in reports, help or other human readable explanations
Enumeration	Integer	Value to communicate instead of sending string to optimize bytes as in mobile phones
Deactivate date time	Date Time	Records will not be deleted from database only deactivated to maintain referential integrity

Table 53 Facility Status information

<b>Attribute</b>	<b>Data Type</b>	<b>Comment</b>
Facility Status*	Varchar	States can range from designed, under construction, operational, closed, etc.
Description	Varchar	Detailed explanation of the status to be used in reports, help or other human readable explanations
Enumeration	Integer	Number to communicate instead of sending string to optimize bytes as in mobile phones
Deactivate date time	Date Time	Records will not be deleted from database only deactivated to maintain referential integrity

Table 54 Facility information

<b>Attribute</b>	<b>Data Type</b>	<b>Comment</b>
Facility UUID*	Integer/Varchar	System assigned universal unique identifier
Facility Category*	Varchar	Same as in Table 22
Facility Type*	Varchar	Same as in Table 23
Facility Status*	Varchar	Same as in Table 24
Description	Varchar	Detailed explanation of the status to be used in reports,

		help or other human readable explanations
Location UUID	Varchar	Location UUID same as in Table 5
Create date time*	Date Time	To identify when the record was created
Create by*	Varchar	User or System creating the record
Create process*	Varchar	How the record was created; e.g. web, mobile phone, the application, external
Modify date time	Date Time	Identify when record was last modified
Modify by	Varchar	User or System modifying the record
Modify process	Varchar	The method the record was modified
Deactivate date time	Date Time	Records will not be deleted from database only deactivated to maintain referential integrity

### 11.1.12.7 Associations

- Facility is inherited by objects: cases.
- Facility inherits Address, Contact, and Location objects

Table 55 Other GUIs quasi modally accessing the Facility controls: forms & reports

<b>Interface Name</b>	<b>Remarks</b>
✓ Cases add and edit controls	A patient record may be received from a hospital

### 11.1.12.8 Implementation Notes

- Identify and add set of facility categories and related types with hierarchy in database
- Define the set of facility status to the implementer's liking

## 11.1.13 BSM Module Functionality

### 11.1.13.1 Entity Relationship Diagram

This section describes the module specific objects that provide functionality with respect to the Biosurveillance domain requirements termed as the BSM. The specifications focus on two main objects called the “diagnosis” and “cases”; where the diagnosis provides the data structure of the disease, symptoms, signs, and causality factors and the cases provides the data structure with functionality to capture health records and related information for carrying out the disease outbreak detection analysis and services for intervention and prevention . The relevant module objects inherit selected classes from the core module.

The entity relationship diagram in Figure 40 describes the data structure and associations with core module components. The person core object is used to define the roles: “health worker” and “patient” both of whom are actors of the health domain. The health worker role would be further segregated according to the various types such as epidemiologist, regional epidemiologist, Medical Officer of Health, Public Health Worker, and community health worker (Suwacevo) in the Sri Lankan setting and

Deputy Director of Health, Public Health Center Doctors, Public Health Center Nurses, Health Inspectors, and Village Health Nurses in the Indian setting. The patients and health workers will contain contact details and address information.

For the purpose of biosurveillance and with respect to the health sector, a “Health” location category will be established with various types embedded with the category such as national, regional, provincial, district, divisional, and areas in the Sri Lankan context and national, state, district, block, and village in the Indian context. The location is associated with the patient records through the cases object. Health workers, health facilities, and patients are further directly associated through the inherited location attribute or the address object.

Service can be associated with any entity but for the purpose of Biosurveillance will be, mainly, associated with the cases entity to define a public health worker to follow up investigating a case that requires a house visitation to inspect the environment or a patient requested to obtain laboratory services of a full blood test.

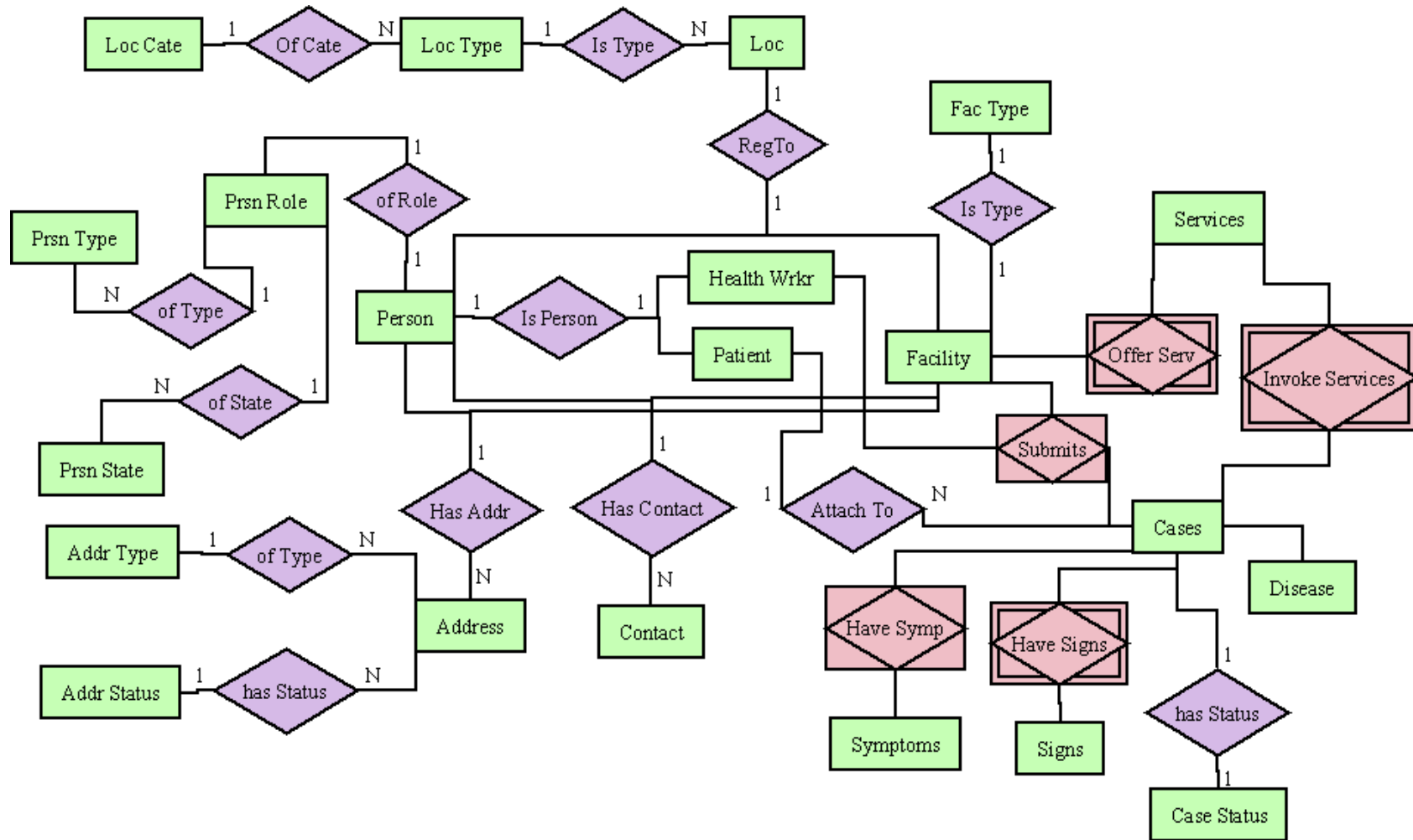


Figure 40: SHN BSM Module Entity Relationship diagram

### 11.1.14 Diagnosis

The BSM module comprises a cases and a diagnosis object. This section discusses the diagnosis object used by the cases object, a construction of four entities: disease, symptom, sign, and causality factors. The term diagnosis is used to indicate the functional aspect of the process of identifying the symptoms, signs then implicating a disease. Symptoms are what the patient would report. Signs are what the health worker examining the patient would observe. Causality factor is the element that causes the illness such as consumption of expired food in the case of food poisoning. Disease is the name given to the health condition with the defined symptoms and signs or a variation of them within the scope. WHO has defined a set of ICD – International Classification of Disease codes which will be assigned to the known diseases whenever they exist (i.e. not all diseases have an ICD code)

#### 11.1.14.1 Real Need

- Contains elements of the medical knowledge specifics for human disease Biosurveillance
- Used by the health cases object to create records sets of diseases, signs, symptoms, and causality factors
- Provides a grouping structure for producing aggregated health reports for monitoring the health status by certain diseases, symptoms, signs, or causality factors
- Used by the analytics algorithms as the basis information for detecting disease outbreaks

#### 11.1.14.2 User Goals

- Setup and relate sets of diseases, symptoms, signs, and causality factors
- Use the related diagnosis information in the health cases records with provision to add, edit, and delete the values based on the different scenarios or existence of predefined values
- Design aggregated reports grouped by diseases, symptoms, signs, or causality factors over geospatial dimensions (i.e. locations).
- Periodically update the diagnosis information and relationships
- Associate periodically updated WHO ICD codes with the datasets

#### 11.1.14.3 Actors & Roles

- *Super User (Implementer/DBA):*
  1. Define disease types
- *User (Health Worker)*
  1. Search, Add, Edit, and Delete disease records
  2. Search, Add, Edit, and Delete symptom records
  3. Search, Add, Edit, and Delete sign records
  4. Search, Add, Edit, and Delete causality factor records

## 5. Relate disease with sets of symptoms, signs, and causality factors

### 11.1.14.4 Use-Case Diagrams

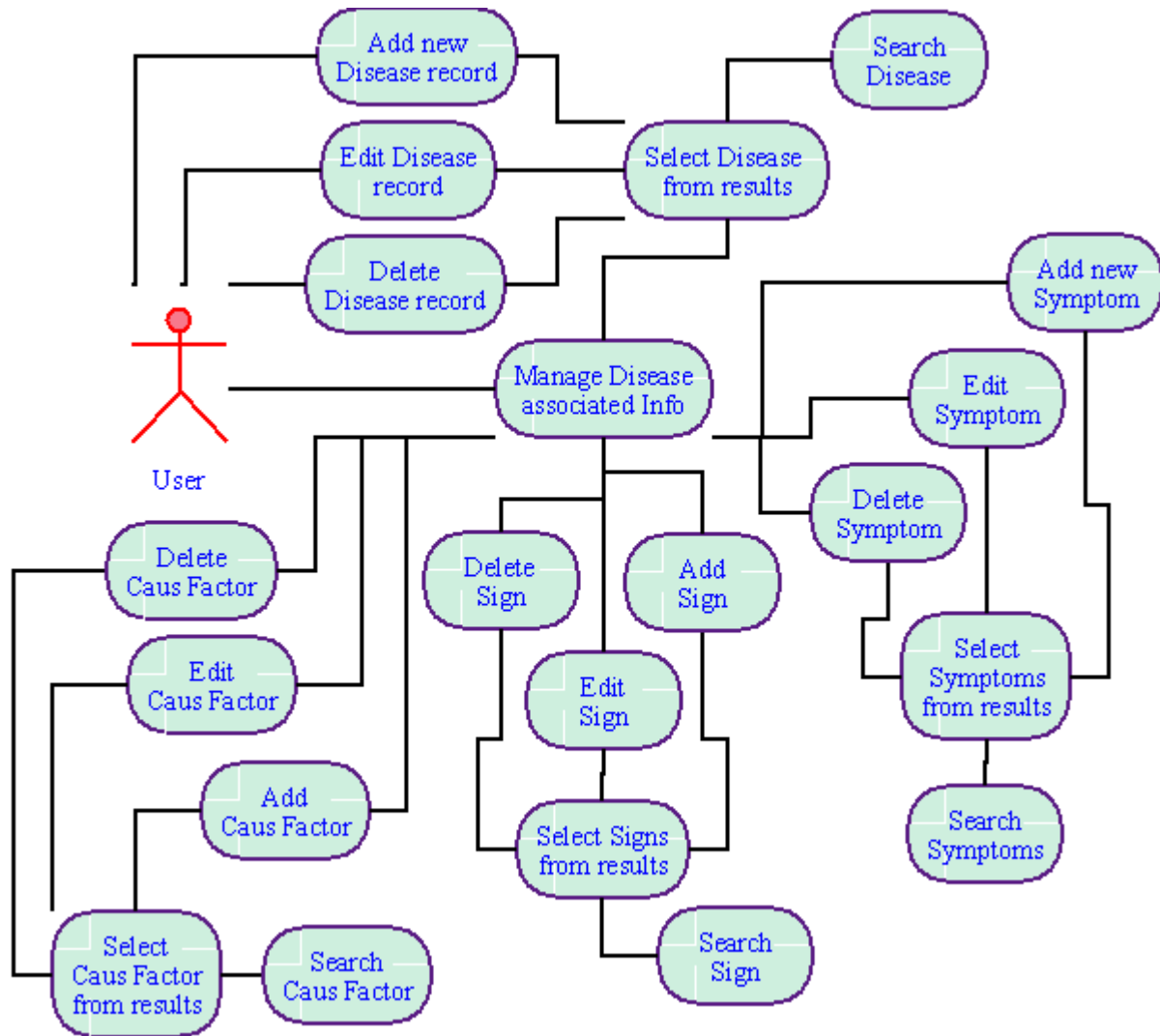


Figure 41: diagnosis (disease, sign, symptoms, and causality factor) use case diagram

Table 56 description of use cases in Figure 41

Search disease record	Provide necessary and sufficient set of attributes for user to enter full or partial information; then apply search function to retrieve relevant dataset from database to be displayed in tabular form for user to select one or more records
Select disease from result	First search for the record and select the desired record from result set to proceed with viewing, editing, or deleting functions
Add new disease record	By default the user is forced to search for the record and if not in result then allow to add a new disease record; the record should be assigned to

	a particular disease type from registered list
Edit disease record	First search for the record and select the desired record from result set; then make changes to the values and save
Delete disease record	Tabulated results from the search will be presented with the option to select one or more records for deletion; delete process only deactivates the record by setting the deactivate data and time
Manage disease associated information	Through this use case the user can access the symptoms, signs, and causality factors objects to associate the respective information with a disease
Search symptom	Provide necessary and sufficient set of attributes for user to enter full or partial information; then apply search function to retrieve relevant dataset from database to be displayed in tabular form for user to select one or more records
Select disease from result	First search for the record and select the desired record from result set to proceed with viewing, editing, or deleting functions
Add new symptom	By default the user is forced to search for the record and if not in result then allow to add a new symptom record to save to database
Edit symptom	First search for the record and select the desired record from result set; then make changes to the values to update record
Delete symptom	Tabulated results from the search will be presented with the option to select one or more records for elimination; delete process only deactivates the record by setting the deactivate data and time
Search sign	Provide necessary and sufficient set of attributes for user to enter full or partial information; then apply search function to retrieve relevant dataset from database to be displayed in tabular form for user to select one or more records
Select disease from result	First search for the record and select the desired record from result set to proceed with viewing, editing, or deleting functions
Add new sign	By default the user is forced to search for the record and if not in result then allow to add a new disease record to save to database
Edit sign	First search for the record and select the desired record from result set; then make changes to the values to update record
Delete sign	Tabulated results from the search will be presented with the option to select one or more records for elimination; delete process only deactivates the record by setting the deactivate data and time
Search cause factor	Provide necessary and sufficient set of attributes for user to enter full or partial information; then apply search function to retrieve relevant dataset from database to be displayed in tabular form for user to select one or more records
Select disease from result	First search for the record and select the desired record from result set to proceed with viewing, editing, or deleting functions
Add new cause factor	By default the user is forced to search for the record and if not in result then allow to add a new causality factor record to save to database
Edit cause factor	First search for the record and select the desired record from result set;

	then make changes to the values to update record
Delete cause factor	Tabulated results from the search will be presented with the option to select one or more records for elimination; delete process only deactivates the record by setting the deactivate data and time

#### 11.1.14.5 Main Scenarios

- Search disease records
- Create disease records
- Edit disease records
- Delete disease records
- Lookup and associate symptoms <<symptom>>
- Lookup and associate signs <<sign>>
- Lookup and associate causality factors <<causality factor>>
- Search symptoms records
- Create symptom records
- Edit symptom records
- Delete symptom records
- Search sign records
- Create sign records
- Edit sign records
- Delete sign records
- Search causality factor records
- Create causality factor records
- Edit causality factor records
- Delete causality factor records

#### 11.1.14.6 Data Storage (files and databases)

Table 57 Disease Type information

<i>Attribute</i>	<i>Data Type</i>	<i>Comment</i>
Disease Type	Varchar	Distinguish between classes of diseases such as heart diseases, skin diseases, ENT diseases
Description	Varchar	Explanation of the type, which may be found in the ICD definitions as well
Deactivate date time	Date Time	Records will not be deleted from database only deactivated to maintain referential integrity

Table 58 Disease information

<i>Attribute</i>	<i>Data Type</i>	<i>Comment</i>
Disease	Varchar	The name of the disease in short form, which is

		also the primary key of the record and cannot be duplicated
Enumeration	Integer	Value to communicate instead of sending string to optimize bytes as in mobile phones
Disease Type	Varchar	Same as in Table 28
Disease Priority	Varchar	Indicates whether it is a high, medium, or low priority, which defines the level of attention given to the health case
ICD Code	Varchar	International Classification of Diseases codes
ICD Description	Varchar	Human readable description of the ICD code
Notes	Varchar	Other notes relevant to the disease
Deactivate date time	Date Time	Records will not be deleted from database only deactivated to maintain referential integrity

Table 59 Symptom detail information

<b>Attribute</b>	<b>Data Type</b>	<b>Comment</b>
Symptom	Varchar	The name of the symptom in short form, which is also the primary key of the record and cannot be duplicated
Enumeration	Varchar	Value to communicate instead of sending string to optimize bytes as in mobile phones
Symptom Priority	Varchar	Indicates whether it is a high, medium, or low priority, which defines the level of attention given to the health case
Description	Varchar	Human readable explanation of the symptom that can be used in presentation material such as reports
Symptom Code	Varchar	A standard coding system, similar to the ICD codes, used to classify symptoms
Deactivate date time	Date Time	Records will not be deleted from database only deactivated to maintain referential integrity

Table 60 Sign detail information

<b>Attribute</b>	<b>Data Type</b>	<b>Comment</b>
Sign	Varchar	The name of the sign in short form, which is also the primary key of the record and cannot be duplicated
Enumeration	Varchar	Indicates whether it is a high, medium, or low priority, which defines the level of attention given to the health case
Sign Priority	Varchar	Indicates whether it is a high, medium, or low priority, which defines the level of attention given

		to the health case
Description	Varchar	Human readable explanation of the sign that can be used in presentation material such as reports
Sign Code	Varchar	A standard coding system, similar to the ICD codes, used to classify signs
Deactivate date time	Date Time	

Table 61 Causality Factor detail information

<b><i>Attribute</i></b>	<b><i>Data Type</i></b>	<b><i>Comment</i></b>
Causality Factor	Varchar	The name of the causality factor in short form, which is also the primary key of the record and cannot be duplicated
Enumeration	Varchar	Indicates whether it is a high, medium, or low priority, which defines the level of attention given to the health case
Causality Factor Priority	Varchar	Indicates whether it is a high, medium, or low priority, which defines the level of attention given to the health case
Description	Varchar	Human readable explanation of the causality factor that can be used in presentation material such as reports
Causality Factor Code	Varchar	A standard coding system, similar to the ICD codes, used to classify causality factors
Deactivate date time	Date Time	Records will not be deleted from database only deactivated to maintain referential integrity

#### 11.1.14.7 Associations

Figure 42 shows the association of the disease class with the symptom, sign, and causality factor classes. The disease class uses the lookup function to invoke the symptom, sign, or causality factors. Each of the class objects have their own search, add, edit, and delete functions to manage the data within the individual classes.

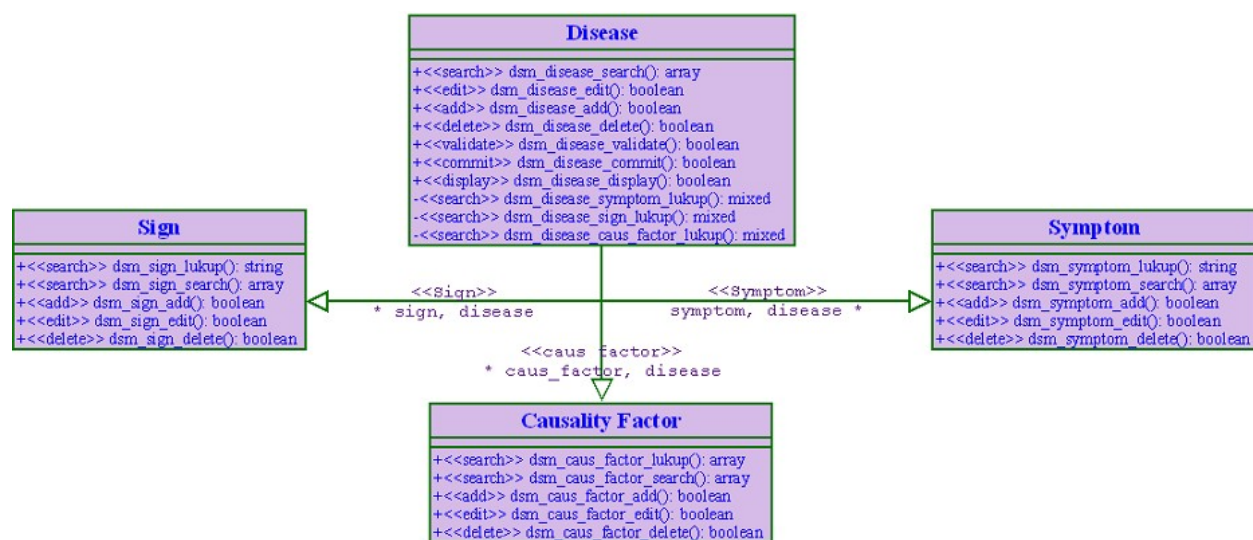


Figure 42: Class inheritance diagram

Table 62 Other GUIs quasi modally accessing the location object

Interface Name	Remarks
Person add and edit form (web interface)	A health worker is associated with a location; e.g., a Public Health Inspector is assigned a jurisdiction.
Facility add and edit form (web interface)	A hospital is associated with a location; e.g. Kuliapitya base hospital is situated in the Kuliapitiya MOH division
Service add and edit form (web interface)	A service such as investigating a patient can be carried out in a particular Public Health Inspector area.
Case add and edit form (web interface)	A case has to be identified with a location to calculate the disease densities.
Address add and edit form (web interface)	An address may belong to a particular governance area such as a tribunal or village or a district

#### 11.1.14.8 Implementation Notes

- Step 1: define the disease types
- Step 2: define the list of symptoms, signs, and causality factors
- Step 3: define the set of diseases and associate the respective type, symptoms, signs, and causality factors

#### 11.1.14.9 Cases

Health “cases” is the key object that stores the health domain patient specific information for the BSM module. It inherits the diagnosis, person, service, facility, and location abstract classes.

A health case is a record that contains a patient’s identification details, diagnosis information, and location information. The main goal of the Biosurveillance module is to identify adverse disease

clusters and disease density propagation through the geographical space. The relevant information for detection is obtained through the set of cases datasets.

#### **11.1.14.10 Real Need**

- Main piece of health information for Biosurveillance, which contains the source, carrier, disease, symptoms, signs, time, and location
- Required for analysis for detecting disease outbreaks or finding adverse health events in the datasets of patient health data
- Producing aggregated health reports for monitoring the health status
- Provides health case history for a given patient (person)

#### **11.1.14.11 User Goals**

- Define and relate sets of diseases, symptoms, and signs
- Define case related services
- Define locations and facilities to relate to cases
- Assign a parent location (i.e. larger geographic area) to a location; e.g. a province to a district
- Create, edit, add, and delete a health case record with mandatory elements location and symptoms
- Maintain the status history of the case
- Assign and monitor health-case-services

#### **11.1.14.12 Actors & Roles**

- *Super User (Implementer/DBA):*
  1. Define case service types and locations
- *User (Health Worker)*
  1. Search, Add, Edit, and Delete health case records

#### **11.1.14.13 Use-Case Diagrams**

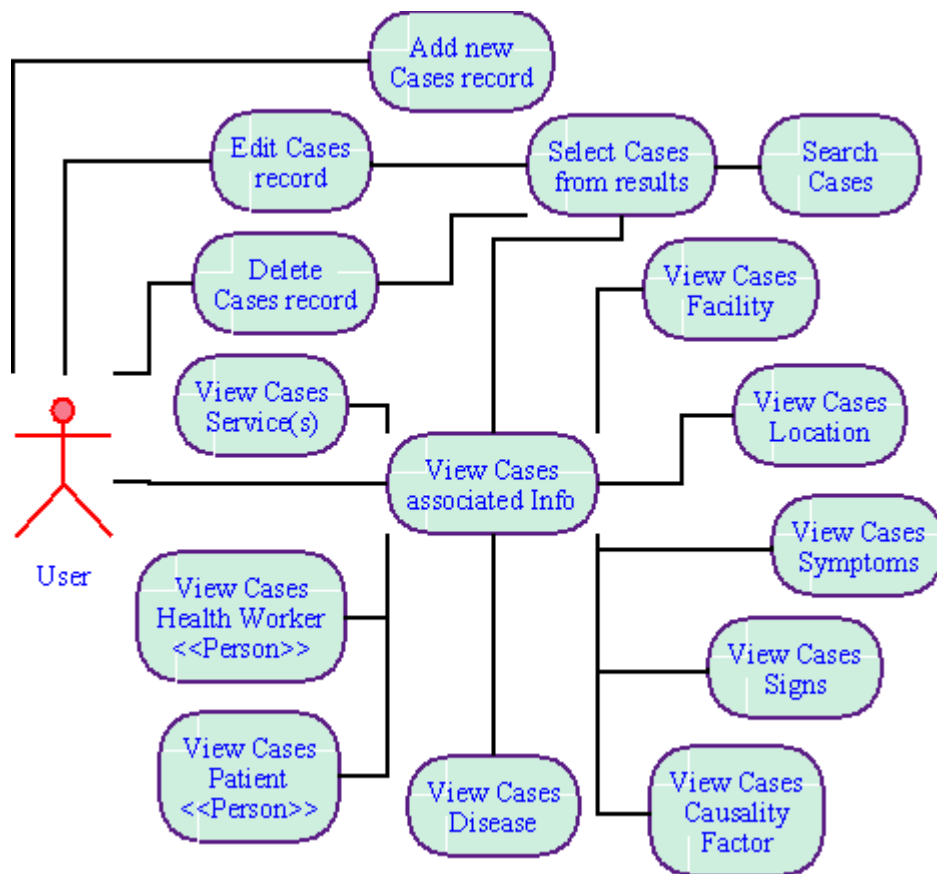


Figure 43: Health Cases use case diagram

Table 63 description of use cases in Figure 43

Search Cases	Provide necessary and sufficient set of attributes for user to select or enter full or partial information; then apply search function to retrieve relevant dataset from database to be displayed in a table for user to select one or more records
Select Cases from result	Tabulated results should be presented with options to select one record for editing and one or several desired records for deleting. Also, provide the option to add a record if desired. Mandatory elements displayed in table are the case uuid, case reported date, disease, patient name, gender, age group, health worker, facility, and location; while other values are optional but displayed if they are necessary for user to distinguish between two similar cases
Edit Cases record	First search for the record and select the desired record from result set; then make changes to the values and save
Add new record	By default the user is forced to search for the record and if record is not in result then allow to add a new case record; mandatory values for saving record are symptoms and location
Delete Cases record	First search for the record and select the desired record from result set; then apply delete function

Manage Cases Associated Information	This is to relate a case with existing disease, symptom, sign, causality factor, location, facility, service, patient, and health worker information by adding the information, editing already related information, or deleting already added information
Manage Cases Services	If there are no related services, then the process invokes the add service use case; if services already exist then user may select one of the service, which will invoke the edit service use case; or user may choose to delete an existing service from the list of related services
Manage Cases Location	If a location is not specified or already specified, the process invokes the search location use case for user to select a defined location or replace already related location, respectively; if desired location is not registered in DB then user may add the location first then select to relate the location with health case; removing a related location is not allowed as location is mandatory for a case record; see 7.1 for location use cases
Manage Cases Facility	If a facility is not specified or already specified, the process invokes the search facility use case for user to select an already defined facility from DB or replace the related facility with another value from DB, respectively; if desired facility is not registered in DB then user may add the facility first then select to relate the facility with health case; to remove an already related facility, simply chose to delete relationship; see section 7.4 for facility use cases
Manage Cases Disease	If a disease is not specified or already specified, the process invokes the search disease use case for user to select an already defined disease from DB or replace the related disease with another value from DB, respectively; if desired disease is not registered in DB then user may add the disease first then select to relate the disease with health case; to remove an already related disease, simply chose to delete relationship; see section 8.2 for disease use cases
Manage Cases Symptoms	If symptoms are not specified or already specified, the process invokes the search symptoms use case for user to select an already defined symptom from DB or replace the related symptoms with other values from DB, respectively; if desired symptom is not registered in DB then user may add the symptom first then select to relate the symptom with health case; to remove an already related symptom, simply chose to delete relationship; since symptom is a mandatory element of the health case record, at least, one symptom must be related for it to be a valid record, see section 8.2 for symptoms use cases
Manage Cases Signs	If signs are not specified or already specified, the process invokes the search signs use case for user to select an already defined sign from DB or replace the related signs with other values from DB, respectively; if desired sign is not registered in DB then user may add the sign first then select to relate the sign with the health case; to remove an already related sign, simply chose to delete relationship; see section 8.2 for symptoms use cases

Manage Cases Causality Factors	If causality factors are not specified or already specified, the process invokes the search causality factors use case for user to select an already defined causality factor from DB or replace the related causality factors with other values from DB, respectively; if desired symptom is not registered in DB then user may add the causality factors first then select to relate the causality factor with health case; to remove an already related causality factor, simply chose to delete relationship; see section 8.2 for symptoms use cases
Manage Cases Patient <<Person>>	If a patient (category = person) is not specified or already specified, the process invokes the search person use case for user to select an already defined person from DB or replace the related person with other values from DB, respectively; if desired person is not registered in DB then user may add the person first then select to relate the person with the health case; to remove an already related person, simply chose to delete relationship; see section 7.3 for person use cases
Manage Cases Health Worker <<Person>>	If a health worker (category = health worker) is not specified or already specified, the process invokes the search person use case for user to select an already defined person from DB or replace the related person with other values from DB, respectively; if desired person is not registered in DB then user may add the person first then select to relate the person with the health case; to remove an already related person, simply chose to delete relationship; see section 7.3 for person use cases

#### 11.1.14.14 Main Scenarios

- Create a health case (add)
- Edit a health case
- Delete a health case
- Search a health case
- Edit case status history <<case history>>
- Lookup and associate patient <<person>>
- Look up and associate location <<location>>
- Lookup and associate facility <<facility>>
- Look up and associate services <<service>>
- Lookup and associate health worker <<person>>
- Lookup and associate disease <<disease>>
- Lookup and associate symptoms <<symptom>>
- Lookup and associate signs <<sign>>
- Lookup and associate causality factors <<causality factor>>

#### 11.1.14.15 Data Storage (files and databases)

Table 64 Cases detail information

<b>Attribute</b>	<b>Data Type</b>	<b>Comment</b>
Universal Unique ID (uuid)	Integer/Varchar	Unique identifier for the record
Case date time	Date Time	Identifier pointing to the parent location
Patient person UUID	Integer/Varchar	Human readable name to id the location
Patient Full Name	Varchar	Health, Governance,
Health Worker person UUID	Integer/Varchar	Health location types: MOH, PHI,
Health Worker full name	Varchar	Additional human readable info
Facility UUID	Integer/Varchar	ISO 8440 international location code
Facility Name	Varchar	Geometric shape of the location e.g. circle, polygon, line, point
Location UUID	Integer/Varchar	A polygon will have a set of x coordinates $X = (x1, x2, \dots, xn)$ e.g. latitudes
Location Name	Varchar	The same polygon will have equal number of y coordinates $Y = (y1, y2, \dots, yn)$ ; e.g. longitudes
Disease	Varchar	If 2 dimensional then a set of Z coordinates representing the height else zero $Z=(0, 0, \dots, 0)$
Disease diagnose date time	Date Time	To identify when the record was created
Agent	Varchar	
Gender	Varchar	
Age	Decimal	
Age Group	Varchar	
Notes	Varchar	
Create by	Varchar	User or System creating the record
Create process	Varchar	How the record was created; e.g. web, mobile phone, the application, external
Modify date time	Date Time	Identify when record was last modified
Modify by	Varchar	User or System modifying the record
Modify process	Varchar	The method the record was modified
Deactivate date time	Date Time	Records will not be deleted from database only deactivated to maintain referential integrity

#### 11.1.14.16 Associations

When collaborating with other objects such person, facility, service, address, or case the entry point for associating a location with these objects is through the search use case.

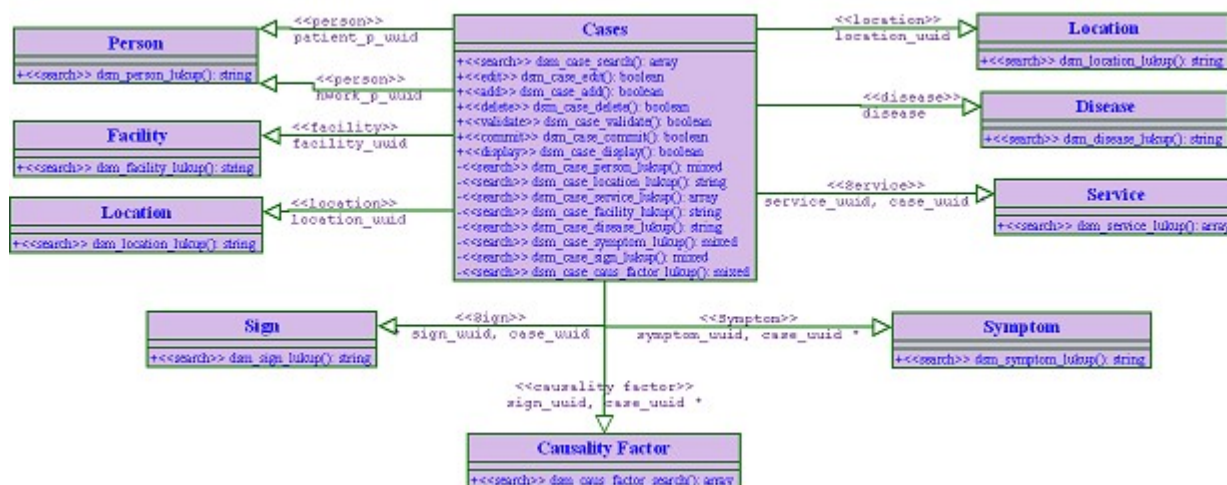


Figure 44: Cases object and the inherited and associated objects

Table 65 Other GUIs quasi modally accessing the location object

Interface Name	Remarks
Person add and edit form (web interface)	A health worker is associated with a location; e.g. a Public Health Inspector is assigned a jurisdiction.
Facility add and edit form (web interface)	A hospital is associated with a location; e.g. Kuliypitiya base hospital is situated in the Kuliypitiya MOH division
Service add and edit form (web interface)	A service such as investigating a patient can be carried out in a particular Public Health Inspector area.
Case add and edit form (web interface)	A case has to be identified with a location to calculate the disease densities.
Address add and edit form (web interface)	An address may belong to a particular governance area such as a tribunal or village or a district

#### 11.1.14.17 Implementation Notes

- Install the Hardware (Server and Network) Software (operating system and web server)
- Setup the alias directory system to access the application with a web browser over the internet
- Test the accessibility from an external personal computer connected to the internet
- Identify the set of location categories to be used in the implementation and set the category values
- Identify the set of types (sub categories) under each category and their hierarchy then enter those values with corresponding category
- Setup an indexing system for the location universal unique identifier
- Open the search form to ensure the categories and related types are displayed

## 11. References

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## ***11.2 Mobile health applications software requirements***

### **11.2.1 Overview**

These days most of the people own mobile phones and use it predominantly for voice communications but the mobile phone is also emerging as a ubiquitous tool for data collection in Information and Communication Technology (ICT) systems. The goal of the Real Time Biosurveillance Program (RTBP) is to collect the rural health data through mobile phones and to be uploaded in to a centralized database. The ICT system collecting the data through mobile handhelds uses General Packet Radio Service (GPRS). Using GPRS, one can access the mobile application for data collection. The application is designed with an easy to use and user-friendly graphic user interface with the capability to store records on the mobile phone's memory in the absence of GPRS signal (or connectivity), warn the user in the event of inadequate memory by alerting the user to take remedial actions.

Functional requirements have given rise to challenging design constraints that are a result of limitations on developing the applications using mobile devices. If we use high standard mobile devices (above USD 200) we may be able to overcome these limitations, but the disadvantage is the high cost of the mobile device that cannot be justified in developing countries.

Following are the limitations of designing the applications using mobile device:

- Limited processing speed.
- Very limited memory for application memory (JAR file) and heap memory.
- Very low signals in Rural Areas.
- Users may feel some difficulties to operate the keypad.
- Small screen size.
- Cost of mobile phone should be around USD 100 affordable to rural folks.
- Issues in Data Security.
- It is not very user friendly.
- GPRS is cheaper compared to Short Message Service (SMS)
- However, SMS is more reliable than GPRS.

### 11.2.1 Functionality

The application has two parts:

- A client application runs in the mobile device (J2ME Application).
- The mobile application sends the data to standalone server using GPRS Wireless Application Protocol (WAP). Here the GPRS is a very familiar technique for data collection.

#### 11.2.1.1 Functional Requirement: “Mobile Application”

The healthcare worker (e.g., VHN or PHI) has to carry the mobile phone with health application installed, to the villages at the time of health visit. They have to fill the health survey form and send the data to the RTBP server through GPRS.

The Application has following functions,

- Create a profile.
- Download locations.
- Download disease and syndrome data.
- Download other implementation specific lookup values.
- Health Survey.
- Offline survey.

#### 11.2.1.2 Real Need

- Create Profile
  - Stores the health worker information in the database and Java RMS storage for accountability.
  - Attach a user name with submitted records for system to identify who sent record.
  - A single mobile phone to be used by multiple users.
- Download Locations
  - To avoid the misspelling of location names.
  - Instead of typing the location name on every single usage, one can just select from the drop-down menu in “Health Survey” form.
  - The location information is available in RTBP server as well Java RMS storage.
- Download disease and syndrome data
  - Reduce the typing of diseases and syndrome in health survey form.
  - Reduce misspelling of disease and syndrome data.
  - Disease list (and its known symptoms and signs), Health worker type, gender, age group, location types are available in offline mode (stored in Java RMS)
- Download other implementation specific lookup values

- Selection of age-group for fast data entry and avoid typing
- Selection of gender for fast data entry, avoid typing, and misspelling
- Selection of disease status for fast data entry, avoid typing, and misspelling.
- Selection of location type to download location names.
- Health survey
  - Main function for submitting health records.
  - Acquire all patient health related information (except ethical data) from rural areas to for disease outbreak detection.
  - Ability to submit health records in real-time.
  - Identifying the patient disease, syndrome and demographic information.
- Offline Survey
  - In case signal GPRS failed then store survey information in Java RMS Capability to continue the survey in offline mode (i.e. absence of GPRS connectivity)

#### **11.2.1.3 User Goals**

The following goals have to be achieved for developing the mobile application:

- Healthcare workers want to able to create their profiles.
- Single phone to be shared by multiple healthcare workers. (i.e. register several health worker profiles)
- Healthcare workers able to download their locations.
- Give selection lists instead of typing value from the keypad to reduce misspelling and data entry times.

#### **11.2.1.4 Actors & Roles**

- Field Health worker,
  - He/She carries mobile for health survey in the field.
  - Download mobile phone application and configure application. Fill the health survey form and sends data to the central database.
- Administrator,
  - Monitor and maintain the overall server applications and database.
  - Host the mobile application on HTTP server for health workers to download and install.
- Field Officer,
  - Giving the training to the field health worker.
  - In case of any problem, he will provide the support to the field health worker.

#### **11.2.1.5 Usability**

- The user interface must be GUI based.
- The users are required to input the data from cell phone keypad.
- The User Interface consists of J2ME GUI components like Forms, Buttons, Canvas, Textbox,

Text Field, Alert Boxes and Lists.

- User has the options to change the settings locally and remotely.
- Reduce the typing option by giving support for select menus.
- Enable the dictionary words.

#### **11.2.1.6 Design Constraints**

The SRS document has been developed based on the requirement with assumption. Here each actor needs some requirement to fulfill the user expectations.

The following supports are needed for mobile phone,

- Java (J2ME) Enabled.
- WAP 1.0 or above.
- GPRS enabled
- MIDP 2.0.
- CLDC 1.1.

The following supports are needed for network,

- 50% of Network coverage and signal strength in the areas
- GPRS service
- Network consistency and reliability for sending/receiving the data

The following components are needed for server,

- Web server like Apache, Web logic, Web sphere etc.
- Web services programming support like PHP, PERL, etc.
- Database support like MySQL, PostgreSQL, Oracle

The following tools are used to build the Mobile application,

- Java 1.4.1 or later.
- Wireless Tool Kit (WTK).
- J2ME MIDP 2.0 and CLDC 1.1.
- Third party emulators like Nokia, Motorola etc.
- Netbeans or Eclipse IDE.
- WTK optional packages

The following constraints have to achieve in the mobile application.

- User-friendly GUI form.
- Online and offline health survey.
- Application should be platform independent for Java enabled mobile.
- Application must have security.

- Health Application can be developed on a Windows NT/Linux workstation/operating system.

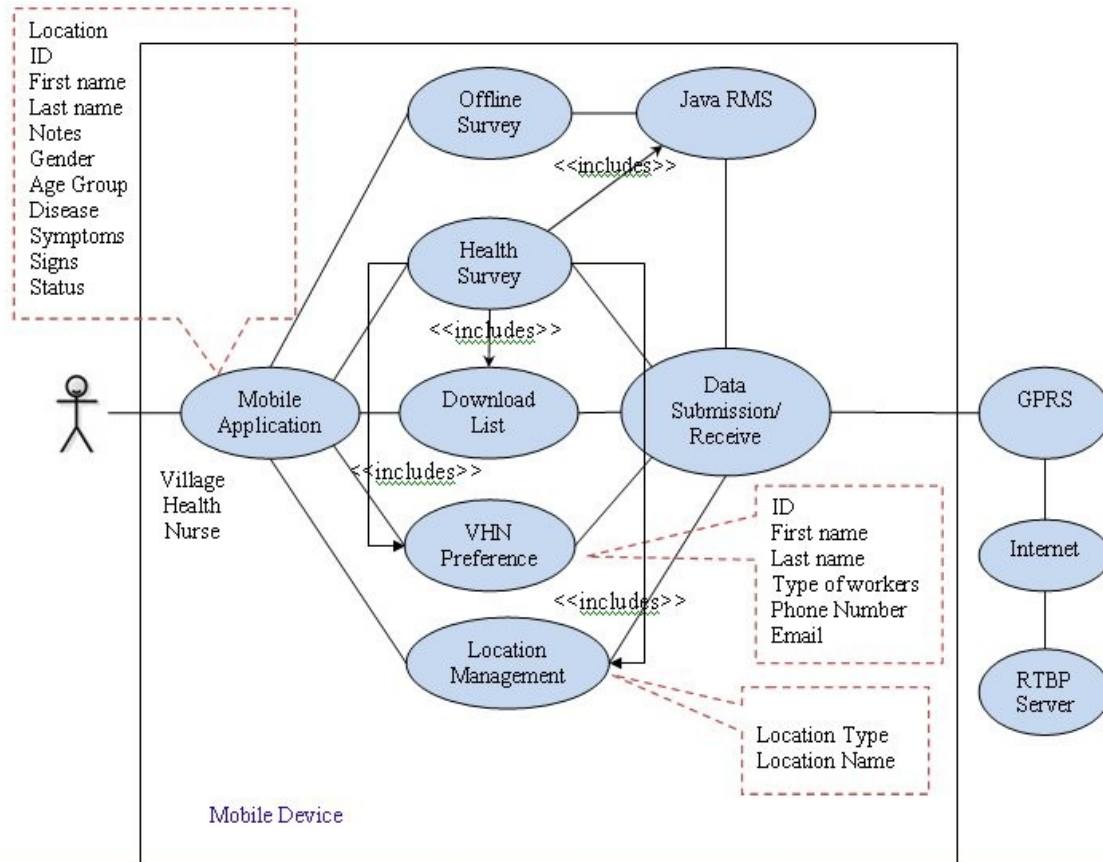


Figure 45: Mobile application initialization and data submission use cases

### 11.2.1.7 Use-Case Diagrams

#### Health Survey:

The Health survey form is used to enter the patient disease information and it is sent to the database. In case of GPRS signal failure, it will store the data into Mobile RMS database ("SURVEY"). RMS data will be uploaded into the server once mobile reestablishes GPRS connectivity. Here the application gets the known health worker ID, age group, gender location name, status, disease, signs, and symptoms list from RMS storage downloaded in 'Download List Form'.

#### Offline:

It is used to store the Health Survey form data in the absence of network connectivity to submit records to the database. Once network is available, the application will send the data in the offline storage to the central database.

**Download List:**

It downloads the known health worker type, age group, gender and location type and Disease with Symptoms and Signs, along with the primary/foreign key relationships from the database, are stores in the Java RMS in the DIS, SYM, SIGN, Type, age, gender, Loc Type databases respectively. The data must exist in the database before they can be downloaded in the mobile phone.

**Healthcare worker profile:**

Healthcare worker can save their own profiles in java RMS in the “Healthcare Worker” database and upload to the RTBP relational database. The method allows for more than one health worker profile but will limit the number based on the memory constraints.

**Location Download:**

Healthcare Worker has to download their own Locations in RMS “Loc” database; e.g. type = “PHC” and location name = “Nerkuppai”. The location will also contain the parent location it belongs to; i.e. the larger area the location is embedded in such as a village in a district.

**11.2.1.8 Main Scenarios**

The program must validate GUI inputs.

- If the login is incorrect, the program must show alert message to the user about incorrect login.
- Provide the possible Information/Warning/Error using alert.
- User can easily move from one screen to another screen.
- Enable the mobile dictionary to enter the values.
- Must validate the values like E-Mail ID, Decimal, Real values etc.
- Users have to know the status information and alerting information.
- Data should be stored in the local database when GPRS is not activated.
- Once GPRS is connected, the local data must be sent the server from the local database.
- Application updates through GPRS.

**11.2.1.9 Flow diagram of the mobile phone application**

The overall flow diagram for mobile application is shown in Figure 46. The Mobile application contains five functional components named:

- Health Survey
- Offline Survey
- Download List
- Profile
- Location Download

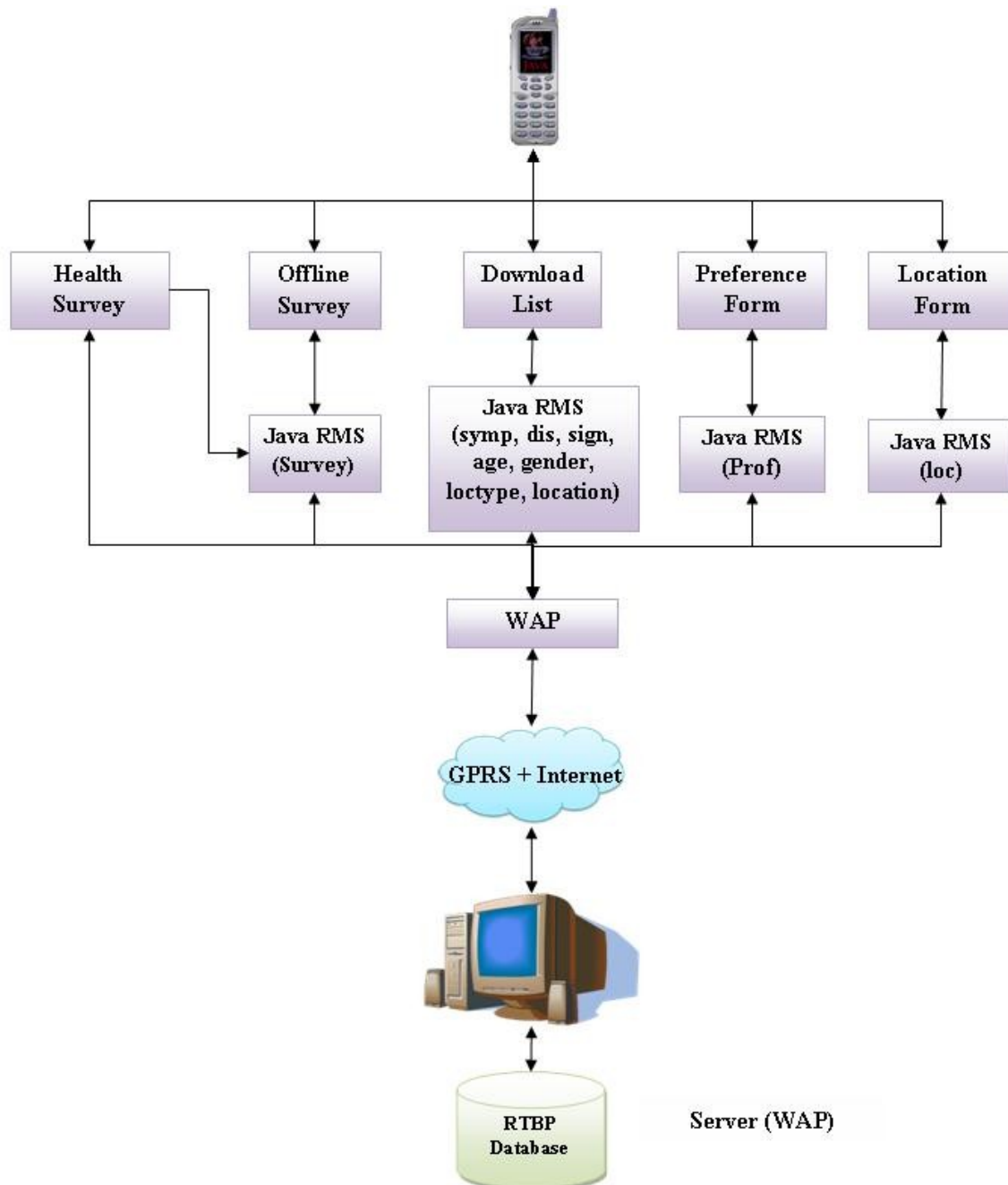


Figure 46: Information flow between mobile phone and database

#### 11.2.1.10 Download List function

To initialize the application we have to download the list, fill up the profile and download the location forms. The Download list form is used to download the health worker type, age group, gender and location type, status, sign, symptoms and disease from the database. The user cannot use the application without downloading the disease, symptoms, signs, age group, gender, location type and

health worker type list. Download list is used to avoid misspelling of strings and jeopardizing data integrity issues in the database and causing inaccuracy in analysis. The data of the download list, profile and location forms will be sent to server as well as Java RMS. Once we have done the download process the location, disease and its related sign and symptoms, age group, gender and user ID will be available to the health survey form from the RMS. Then we can start to fill up the Health survey form. This health survey data will be sent to the server through GPRS. If no signal then the data will be stored in the RMS. Thereafter, user can view the stored data using the Offline Survey form. Once we got the signal then the user has to send the data from the Offline survey form to RTBP server.

User needs to download the symptoms, signs, disease, age group, gender, location type, status, and health worker type list from Server through GPRS. The flow chart in Figure 47 describes the “Download List” menu; it is used to download the symptoms, signs, disease, age group, gender, location type and health worker type list from server using GPRS. When we launch this list, it will check whether the GPRS is enabled or not. If signal is there, the list will be updated from the server to RMS. If there is no signal, it will terminate. If there is an error in “formulating the list” at the database then that error should be communicated to the use.

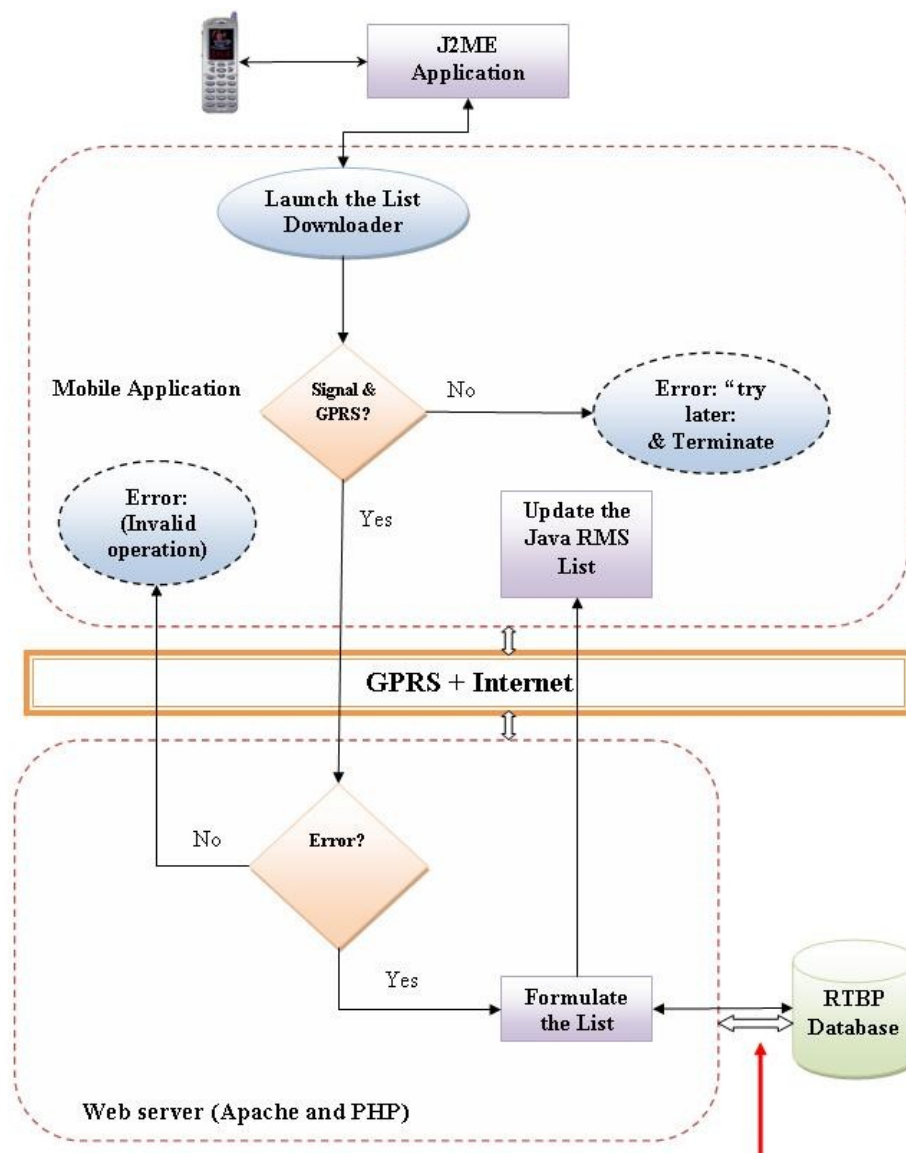


Figure 47: Flow chart for loading data from database

#### 11.2.1.11 Health Survey Form

When health worker selects the Health Survey form, it gets the following information from Java RMS named location, profile information, age group, gender, disease, known symptoms and signs. Once the health worker has filled the information and the validation process has been completed, she has to submit the data to server and it will check for the GPRS signal. If signal is available, then the data will be submitted to the RTBP database and updated message will be displayed in the screen. If there is an error or no signal, the data will be stored in the RMS.

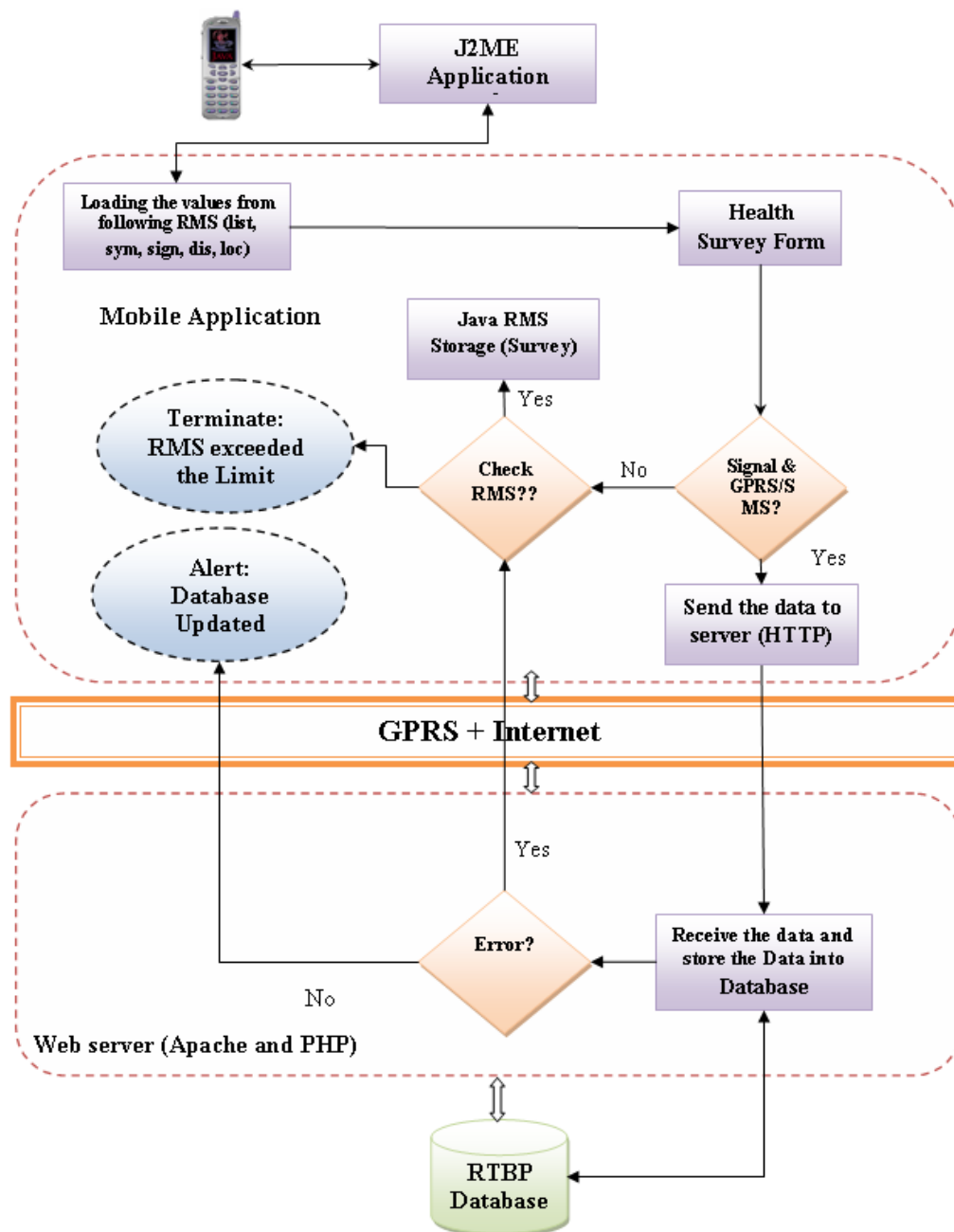


Figure 48: Health Survey form data flow chart

The Healthcare worker has to send the following information to RTBP server

- Date and time of the visit\*
- Location\* (from Location Form)

- Health worker ID\* (from Profile Form)
- Patient First name
- Patient Last Name
- Notes
- Gender\*
- Age Group\*
- Disease
- Symptoms\*
- Signs
- Status

[\*] Fields labeled with an asterisk are mandatory, while the others are optional

It also provides an option to search disease, symptoms and signs that are available in the RMS. When a health worker selects a disease from the list, it automatically displays few common symptoms and signs related to that particular disease. Health worker can add/edit symptoms and signs according to the patient. When the health workers add/edit the symptoms/signs, it will display all symptom that start with health worker input. For example, when health worker type 'C' in the symptom box, it displays all the symptoms start with the letter 'C' such as 'cold, cough...'

#### **11.2.1.12 Offline Upload (from Java RMS 'SURVEY')**

The flow chart in Figure 49 describes the uploading of the Offline Survey data (Stored by Health Survey Form) to the RTBP server once network is available. The Health worker has to manually select the "Offline Survey" (available in the main screen) menu, whenever they want to upload the offline data. If the "SURVEY" Java RMS is empty, it will give information to healthcare worker.

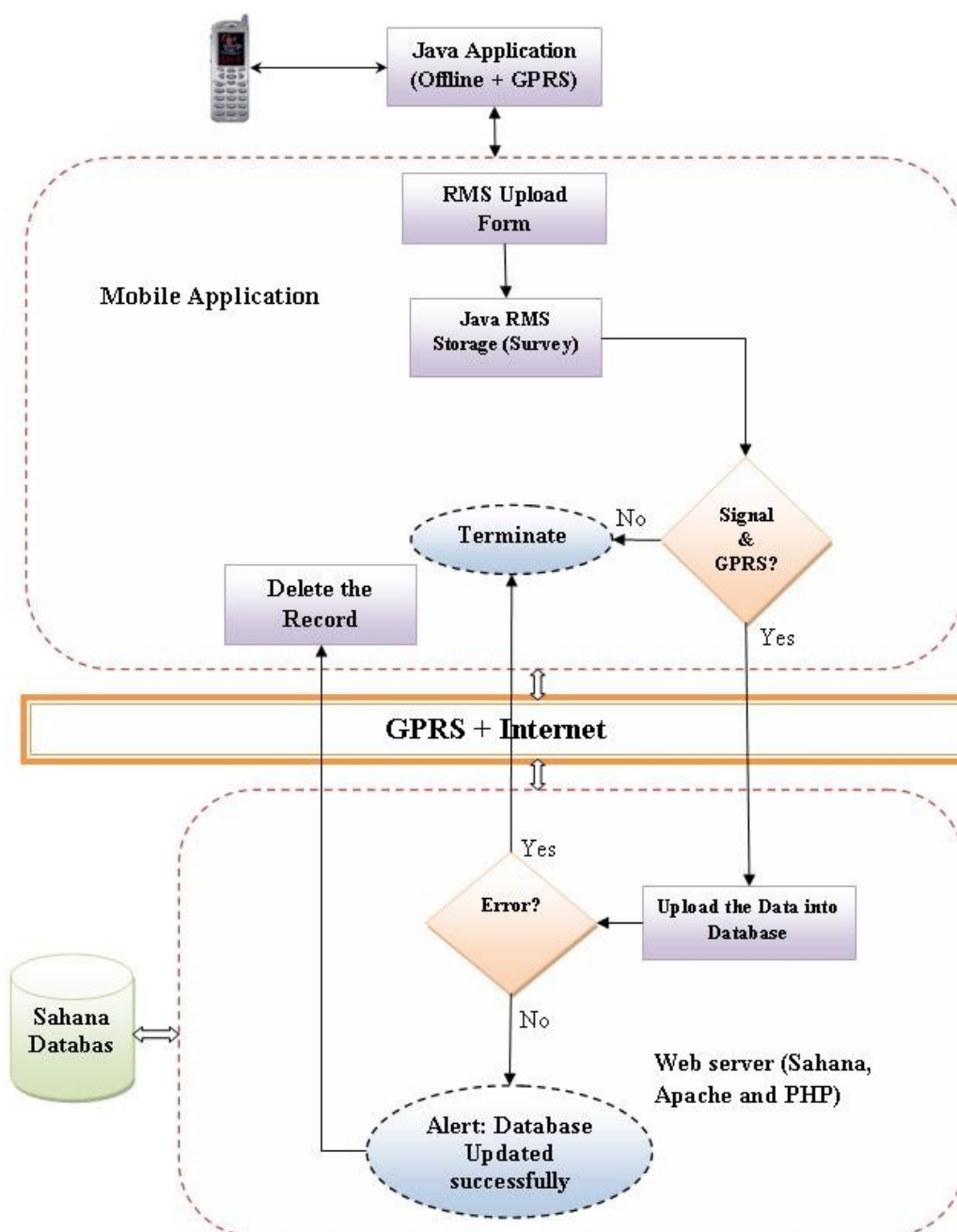


Figure 49: Offline Survey flow chart

### 11.2.1.13 Profile Form

Health worker information should be available in the database as well as RMS to access the health survey form effectively. When a health worker registers the profile information, the application will check for the availability of the profile in the database. If that profile already available in the database, it stores the data only in the RMS. If not, it stores the data in the database as well as RMS. This helps to

avoid iterative registration when the health worker upgrades the version. If there is no signal or error during the registration, then the form will be terminated; even it will not store the value into RMS. This form has the option to add new the healthcare workers and we can create more than one profile in this form. Figure 50 illustrates the data flow.

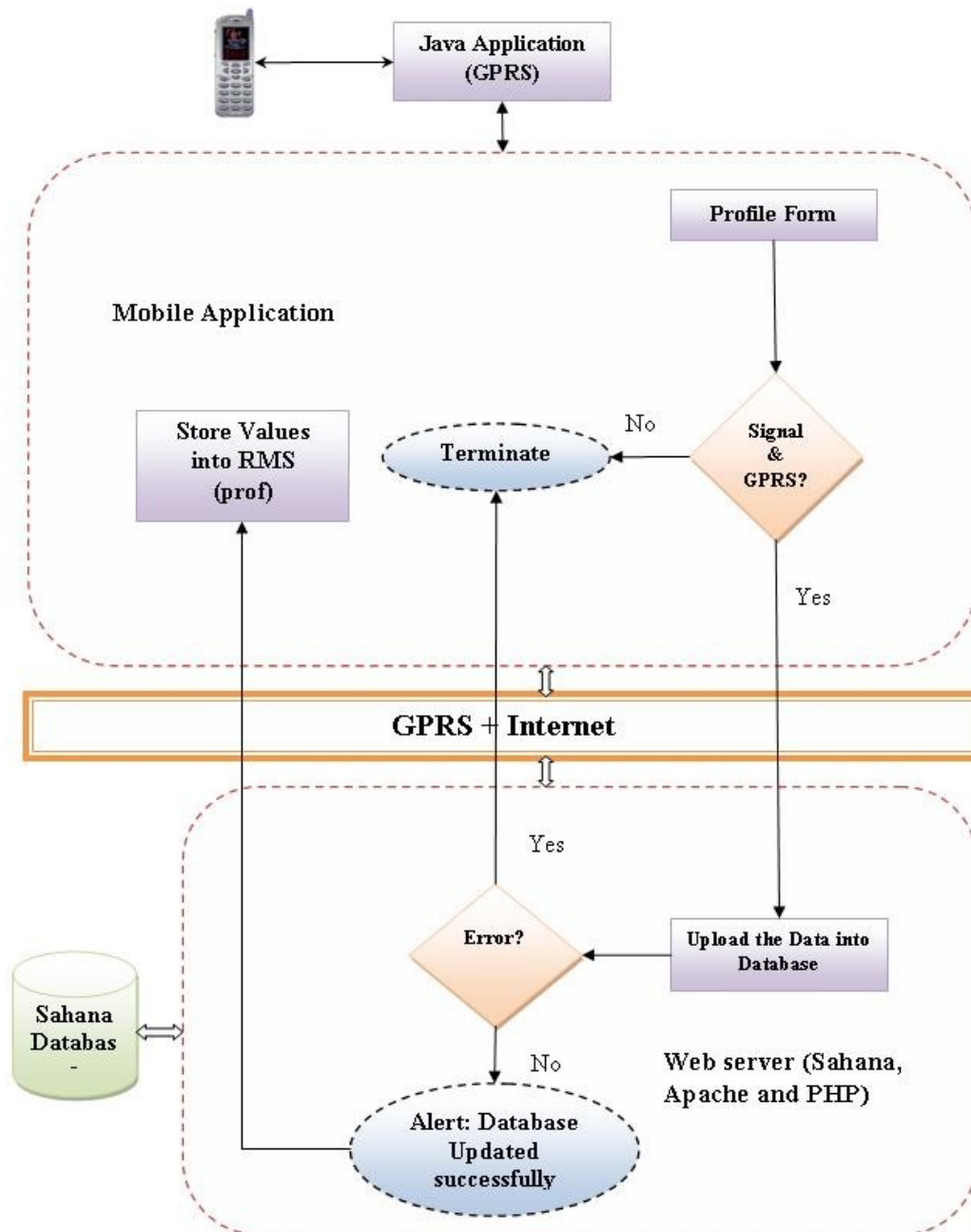


Figure 50: Profile form flow chart

The profile form must have the health worker types (i.e. health worker types) in the RMS before they begin with profiles. The list of health worker types can be downloaded from the RTBP server.

The Healthcare worker has to configure the following information,

- Healthcare worker's ID\*
- Health Worker First name\*
- Health Worker Last name
- Type\*
- Phone
- E-mail Id

[\*] Fields labeled with an asterisk are mandatory, while the others are optional

#### **11.2.1.14 Location Form**

The healthcare worker has to choose their location type (e.g. PHC) and need to enter the location name (e.g. PHC name “Thirukostiyur”) then sends to the server. Based on the location type and its location name the related village name will download from the RTBP server to Java RMS. Whenever the healthcare worker select health survey form the location information loaded from the Java RMS and displayed for selection. If there is no signal or error then the process will be terminated. If the location type and the location name combination are mismatched then the DB returns an error message. Otherwise, the DB sends the village names related to the location type and location name to local Java RMS.

If the location submitted by the user is not in the database (e.g. Type is “HSC” and the location name is “PHC name”), then the database will do nothing but return a confirmation to the mobile application. Users are strongly recommended to submit the correct spelling of location name to avoid these issues. The super users should upload all the location names and location type in the database to avoid these issues. The location form must first download the location types from the database before the user can start sending locations. If the user is unsure of the location name, they can search for the name through a Personal Computer browser based application that accesses the data from the same database.

The Healthcare worker has to enter the following information,

- Location Type\* (DDHS, PHC, HSC, Village, PHI area, MOH div, District, Provincial, Regional, and National and etc.,)
- Location Name\* (DDHS name, PHC name, HSC name, PHI area name, MOH div name, District name, Provincial name, Regional name, and National name)

[\*] Fields labeled with an asterisk are mandatory, while the others are optional.

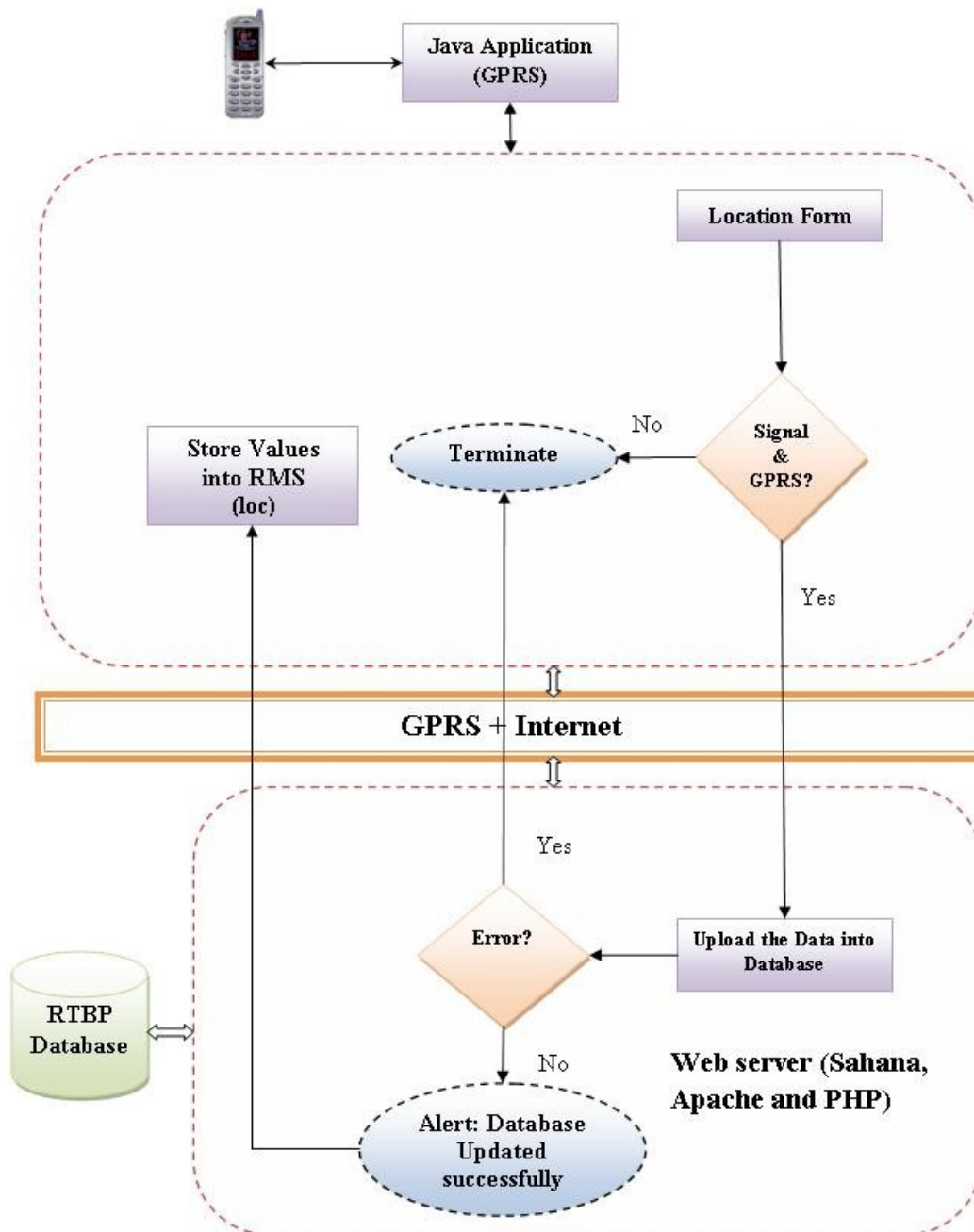


Figure 51: Location form flow chart

#### 11.2.1.15 External Interfaces (if any)

Some external interfaces may be required to develop and test the mobile application,

- USB Cable (PC to mobile communication)

- Serial Port (PC to mobile communication)
- External memory card for mobile device

#### **11.2.1.16 Data Storage (files and databases)**

For offline data storage, we will be using “Record Management Storage”. Basically we are storing the healthcare workers’ user profiles, healthcare workers’ location management and offline survey information in the RMS.

The following Databases are being used to store the records.

DIS – For storing the disease list

SYM – Known symptoms list for the disease

SIGN – Known signs list for the disease

PROF– Used to store the healthcare worker profile information

The syntax of “PROF” RMS database

id#firstname#lastname#type#phoneno#emailid

LOC – Used to store the healthcare worker locations

The syntax of “LOC” RMS database

id#locations

SURVEY – Offline survey health records

AGE – Used to store the patient’s age group

The syntax of “age” RMS database

Age1#age2#age3

GENDER - Used to store the patient’s gender

The syntax of “gender” RMS database

Gender1#gender2

TYPE - Used to store the healthcare worker type

The syntax of “type” RMS database

Type1#type2#type3...

LOCTYPE - Used to store the patient’s age group

The syntax of “LocType” RMS database

loctype1#loctype2

STATUS - Used to store status

The syntax of “age” RMS database

id#locations

#### **11.2.1.17 Implementation Notes**

- How to configure application such as setting URLs to download and store data because this will depend on the implementation, perhaps you need to create an alternate RMS or file to store the application configuration information with instructions for super user or system administrator to use for configuring the executable (JAR).
- Super users or implementers should set up the database and web server first on a desired operating system (windows, Linux, Debian, etc.). Current database is MySQL and web server is Apache.

- The mobile application interfaces with PHP objects to communicate with the database via the web server; hence, PHP 4 or 5 should be installed and running on the server
- A consolidated installation of MySQL, PHP and Apache is made available in the LAMP installation package for Linux operating systems (download - <http://www.linuxhelp.net/guides/lamp/>) “wampserv” installation package for Windows operating systems (downloaded - <http://www.wampserver.com/en/download.php>)
- Implementers must first define the location types, health worker types, status, disease, symptoms, and signs to make it available for the mobile app to download and store in the RMS.
- The mobile application JAR file (i.e. executable file) must be made available on the web for the users to download the app via GPRS on the mobile phone.
- A WAP based installation, application initiation, and user guide must be made available on the same website for users to refer to.

### 11.2.2 References

- <http://java.sun.com/javame/index.jsp>
- <http://www.w3schools.com>
- <http://www.sahana.lk>
- J2ME Mobile Information Device Profile (MIDP) specifications, version 2.0 (JSR 118), Sun Microsystems, Inc., 2004.
- Connected, Limited Device Configuration (CLDC) specifications, version 1.1, Sun Microsystems
- <http://www.javaworld.com/javaworld/jw-12-2002/jw-1220-wireless.html> - Data security in mobile Java applications

### ***11.3 T-Cube Web Interface (statistical data mining & visualization tools)***

#### **11.3.1 Overview**

This project, titled “Evaluating a Real-Time Biosurveillance Project: A Pilot Program”, is aimed at testing the feasibility of setting up a bio-surveillance system in the Kurunegala district (Sri Lanka) and Sivaganga district (Tamil Nadu, India). Auton Lab at Carnegie Mellon University (Pittsburgh, USA) will collaborate with teams in Sri Lanka (LIRNEasia) and India to provide statistical analysis interface for the data collected during this project. The statistical tools will include both time series analysis and spatial analysis with a user interface accessible over the WWW.

Auton Lab has worked on a wide variety of statistical projects in the past. The lab has many years of experience working with bio-surveillance algorithms. The goal of this project is to provide tools for prospective bio-surveillance that will generate timely alerts resulting in efficient response to real disease outbreaks.

#### **11.3.2 Product perspective**

Auton lab will provide disease outbreak detection algorithms. Both temporal analysis and spatial analysis will be performed on the data collected during the project. Auton Lab will use efficient data structures such as T-Cubes [2] to quickly retrieve data in response to the user queries during investigation and data mining.

Using the interface, called as the T-Cube Web Interface (TCWI), users will perform a wide variety of activities including data visualization via time series and maps, statistical analysis, automated analysis views during logins, etc. We intend to show that the front-end system can be scaled up to the national level bio-surveillance system without any problems. We also intend to evaluate the product using synthetic outbreaks injected in the real data collected during the project.

#### **11.3.3 User characteristics**

For statistical data mining via TCWI, users must have basic statistical data mining training. Users must be familiar with moving-average, significance testing, p-values, CUSUM, etc. Note users that intend to only visualize time series data or maps may not have any experience with statistical analysis. We hope the interface will provide helpful information to a wide range of users. Also, the users training time to get acquainted with the interface is expected to be only a few hours.

#### **11.3.4 Requirements**

Here is the list of requirements for the project.

- TCWI works in server-client configuration. The server must run on a Linux machine with Sun Java™ and Apache Tomcat web server installed. It is required that the server is active at all times when the users are interacting with the TCWI.
- The TCWI client can run under Linux or Windows operating system but must be accessed only with either Internet Explorer or Mozilla Firefox browsers.

- The data loaded by TCWI must be both temporal and spatial in nature. For temporal analysis, the data must contain Date attribute with reasonable history to learn the model baselines. For spatial analysis, the data must contain location attribute such as city or village of each patient.
- TCWI internally converts each location into its corresponding latitude and longitude for map plotting purposes. Hence, all information required to plot the map (location boundaries, latitude, longitude, etc.) will be required by the TCWI so that the server can be successfully build.

### 11.3.5 Constraints

Since this is a prototype project, here are a few constraints of the TCWI that will not be relaxed during the scope of this project.

- Software constraints: The TCWI server must run on Linux 32/64-bit machine. Packages required for the TCWI server are Apache Tomcat server (Ver. 6), and Sun Java™ runtime (Ver. 1.5 or better). The TCWI client runs under Internet Explorer (Ver. 6 and 7) or Mozilla Firefox (Ver. 2.0, 3.0). The client will also need Sun Java™ (Ver. 1.6 or better).  
Hardware constraints: The TCWI server must have at least 2.0 GB RAM and Pentium 4 or better PC or processor. The TCWI client should have at least 128 MB free memory available for the application.
- Data constraints: Except an optional Count attribute, all attributes in the data must be categorical (see Section 2.1) in nature. Since most of the data analysis is temporal in nature, the data must contain a Date attribute.
- Data loading constraints: The project data is intended to be on a MySQL database. TCWI will dump the data daily at a pre-specified time from the database and then load it into the temporary cache called T-Cube. During this process, the interface will not allow any server access. All users logged in at this time will have to re-login after the server restarts. We are expecting the data loading time to be less than 30 mins.
- User constraints: There are no constraints for users who want to use the interface for data visualization. For data mining and statistical analysis, users must know basic statistical algorithms and terminology (a few listed under Section 1.2).
- Response constraints: for a few months, not all alerts generated by the system must be treated as real alerts. Auton lab, with the help of local group of data analysts, will configure various input parameters for the algorithm to increase trust in the algorithm response. Once there is reasonable confidence in the algorithm results further action (response teams, investigation procedures, etc.) could be initiated.
- Interface constraints: Since this is a prototype, the user interface will have limited functionality catered towards addressing the major goals of the project: is the system feasible?

is it helpful in detecting outbreaks? can the system scale up to country level? The interface has limited functionality such as no alert reports, no database requirement for storing past alerts, etc. These features along with other user feedback will be collected in response to the project for future development. For now, the interface features will be limited to the ones described in this report.

### 11.3.6 Definitions, Abbreviations

#### 11.3.6.1 Definitions

- **Demographic Attribute:** A column or attribute in data that defines the population characteristics. For a patient data set, the demographic attributes include: Village, Disease, Symptoms, Signs, Gender, Age group, etc. 1
- **Categorical Attribute:** For each record in the data, a categorical attribute can take exactly one value from a finite set of distinct values. Eng, For each patient, Disease can be one of the 10 possible diseases present in the data and hence is a categorical attribute. Height of a patient is a non-categorical attribute as it has infinite values.

#### 11.3.6.2 Abbreviations

Table 2 lists various acronyms in this report.

*Table 66: Abbreviations*

Name	Description
AD-Tree	All-Dimensional tree
CUSUM	Cumulative SUM
FDR	False Discovery Rate
MBSS	Multivariate Bayesian Spatial Scan
T-Cube	Time series Cube
TCWI	T-Cube Web Interface

### 11.3.7 Functionality

This section describes the functionality of the TCWI. There are three main data analysis or investigation components: Time series analysis, Spatial analysis, and Pivot tables. Figure 52 shows these components on the interface. Each component is described briefly below. A few outbreak examples using the data described in Section 11.3.8 are also presented in this section. Apart from demographic attributes, TCWI requires a Date attribute and an optional Count attribute.

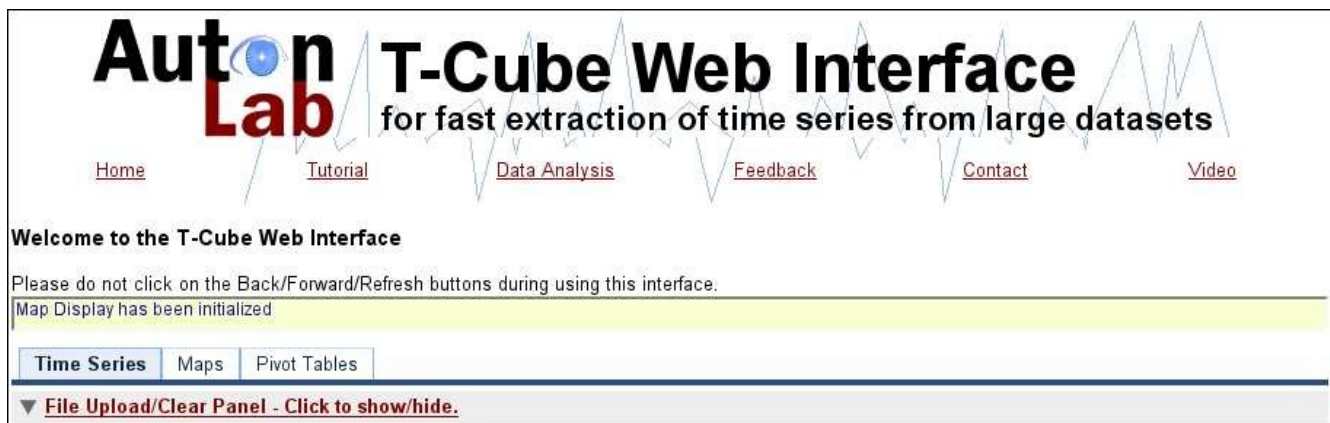


Figure 52: T-Cube web interface

### 11.3.8 Semi-synthetic data

We analyzed the weekly epidemiological data [3] using the TCWI. The data time period started from Dec 23, 2006 and ended on Feb 6, 2009. As TCWI works on daily data, we converted the real weekly epidemiological data into a daily semi-synthetic data assuming the daily distribution as shown in the Table 3. We randomly assigned each patient in a specific city as having a specific disease on one of seven weekdays according to the Table 3 distribution. The list of 26 cities and 9 diseases present in the data are shown in Table 4 and Table 5 respectively. The post-processed data contained 68, 390 records. Here are a few example records present in the data.

date	lk_city	disease	count
DEC-23-2006	Colombo	Dengue_fever	7
DEC-23-2006	Kandy	Dysentery	2
.	.	.	.
.	.	.	.
JAN-30-2008	Kegalle	Viral_Hepatitis	5
JAN-31-2008	Colombo	Dengue_fever	6
.	.	.	.
.	.	.	.
FEB-06-2009	Kegalle	Dengue_fever	2
FEB-06-2009	Ratnapura	Viral_Hepatitis	1

### 11.3.9 Time series analysis

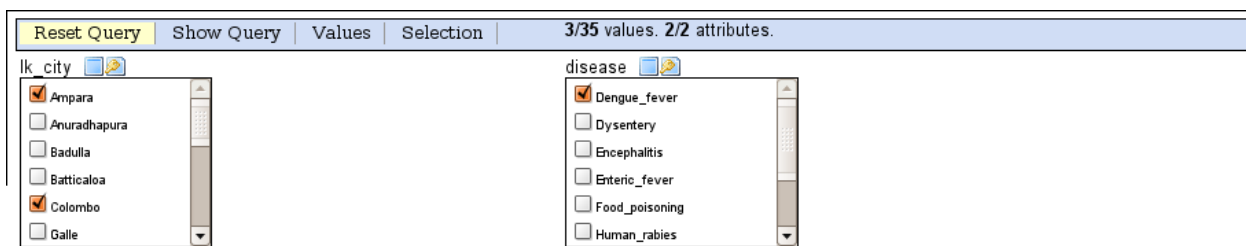
This section describes the time series component of the TCWI. First we describe the various panels available (along with their brief usage) under time series analysis. We then provide a few outbreaks

found in the semi-synthetic data (Section 3.1) using the time series component.

*Table 67: Daily distribution*

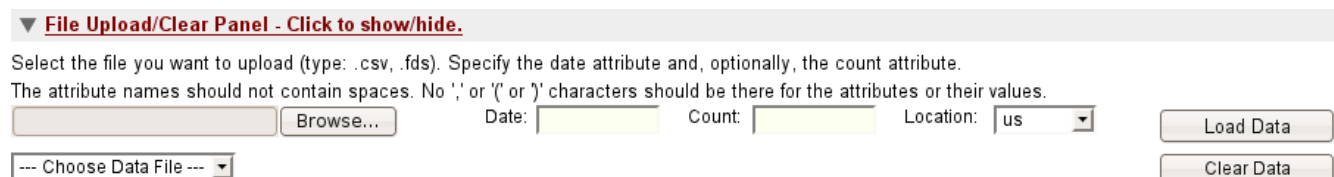
Day-of-Week	Proportion
Monday	12%
Tuesday	8%
Wednesday	18%
Thursday	22%
Friday	17%
Saturday	13%
Sunday	10%

### 11.3.10 Panels



*Figure 53: Query selection panel*

Figure 54 shows the File Upload/Clear panel. This panel can be used to select the data file to be loaded by the TCWI. For our case, the file contains the semi-synthetic data. Figure 53 shows the Query Selection panel. The two demographic attributes (see definition in 2.1) present in the data are patient *lk\_city* corresponding to the city and patient *disease*. This panel selects the query used to create the time series in the time series panel. The user can select multiple values for either attribute, and the corresponding time series will be displayed on the time series panel instantaneously. In Figure 53, we have selected two cities (Colombo and Ampara) and one disease (Dengue fever).



*Figure 54: 1. File upload/clear panel*

Figure 55 shows the Time Series Visualization panel. This panel shows the time series corresponding to the query selected in query selection panel. The alerts generated by the time series analysis algorithms will also be shown in this panel. Simple trend analysis such as moving average, CUSUM are available to the user for quick trend analysis. In Figure 55, the blue time series shows the counts on each day and purple time series shows the corresponding 7-day moving average. The top two scrolling bars can be used to change the start or end date of the time series seen in the panel and the middle scrolling bar (right below the top two scrollers) can be used to pane the time series shown in the panel.

Table 68: Cities present in the semi-synthetic data

Ampara	Hambantota	Kurunegala	Polonnaruwa
Anuradhapura	Jaffna	Mannar	Puttalam
Badulla	Kalmunai	Matale	Ratnapura
Batticaloa	Kalutara	Matara	Trincomalee
Colombo	Kandy	Monaragela	Vavuniya
Galle	Kegalle	Mullaitivu	
Gampaha	Kilinochchi	Nuwara Eliya	

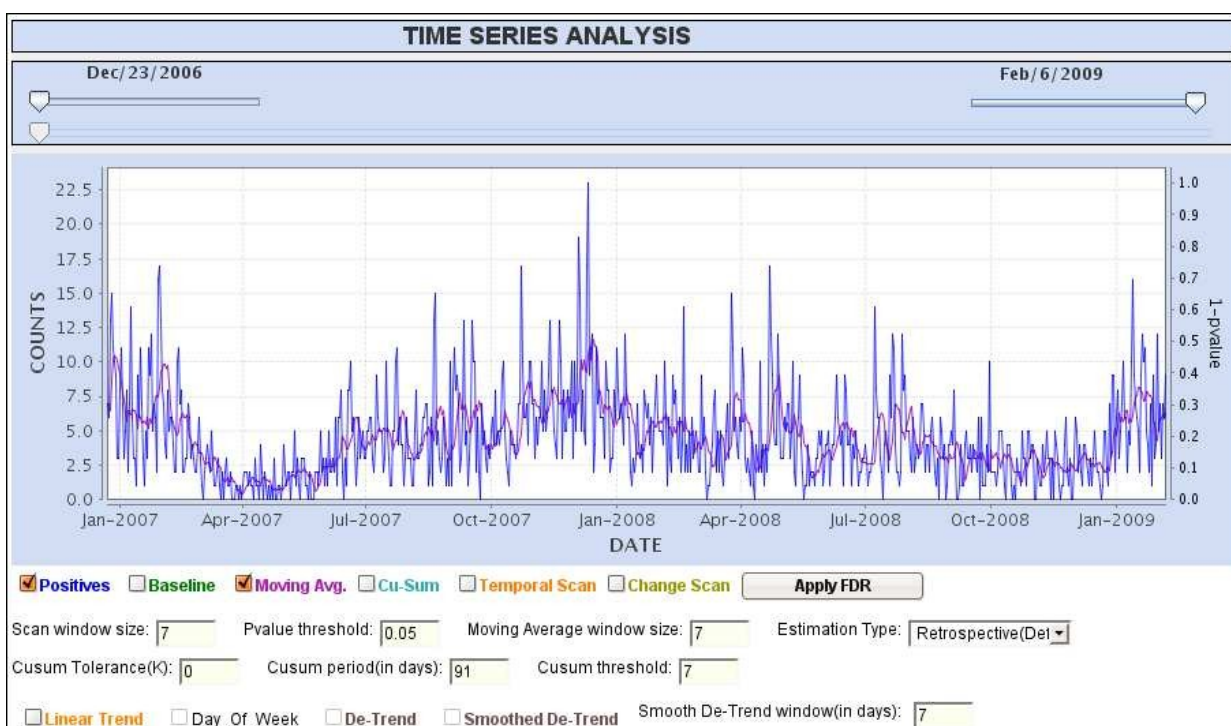


Figure 55: Time series visualization panel

This panel can also be used to perform temporal scan that detects significant changes in distributions suggesting potential disease outbreaks in the data. A temporal scan is performed by moving a window (scan window size parameter) along the time series and comparing the distribution of counts inside the

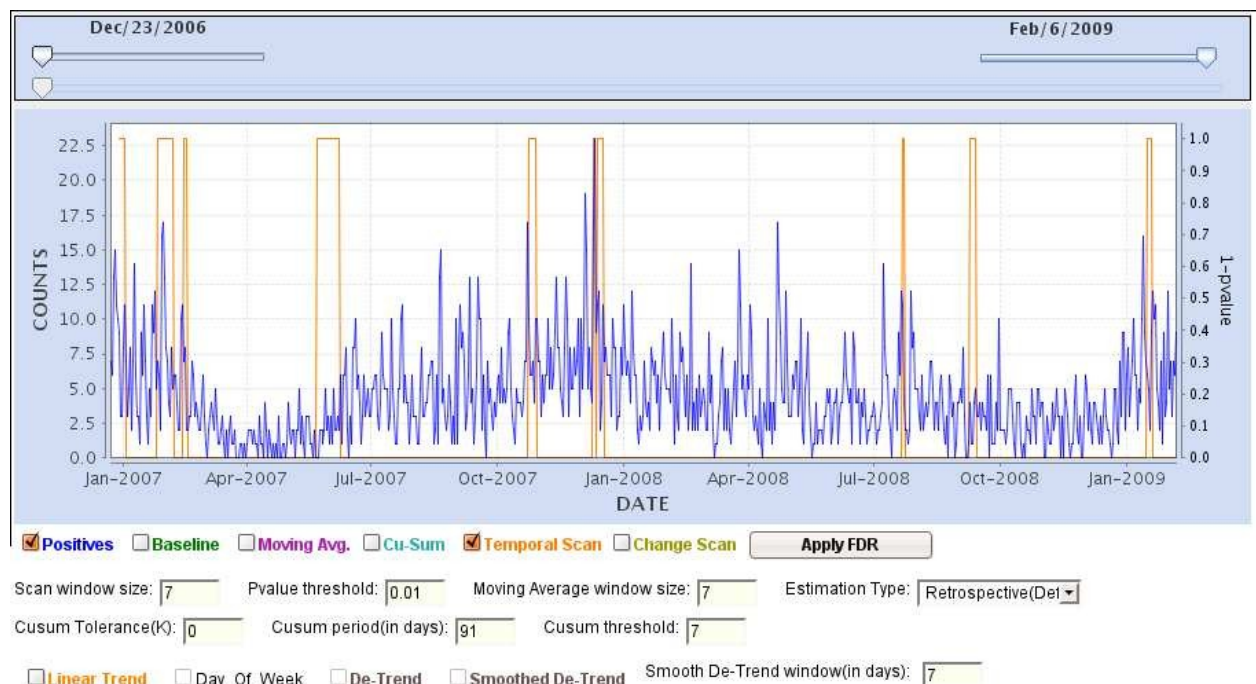
window and outside the window versus the distribution of counts for some baseline time series data. These distributions can be compared using hypothesis testing by setting a standard 2x2 fisher-exact test in case of low count values and chi-square test in case of high values. Tests resulting in high significant values (i.e. low p-values) mean there has been a change in distribution. There are many methods to estimate the baseline: Retrospective (default), Prospective, Moving-average (day of week), Regression (day of week), Regression (day of week, last week mean) and uni-variate.

*Table 69: Diseases present in the semi-synthetic data*

Diseases	Enteric fever	Typhus fever
Dengue fever	Food poisoning	Viral hepatitis
Dysentery	Human rabies	
Encephalitis	Leptospirosis	

Figure 56 shows the result of running the temporal scan (scan window = 7) in orange time series on the blue time series. All peaks obtained after FDR correction are shown in the orange time series (Y-2 axis) and are significant at  $\alpha = 0.01$ .

- Operations Panel Figure 57 shows the Operations panel under time series analysis. This panel can be used to perform investigation such as peak analysis and range analysis. Peak analysis can be used to find the subset of data that best explains a peak on a particular day. Range analysis can be used to compare distributions of two time durations: today versus same day last week, this week versus last week, this week versus last month, etc. This panel also allows users to only look at instances in the time series where the counts increased or decreased drastically as compared to expected (baseline). Sometimes the analysts are only interested in increases as increase in number of patients is of more concern than decrease. As an example, Figure 56 shows the alerts (FDR corrected) when there was an increase in counts compared to expected (red time series).



*Figure 56: Temporal scan analysis*

- Massive Screening Panel Figure 59 shows the massive screening panel. There are many possible queries over the demographic attributes each of which results in a unique time series. Usually an analyst working with the TCWI does not know the query that contains a potential disease outbreak. Since there are exponentially many queries, running and analyzing each time series manually might be very time consuming. This panel automates the process of massively screening lots of time series and reporting a list of alerts for the analyst to investigate.

Figure 58 shows the results of running temporal scan on all possible queries containing exactly one city and one disease. For each query, the algorithm first runs temporal scan. The algorithm then finds if there is any increased activity at 0.01 significance and finally sorts all queries in the order of significance. The list at the bottom of the Figure 59 shows that there is a potential disease outbreak of Dysentery in city Kilinochchi on May 22, 2008 with significance  $\alpha < 1e-10$ .

### 11.3.11 Sample outbreaks

Here are a few sample outbreaks that were found in the semi-synthetic data using massive screening panel. The temporal window was set to 7 days and prospective method was used for baseline estimation. We also applied FDR correction to plot the figures in this section.

- Figure 60 shows a food poisoning outbreak in Monaragela on June 12, 2008. Note that the

Figure 57: Time series operation panel

orange time series acting as an alert indicates that the algorithm quickly detects an emerging outbreak and could potentially save lot of lives if acted on quickly.

- Figure 61 shows a Leptospirosis outbreak in Colombo on Sep 12, 2008.
- Figure 62 shows a Viral hepatitis outbreak in Kandy on June 1, 2007.

### 11.3.12 Spatial data analysis

The semi-synthetic data is both temporal and spatial in nature. Similar to time series analysis, TCWI can also assist in spatial analysis using Map component shown in Figure 63. This component helps both visualize the spatial data on the map as well as perform spatial scan statistics to determine spatially correlated disease outbreaks.

### 11.3.13 Spatial data visualization

Given a set of diseases  $D$ , this feature of TCWI draws circles centered around each city present in data with radius proportional to the total number of patients having any disease in  $D$ . Figure 65 shows the total number of patients reported in each city for the total time duration in the data. The legend for the

circles drawn on the map is shown below the map. Also, the time series drawn with blue bars at the bottom of the Figure 65 shows the total number of reported patients on each day in all cities and all diseases. The green color trend on the time series plot represents the 28-day moving average. The time-period of data to be visualized can be changed by using the scrolling bars to the right of time series plot. It is also possible to sub select the spatial locations and the diseases using the attribute/panel. The attribute panel is shown in Figure 64 and the corresponding spatio-temporal plots are shown in Figure 65. Note that the data represented in Figure 65 is for the year 2008.

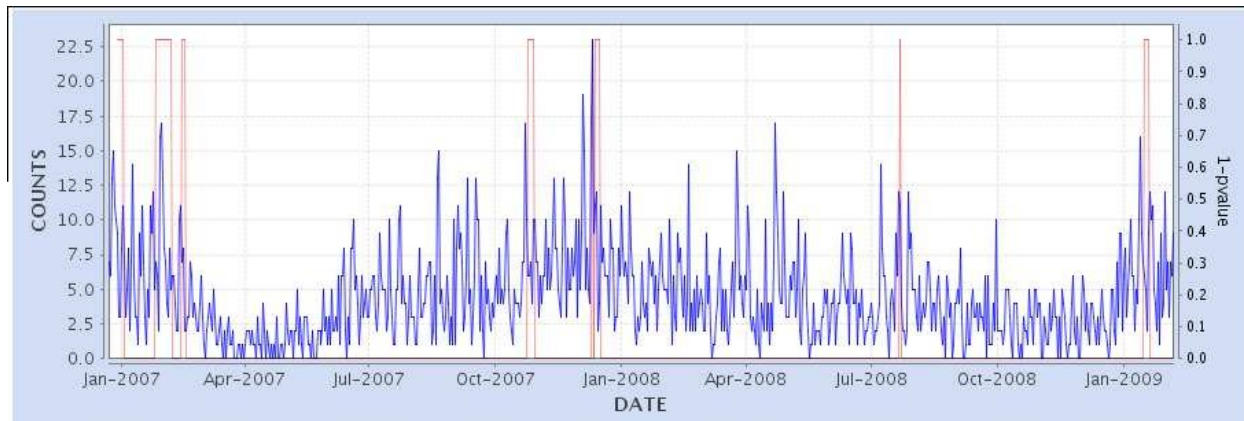


Figure 58: Alert showing increased activity (upper tail test)

#### 11.3.14 Multivariate Bayesian spatial scan (MBSS)

Usually disease outbreaks are often restricted to one disease but rarely to one city. Multivariate Bayesian spatial scan [1] algorithms perform the spatial analysis and finds potential outbreaks spread over various cities. The algorithm requires two input parameter: temporal window size (duration of window for baseline estimation; default: 1) and maximum group size (maximum number of cities that can be affected during an outbreak; default: 20). The complete description of the algorithm can be found in the paper [1].

Figure 66 shows the result of running MBSS for disease Dengue fever on July 3, 2008 with temporal windows size = 7 and maximum group size = 20. The spatial scan global score (right top), 0.9934, represents the total probability of an outbreak on the day of analysis shown as the last day visible in the time series. The red circles on the map indicate the regions that are affected during the outbreak. The legend for colored circles is shown in the left (more red means higher probability of outbreak and more yellow means no outbreak). The blue circles on the map still indicate the total number of patients having Dengue fever in each city.

The red time series on the time series plot indicates the spatial scan global scores (Y-2 axis) for each day. It is evident from this time series that there are a few more outbreaks with high probability in the past.

**▼ Massive Screening Panel - Click to show/hide.**

Select attributes (upto3) and specific values(optional) to run massive screening. You will be able to select specific values only if the attribute is selected.)

☒ Temporal Scan   
 ☐ Change Analysis   
 Scan window sizes:

Start Date(mm/dd/yyyy):    
 End Date(mm/dd/yyyy):    
 Upper Tail

☐ Use Hierarchical Attribute   
☒ Rank Pvalues

<input checked="" type="checkbox"/> lk_city	<input checked="" type="checkbox"/> disease
Ampara	Dengue_fever
Anuradhapura	Dysentery
Badulla	Encephalitis
Batticaloa	Enteric_fever
Colombo	Food_poisoning

SAVED QUERY LISTS    

```

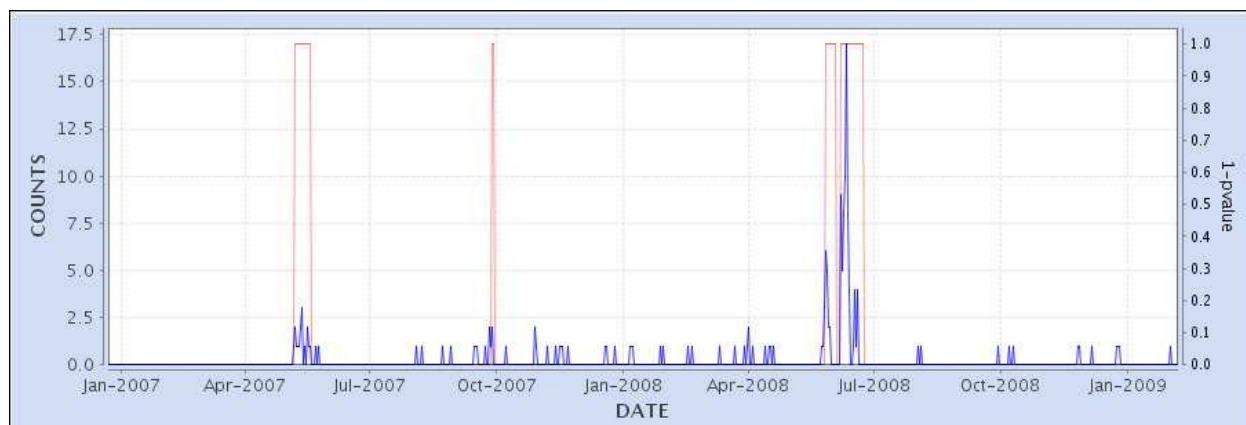
lk_city=(Kilinochchi),disease=(Dysentery) --- PValue=0.000000(MAY-22-2008),Window=7,0.005148, once in 194 days
lk_city=(Batticaloa),disease=(Typhus_fever) --- PValue=0.000000(JUN-04-2007),Window=7,0.009009, once in 111 days
lk_city=(Ratnapura),disease=(Food_poisoning) --- PValue=0.000000(JAN-04-2008),Window=7,0.002574, once in 389 days
lk_city=(Monaragela),disease=(Food_poisoning) --- PValue=0.000000(JUN-12-2008),Window=7,0.002574, once in 389 days
  
```

Figure 59: Time series massive screening panel

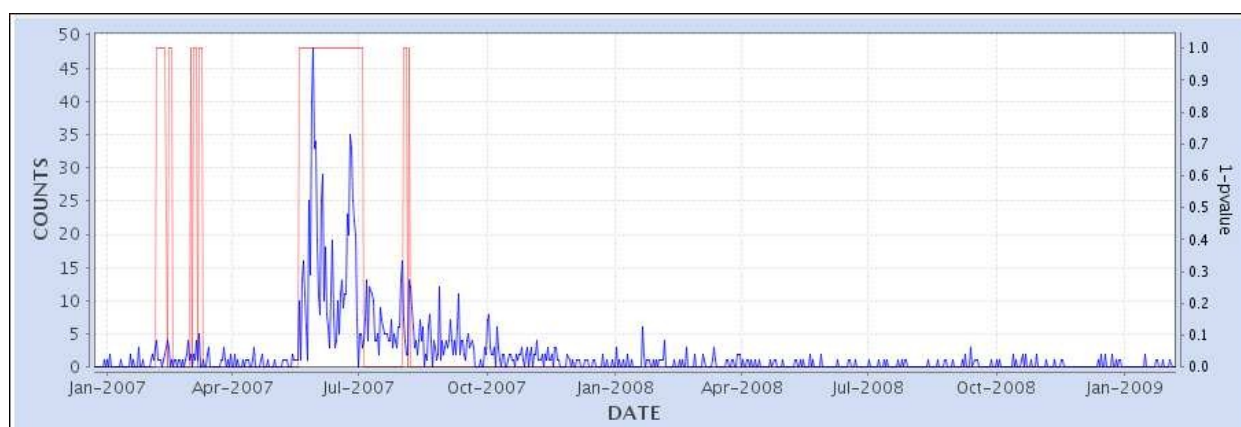
### 11.3.15 Sample outbreaks

Here are a few examples of outbreaks found using MBSS. The temporal size window was set to seven and maximum group size was set to 20 for all examples.

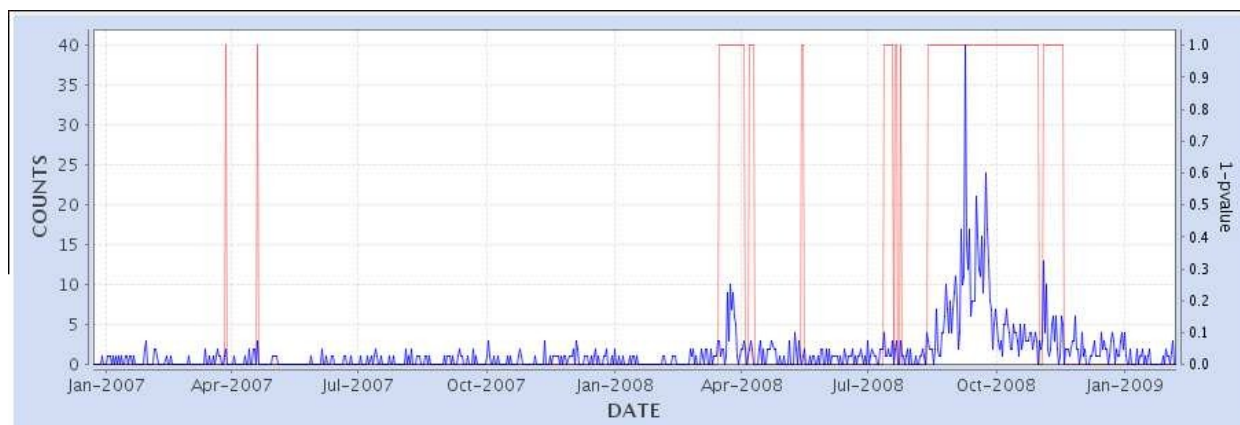
- Figure 67 shows a food poisoning outbreak around Kurunegala on Aug 13, 2008. It looks like six cities were affected with food poisoning cases.
- Figure 68 shows a Leptospirosis outbreak around Colombo on Mar 26, 2008. The whole southwest seems to be affected by this outbreak.
- Figure 69 shows a Dysentery outbreak in central on April 22, 2008.



*Figure 60: Food poisoning outbreak in Monaragela*



*Figure 61: Viral Hepatitis outbreak in Kandy*



*Figure 62: Leptospirosis outbreak in Colombo*

### 11.3.16 Pivot tables

Pivot tables component can display the data in the form of a table or spreadsheet. Since semisynthetic data only has two demographic attributes, we can only put one attribute along one dimension and other along the second dimension. Figure 70 shows the pivot table for the semi-synthetic data. Note that each cell in the table contains the total number of patients visited in the time range (shown at the bottom) selected by the user.

The pivot table also shows the marginal counts both for cities (last column) and diseases (last row). The user can also plot the time series corresponding to any cell in the table by clicking on the cell. Figure 71 shows the time series of Leptospirosis disease counts in Colombo.

### 11.3.17 Ongoing User Interface Work

This section describes various ideas related to the project; some of them will be part of final TCWI interface.

- **Interfacing with MySQL Database** - TCWI loads data into the T-Cube using comma-separated file. The project data resides on the MySQL database. We propose to dump the relevant MySQL data for TCWI daily at a pre-defined time and reload the data into TCWI server cache.
- **User-level Password Access** - Currently, the TCWI has global password access control. We plan to implement user-level password protection. This will allow user management, user usage tracking, system-level performance management, load-balancing, data loading management, etc.
- **User Configuration** - We envision each user running similar kind of analysis everyday on new set of data. Even though the kind of analysis (time series analysis, spatial scan) may be the same, the input parameters to the algorithms will be most likely different for different users. This suggests saving user configuration so that they could re-run their favorite analysis during login. We hope to provide this feature in the final interface.
- **Unified Dashboard for Time Series and Spatial Scan Results** - The current TCWI interface has separate tabs for time series and spatial scan analysis even though the process of analysis has similar flavors. Both search through a set of queries and report the unusual findings. This motivates the idea for having the interface execute both scans and report the results as soon as the user logs into the system. This would help users prioritize the work by investigating the most significant alerts without manually running the scans.

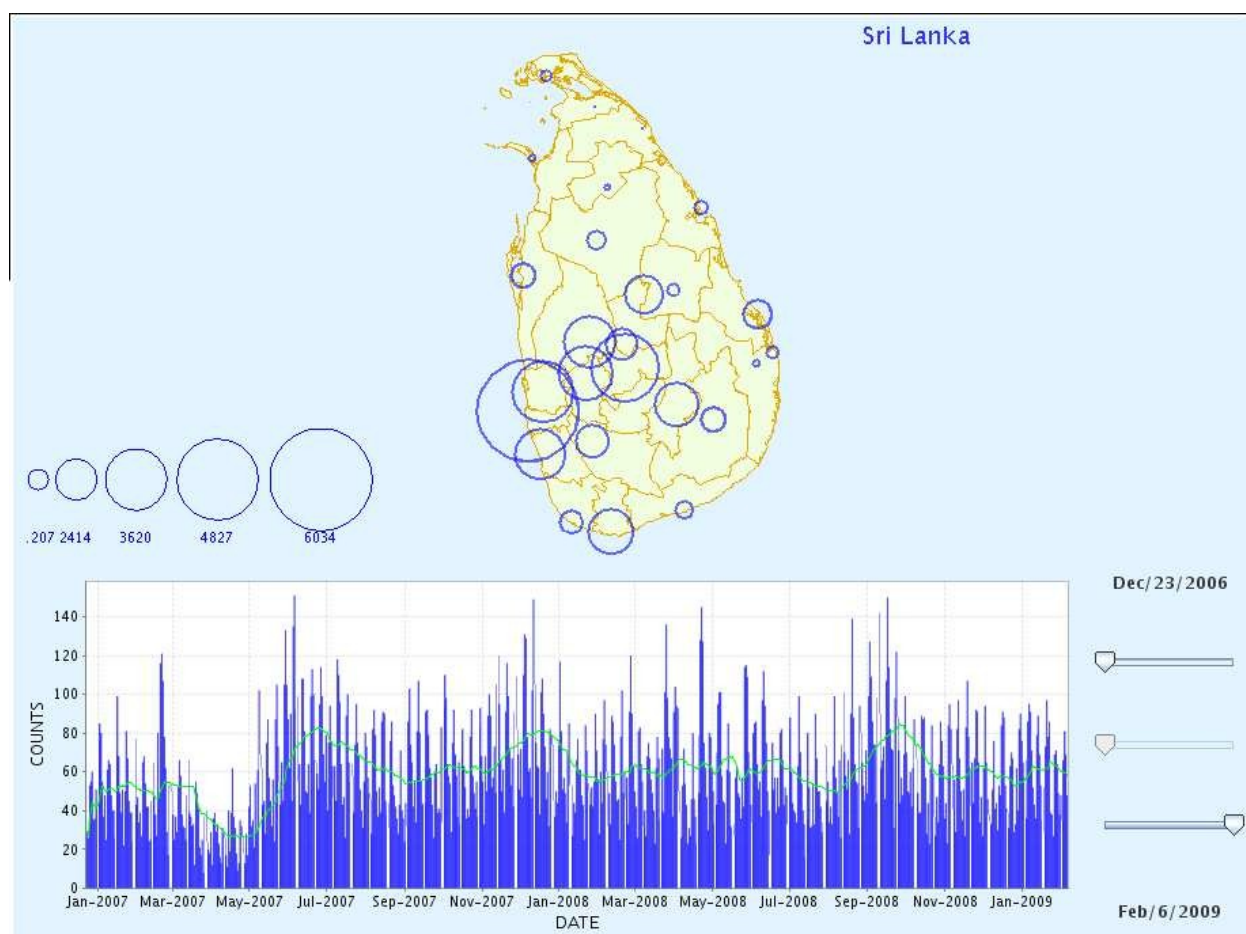


Figure 63: Spatial data visualization of all data on the map

- **Massive Spatial Scan** - The spatial scan can only be executed on a single disease. We propose having massive spatial scan similar to massive time series analysis that reports a prioritized list of disease alerts by scanning over all diseases individually.
- **Restricted Spatial Scan** - MBSS generates alerts for each day in the time series starting from first day in the data. Generally, users are only interested in alerts for recent time (week, month, etc.). This feature will make the MBSS much more responsive and interactive, as it will only need to scan a few days instead of multiple years.

▼ **Attribute Selection Panel 1 - Click to show/hide.**

**Submit/Reset**

<input checked="" type="checkbox"/> lk_city	<input checked="" type="checkbox"/> disease
Anuradhapura	Enteric_fever
Badulla	Food_poisoning
Batticaloa	Human_rabies
Colombo	Leptospirosis
Galle	Typhus_fever

Figure 64: Attribute selection panel under spatial analysis

### 11.3.18 References

- [1] Daniel Neill and Gregory F. Cooper. A multivariate spatial scan statistic for early event detection and characterization. Machine Learning, 2009. In Press.
- [2] Maheshkumar R. Sabhnani, Andrew W. Moore, and Artur W. Dubrawski. T-cube: A data structure for fast extraction of time series from large datasets. Technical Report CMU-ML-07-114, Carnegie Mellon University, April 2007.
- [3] Weekly Sri Lankan Epidemiological data. <http://www.epid.gov.lk/wer.htm>.

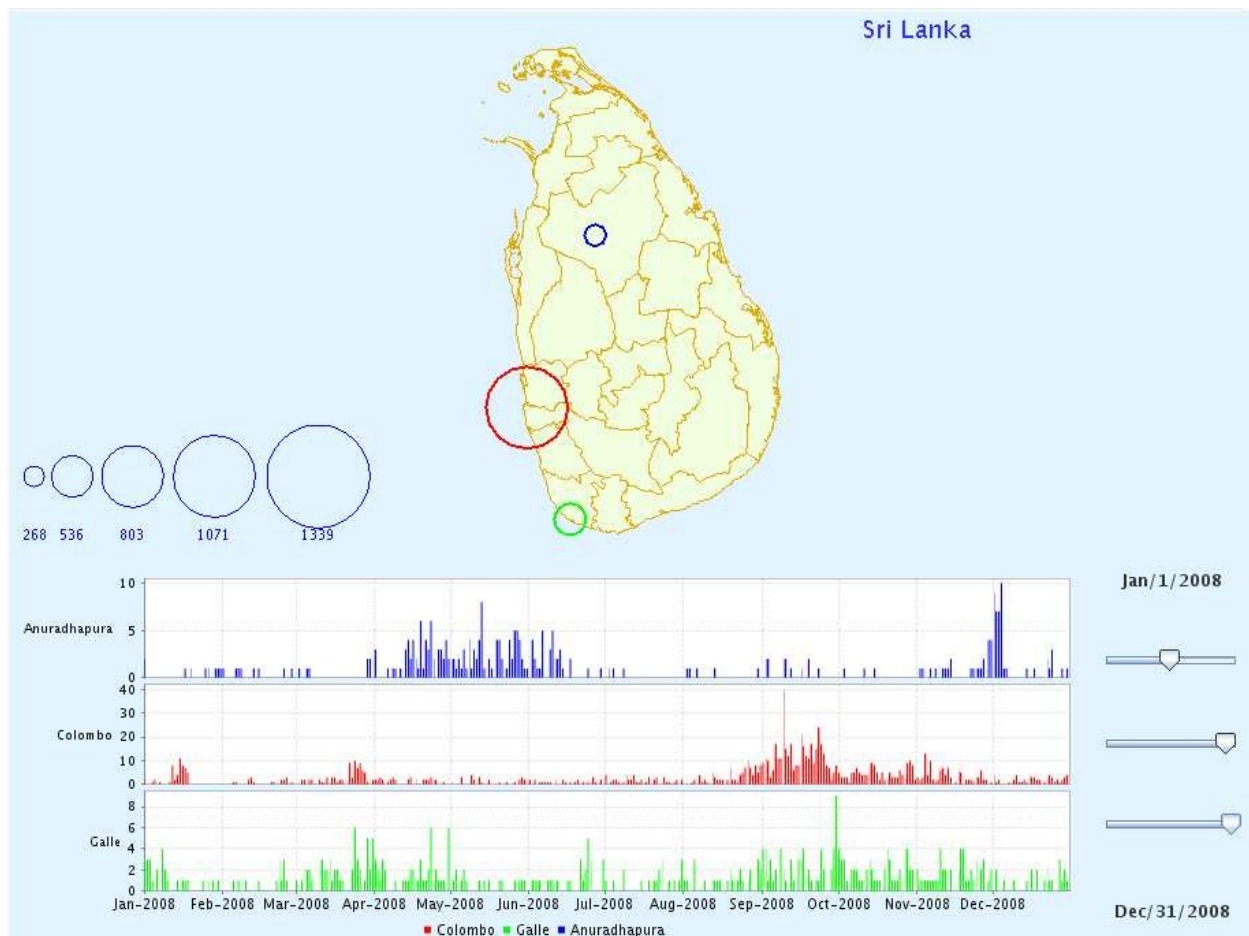


Figure 65: Spatial data visualization for few cities and diseases

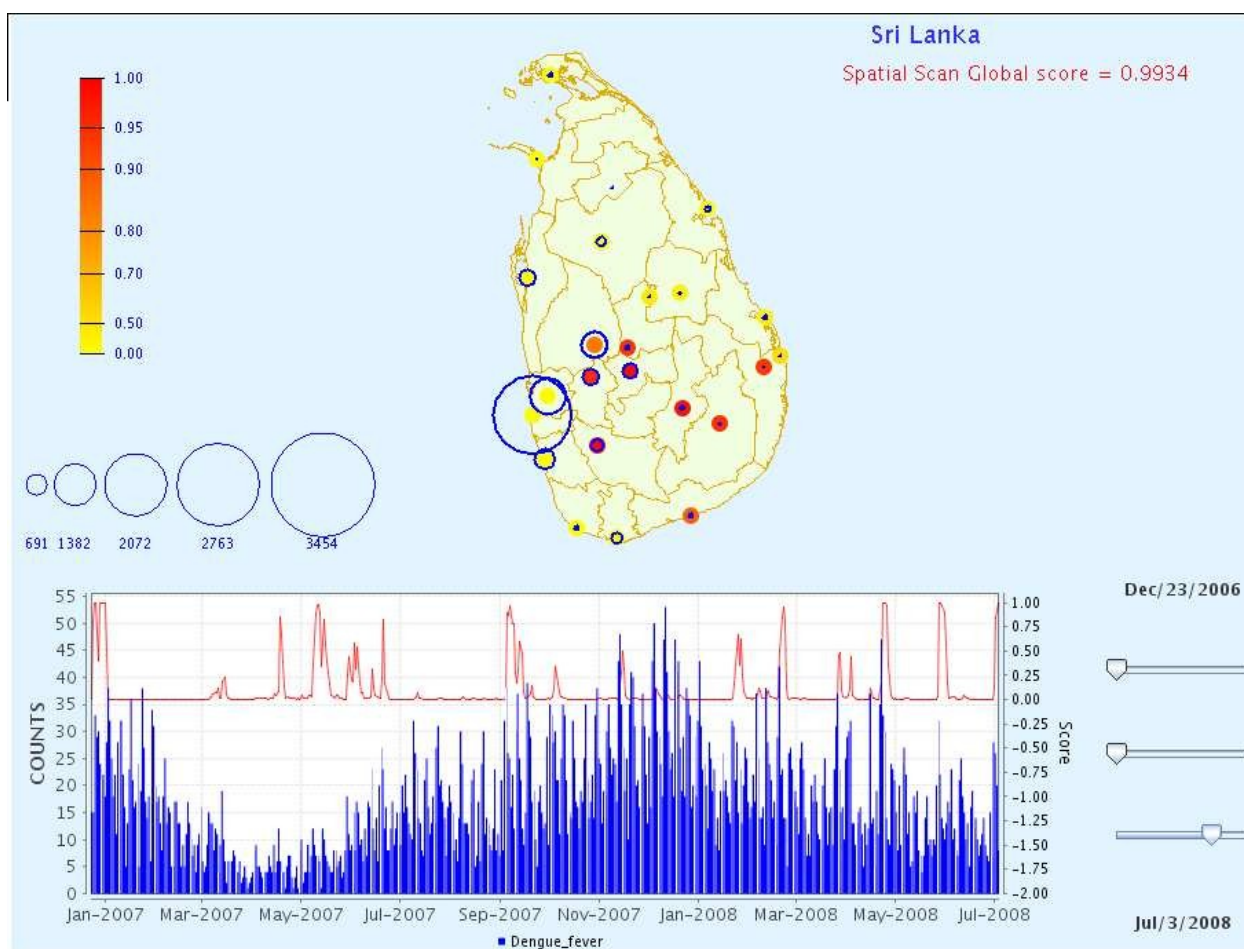


Figure 66: MBSS results for disease Dengue fever on July 3, 2008

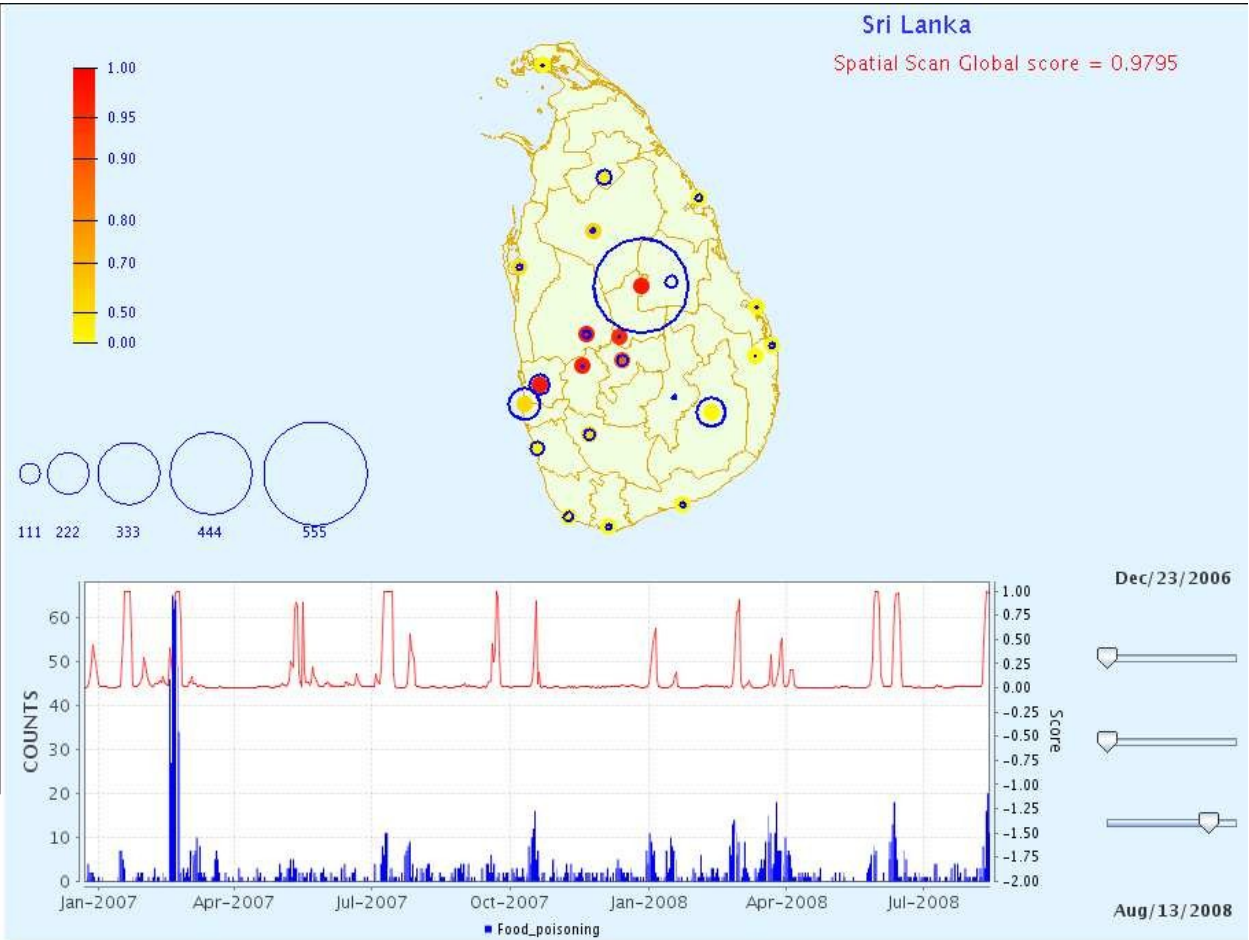


Figure 67: Food poisoning outbreak around Kurunegala on Aug 13, 2008

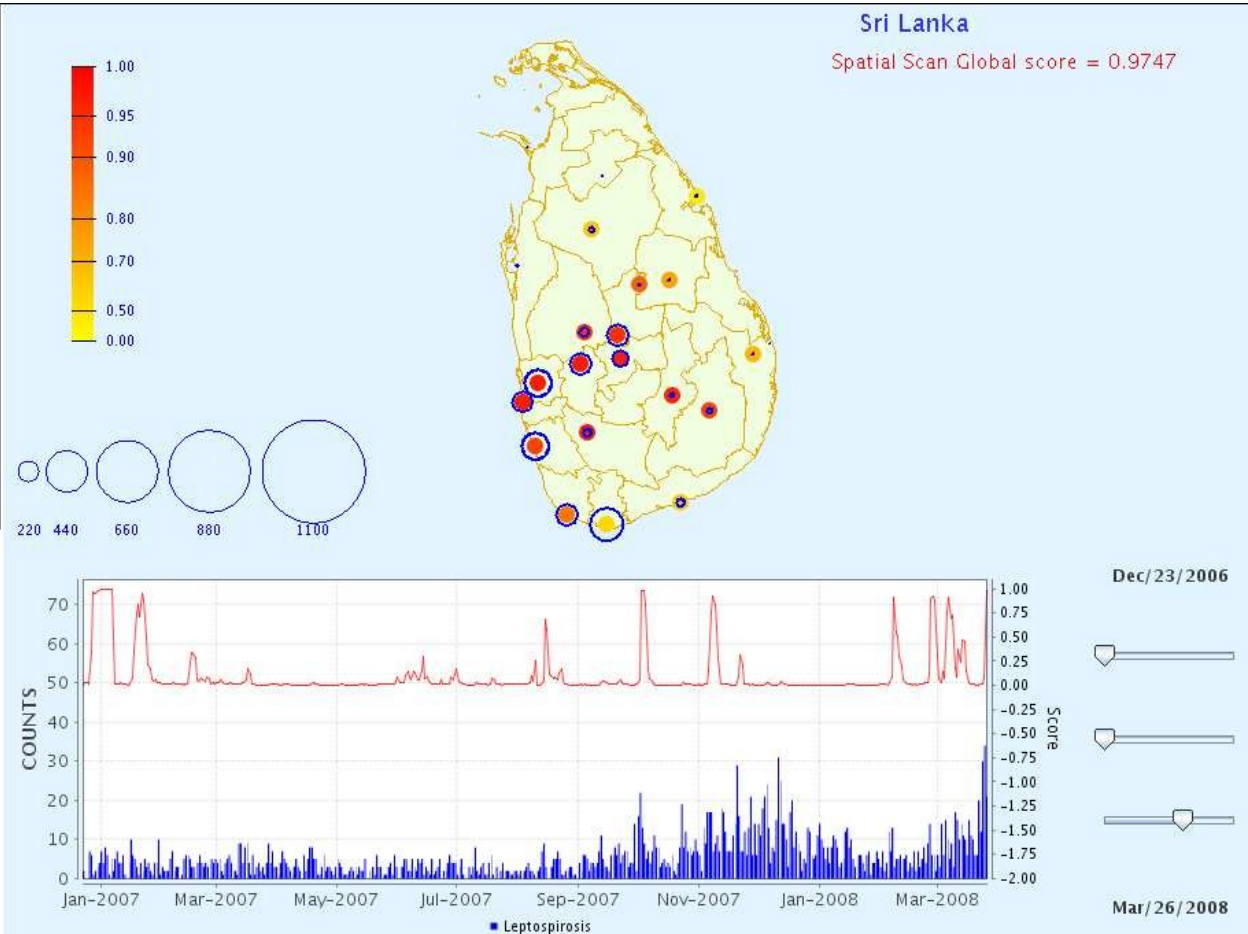


Figure 68: Leptospirosis outbreak around Colombo on Mar 26, 2008

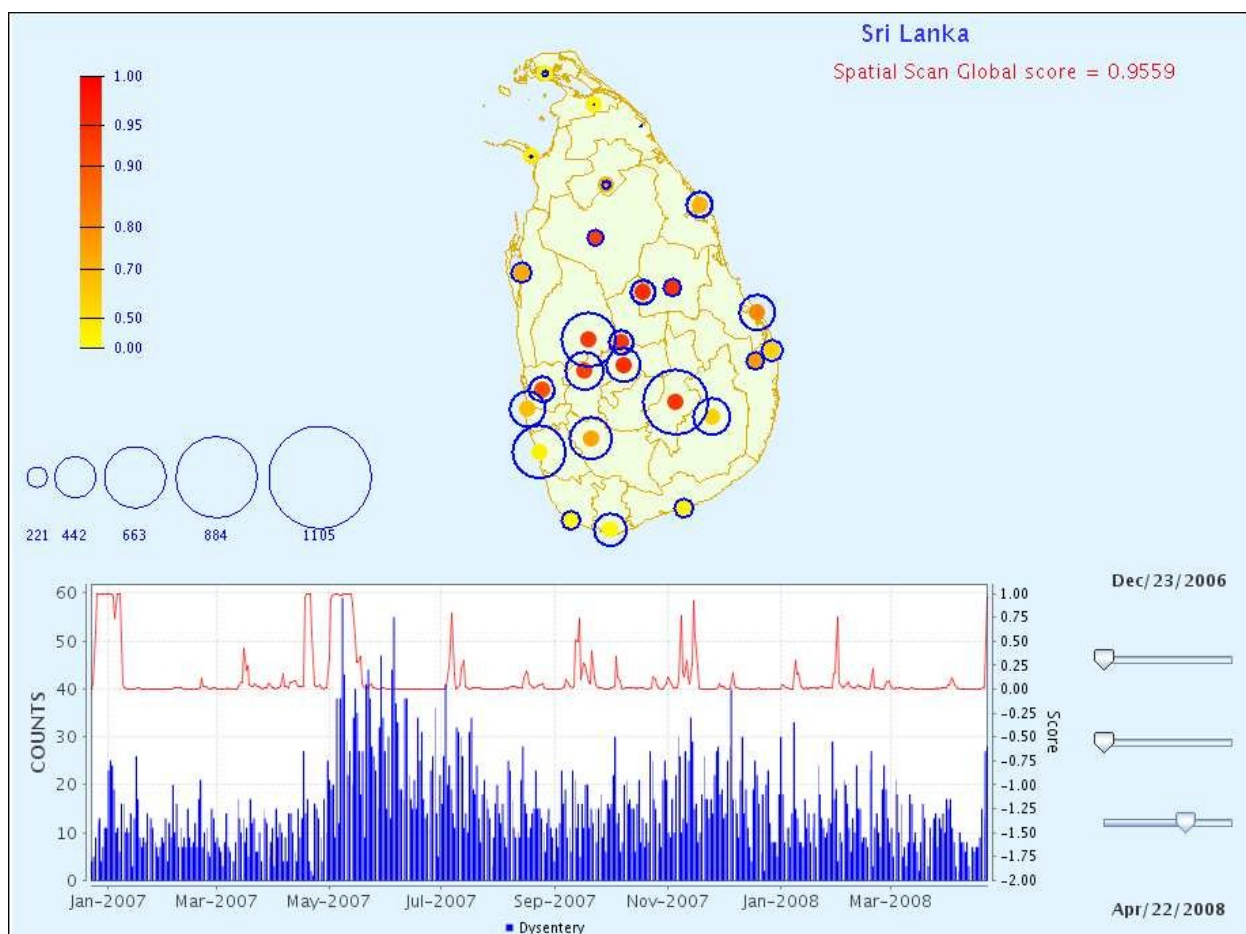


Figure 69: Dysentery outbreak in central Sri Lanka on Apr 22, 2008

Attributes:

Rows: lk\_city

Columns: disease

	Dengue_fever	Dysentery	Encephalitis	Enteric_fever	Food_poisoning	Human_rabies	Leptospirosis	Typhus_fever	Viral_Hepatitis	Total
Ampara	25	308	0	11	7	0	26	2	28	407
Anuradhapura	335	298	18	22	71	1	281	31	55	1112
Badulla	185	1105	18	219	112	1	125	269	577	2611
Batticaloa	163	562	21	47	20	12	8	23	837	1693
Colombo	3454	611	29	329	239	3	1100	12	257	6034
Galle	198	354	35	41	56	3	575	44	32	1338
Gampaha	1624	428	43	137	145	4	906	26	319	3632
Hambantota	242	327	19	33	42	1	197	176	45	1082
Jaffna	138	131	2	200	37	0	0	134	33	675
Kalmunai	67	472	6	21	31	0	6	4	128	735
Kalutara	912	835	22	135	98	2	841	6	100	2951
Kandy	865	639	16	121	103	1	644	199	1463	4051
Kegalle	859	560	39	142	29	1	737	113	724	3204
Kilinochchi	0	11	0	5	0	0	1	2	3	22
Kurunegala	1061	758	27	122	62	14	705	95	183	3027
Mannar	36	50	0	249	0	0	1	1	39	376
Matale	332	384	12	79	24	0	838	7	150	1826
Matara	662	555	27	95	45	2	750	475	43	2654
Monaragela	103	663	4	112	165	1	142	181	101	1472
Mullaitivu	0	13	4	9	0	0	0	0	12	38
Nuwara_Eliya	77	519	6	336	555	0	95	73	595	2256
Polonnaruwa	125	305	4	42	80	0	135	1	66	758
Puttalam	609	358	32	170	47	3	100	50	89	1458
Ratnapura	549	747	35	113	78	0	222	67	127	1938
Trincomalee	205	363	4	35	38	0	40	33	118	836
Vavuniya	52	144	6	34	91	0	10	1	17	355
Total	12878	11500	429	2859	2175	49	8485	2025	6141	46541

Start Date << 12/23/2006 >> End Date << 02/06/2009 >>

Figure 70: Pivot table for semi synthetic data

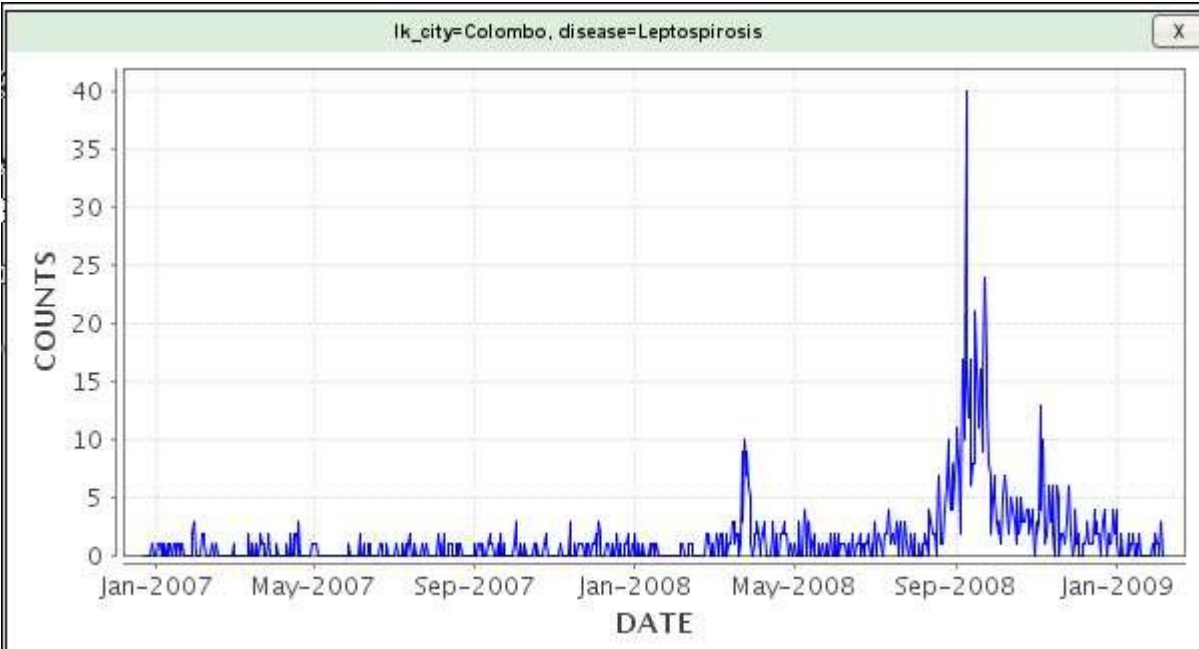


Figure 71: Leptospirosis disease counts in Colombo using pivot table

## ***11.4 Common Alerting Protocol enabled Sahana Alerting Broker***

### **11.4.1 Overview**

The Real-Time Biosurveillance Program (RTBP) is a multi-partner research initiative that will study the potential for new Information and Communication Technologies (ICTs) to improve early detection and notification of disease outbreaks in Sri Lanka and India.

Experts in the field of biosurveillance and health informatics have argued that improvements in disease detection and notification can be achieved by introducing more efficient means of gathering, analyzing, and reporting on data from multiple locations. New information and communication technologies (ICTs) are regarded as a central means to achieve these efficiency gains. The primary research objective of the Real-time Biosurveillance Program (RTBP) is to examine these claims more closely by producing evidence to indicate in what ways and to what extent the introduction of new ICTs might achieve efficiency gains when integrated with existing disease surveillance and detection systems.

The RTBP research design includes the development of a test bed (pilot project) that will incorporate multiple methods to increase the efficiency of data collection and analysis. Under the current system in both Sri Lanka and India, patient data from regional and community health centers is gathered using paper-based forms and procedures. These forms are then sent to regional health officials where data analysis is carried out by qualified staff to identify potential disease outbreaks. Notifications are then issued from the regional health administrations to local authorities again using paper-based reporting methods.

The RTBP test bed will substitute each of these existing procedures with ICT-based components. Patient data will be gathered using software application implemented on handheld electronic devices and transmitted to a central server using a wireless data link. Data will be drawn from the central server and analysis will be carried out using advanced software developed by Carnegie Mellon University Auton Lab. Results will be made available to regional and local health officials as electronic notifications accessible through a variety of devices, including mobile phones.

These guidelines deal exclusively with the notification component of the RTBP test bed. Integration with data gathering and analysis will be essential for the project but each component has specific functional and operational considerations. It is the specific considerations for *alerting and notification* that these guidelines are intended to address.

Considerations related to integration of system components will be addressed in other documents.

In addition to the test bed component, the RTBP will also consider interoperability issues associated with national and international health-related organizations in the region of Sri Lanka and southern India. It is anticipated that implementation of the alerting and notification component will provide important evidence regarding the opportunities and challenges associated with inter-jurisdictional alerting and notification for e-Health systems in the region.

The RTBP Alerting and Notification Guide is based on the US Center for Disease Control's Public Health Information Network (PHIN) Communication and Alerting Guide (PCA). The PCA Guide has been identified as useful model on which to base the RTBP Guide because it addresses the problem of inter-jurisdictional alerting, provides a comprehensive set of alerting attributes identified through extensive consultation by public health experts and expresses these attributes using Common Alerting Protocol (CAP) and Emergency Data Exchange Language (EDXL). RTBP will incorporate both CAP and EDXL as data interchange standards for use in the test bed in order to serve the primary objective of the project but also to take into account other objectives related to system growth and regional interoperability.

### **11.4.2 Objectives**

The objective of this specification document is to provide a comprehensive description of the functional aspects of alerting and notification for the RTBP test bed. RTBP-compliant alert and notification messages must process, and manage alerts in a manner consistent with the requirements of this guide.

This implementation guide defines functional and technical specifications for any system intended to support RTBP Alerting and Notification. Readers are advised that RTBP is a research project and does not constitute an operational alerting system. As such, not all elements or functions of the RTBP test bed may be active or implemented at any specific time.

A primary contribution of this document is to define alerting attributes to be used in the RTBP test bed and how those attributes will be expressed using Common Alerting Protocol (CAP) Version 1.1, and the Emergency Data Exchange Language (EDXL) Version 1.0 Distribution Element.

Readers should have a basic conceptual understanding of CAP, EDXL, and XML in order to use this document.

### **11.4.3 RTBP Alerting and Notification Subsystems**

The RTBP alerting and notification functionality will consist of five interconnected subsystems:

- ✓ Message creation and validation
- ✓ Message distribution
- ✓ Message delivery
- ✓ Message acknowledgement
- ✓ Message system administration

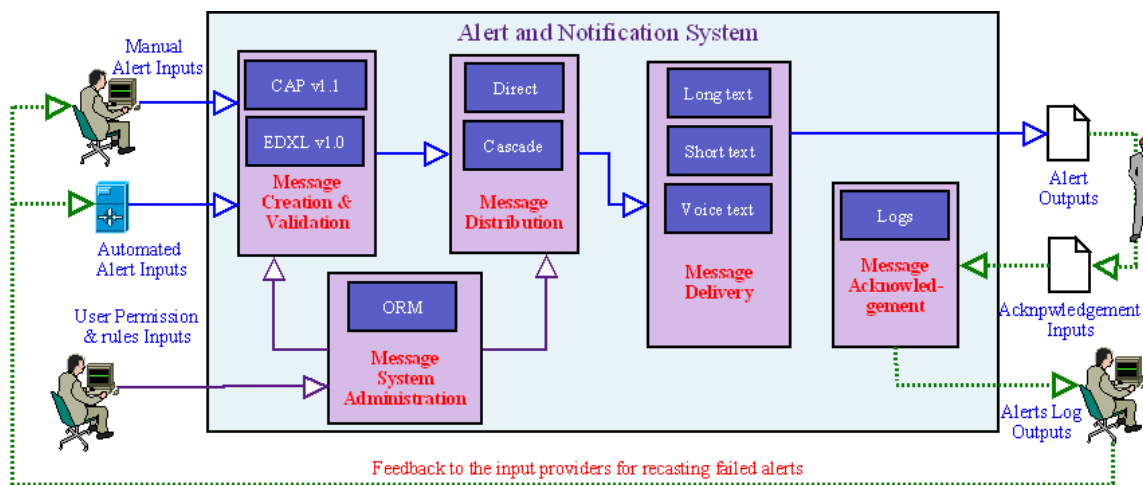


Figure 72: Alert and Notification subsystems with inputs and outputs

#### 11.4.4 Message creation and validation

Message creation can be done manually or can be automated through middleware linked to the detection/decision component. Manual creation of messages requires one or more authorized users trained in policy and procedures for alerting and notification. A software interface and associated application(s) to support manual message creation will need to be implemented for the RTBP. The foundation for such an application is currently available with the open source Sahana Disaster Management System Messaging Module.<sup>17</sup> At present, the Messaging Module provides a set of generic menus and inputs based on Common Alerting Protocol v1.1. A degree of customization of the module will be necessary for it to conform to RTBP alerting and notification attributes and vocabulary as defined in this SRS.

Automated message creation will require a software application that is capable of formatting data provided by the detection and decision component and merging it with distribution and other data. A software application to support automated message creation will need to be identified or, more likely, custom designed for the project. This would entail opening a set of Messaging Module APIs for the external applications to directly use for issuing automated alerts. For example, the Auton Lab software components will run the detection algorithms as a services periodically (once a day), may detect a possible adverse event (i.e. disease outbreak). Then the Auton Lab software should be able to identify certain elements of the adverse event and use the Messaging Module APIs to communicate the necessary information related to the detected adverse event to health officials who engage in analysis and decision-making. The aim of the alert is to get the analysis and decision making health officials to

17

Sahana is a Free and Open Source Software platform that was created in the wake of the 2004 Indian Ocean Tsunami by the Lanka Software Foundation to address interoperability problems with existing disaster management systems. The CAP-based Messaging Module was later developed for the LIRNEasia HazInfo Project, but further development work is needed for its application in a biosurveillance context. For more information on Sahana see: <http://www.sahana.lk/>. For access to a demo version of the Messaging Module see: <http://demo.sahana.lk/index.php?act=login>.

investigate the situation to take further action such as communicating the event to other health officials to notify them of the predicted threat.

RTBP research design at present does not include a provision for automated message creation. However, a generic API that provides a set of inputs to the Messaging Module can easily accommodate the automated alerting process where the input would be similar to a CAP XML file and predefined EDXL Distribution Elements.

In case, alerting and notification messages will be formed using pre-established attributes and vocabulary implemented in conformance with the Common Alerting Protocol (CAP) v1.1 standard and Emergency Data Exchange Language (EDXL) Distribution Element v1.0. Section 3 of this document provides detailed explanation of those elements and their implementation.

Message creation can be centralized or distributed depending on the alerting and notification architecture adopted for the RTBP test bed. In the context of manual message creation, a centralized system provides a degree of simplicity but may place limits on the ability of the system to simulate real-time 24/7/365 alerting and notification because it may place limits on the number of authorized users that are reasonably able to access the system.

A distributed architecture is more complicated but will provide more flexibility in terms of assigning authorized users and simulating a real-time 24/7/365 alerting and notification context. Distributed message creation will likely require access to the application interface through an Internet-enabled desktop PC; however, it may be possible to provide access using a wireless mobile handheld device—although this would add to the complexity of the project and possible delays during implementation and testing. Therefore, the primary phase of the RTBP will only implement the PC desktop and internet enabled alerting version.

A third possibility is a system based on hybrid manual/automated message creation. Using this approach, a set of threshold variables could be identified within the analysis component to prompt a software application to create and issue an alert message under certain conditions. For instance, an automated system might send a message only to authorized users for a pre-determined condition that requires their immediate attention. If upon closer inspection by an authorized user the condition were then to warrant a wide-area alert or notification to local health officials, then this could be created and issued manually by that authorized user or his/her designate.

In other instances, if a certain pre-determined critical threshold were to be exceeded at the outset then the automated system might be authorized to issue wide-area alerts directly to health officials without the manual intervention of an authorized user.

A hybrid system could be based on a combination of centralized and distributed architecture for message creation. An important variation on the manual/automated hybrid is the concept of *cascade alerting*, which will be described in more detail in the message distribution subsection below. Although cascade alerting is, strictly speaking, a distribution method it involves a process of automated message generation.

The hybrid system design presents important opportunities from a research standpoint but it adds complexity on several dimensions and would require close attention to policy and procedural issues.

Table 70 Summary of message creation options

Manual message creation	centralized architecture
	distributed architecture
Automated message creation	centralized architecture
	cascade alerting*
Manual/automated hybrid	centralized architecture
	distributed architecture
	cascade alerting*

### 11.4.5 Message distribution

Once an alert or notification has been created, it must then be distributed to designated recipients. The PHIN PCA Guidelines describe two primary methods for message distribution:

**Direct alerting** is the normal process in which an alerting system delivers an alert to a human recipient. This is the normal mode of alerting when the recipient works within the organization or its jurisdiction. However, direct alerting can also be used to accomplish cross-jurisdictional alerting: an alerting system in one jurisdiction sending messages to recipients within another jurisdiction.

**Cascade alerting** is a process in which an alert is sent as a system-to-system message from one jurisdiction to another; the receiving system then distributes the alert to the appropriate recipients within the receiving jurisdiction. The message contains the alert along with parameters describing how and to whom the message should be delivered. Cascade alerting is the preferred method for sending cross-jurisdictional alerts, but it requires greater technical sophistication to implement.<sup>18</sup>

For the purpose of the RTBP test bed, direct alerting will likely be the primary focus for the initial work. However, considerations for cascade alerting should be included in design and development efforts with a view to possible testing of an implementation during a later stage in the project. Cascade alerting will likely have more relevance as cross-jurisdictional consideration come into play, and this may be an important consideration as the project evolves.

EDXL Distribution Element is an important consideration in message distribution and several attributes have been identified in this doc pertaining to it. While its full implementation may not be immediately relevant to the project, it is advisable to include provisions for it in the event that the project seeks to attempt more advanced testing with distribution and, in particular, cascade alerting.

<sup>18</sup> <United States Centers for Disease Control and Prevention, 2008 #3, p. 14>

### 11.4.6 Message delivery

Messages must reach their destination through an appropriate receiving device, be it a mobile phone, desktop PC, or other means. The contents of the CAP XML message must then be rendered into human readable form while taking into account the limits of bandwidth, processor capabilities, and message display constraints inherent in any particular device. A software application is implemented on the receiving device to carry out this function.

Message delivery options can be categorized into three types based on PHIN PCA designations:

- *Long text*—content rendered in a form appropriate for email, fax, or web presentation;
- *Short text*—content rendered in a form appropriate for SMS and pagers;
- *Voice text*—content rendered in a form appropriate for voice delivery or automated voice delivery by telephone.<sup>19</sup>

At present, RTBP make provisions for message delivery as Long text and Short text. Sahana Messaging Module currently has an Email and SMS push function but would require a web post function but compliant with CAP and EDXL.

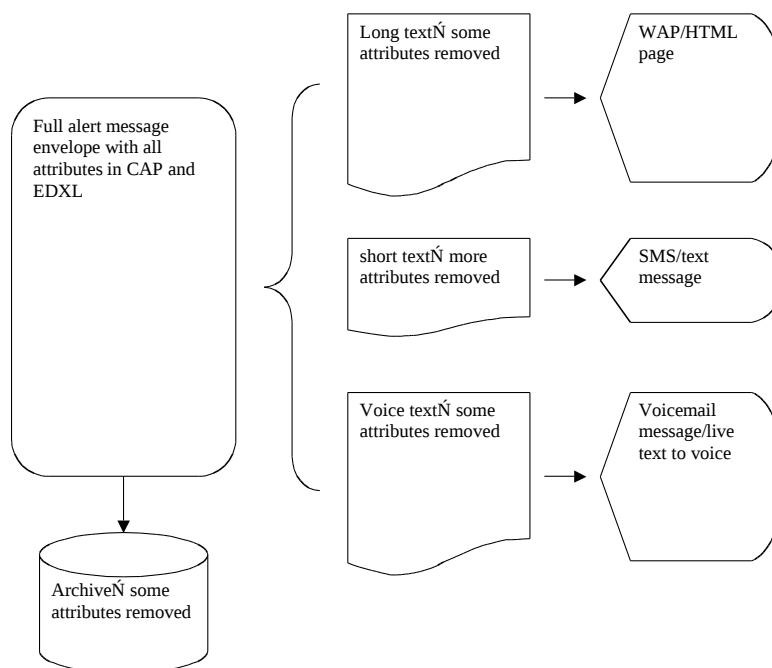


Figure 73: Rendering a CAP-XML message for end-user devices

<sup>19</sup> <United States Centers for Disease Control and Prevention, 2008 #3, p. 9>

Table 71 Suggested CAP elements and example for the delivery types

<b>Message delivery type</b>	<b>Terminal Device Display Attributes</b>	<b>Example</b>
Long Text	<u>All elements of CAP</u> <info.headline> <area.areaDesc> <info.category> <info.event> <info.senderName> <alert.sender> <alert.incident> <alert.identifier> <alert.sent> <alert.msgType> <alert.status> <alert.scope> < alert.restriction> <info.language> <info.value> <info.valueName> <info.urgency> <info.severity> <info.certainty> <info.description>  <info.web> <info.contact>	Cholera outbreak is in effect Kurunegala District Health Disease outbreak Sarvodaya Suwadana Center <a href="mailto:suwacevo@sarvodaya.org">suwacevo@sarvodaya.org</a> 200907240001 suwacevo-200807240001001 2009-07-24T16:49:00+05:30 Alert Exercise Restricted This message is for registered health care workers English Priority High Expected Moderate Observed This message is for an <i>Exercise</i> event, repeat this message is for an <i>Exercise</i> event - A <i>high</i> priority <i>Cholera outbreak is in affect</i> for the Kurunegala District. The <i>Health</i> alert for the <i>disease outbreak</i> was issued at 4:49pm on 24 <sup>th</sup> day of July 2009 by the Sarvodaya Suwadana Center. For further instructions visit the website - <a href="http://www.sarvodaya.org/healthalert/">http://www.sarvodaya.org/healthalert/</a> or call +9411255566 - This message is for an <i>Exercise</i> , repeat this message is for an <i>Exercise</i> event. <a href="http://www.sarvodaya.org/healthalert/">http://www.sarvodaya.org/healthalert/</a> +9411255566
Short Text	<info.headline> <area.areaDesc> <info.value> <info.valueName> <info.category> <info.event> <info.senderName> <alert.identifier> <alert.sent> < alert.msgType >	Cholera outbreak is in effect Kurunegala District Priority High Health Disease outbreak Sarvodaya Suwadana Center sarvodaya-rtbp-2255 2009-07-24T16:49:00+05:30 Alert

	< alert.status> <info.web> <info.contact>	Exercise <a href="http://www.sarvodaya.org/healthalert/">http://www.sarvodaya.org/healthalert/</a> +9411255566
Voice Text	<info.headline> <info.description>	Cholera outbreak is in effect This message is for an <i>Exercise</i> event, repeat this message is for an <i>Exercise</i> event - A <i>high priority Cholera outbreak is in affect</i> for the <i>Kurunegala District</i> . The <i>Health</i> alert for the <i>disease outbreak</i> was issued by the <i>Sarvodaya Suwadana Center</i> . For further instructions visit the <i>Suwadana Center Health Alert</i> website or call <i>their hotline number +9411255566</i> - This message is for an <i>Exercise</i> , repeat this message is for an <i>Exercise</i> event.

#### 11.4.7 Message acknowledgement

Finally, in some cases it may be advisable or desirable to include a backchannel for message acknowledgement from recipients. This would require a communication link back to the message delivery system to collect acknowledgement receipts and present these as a report. The software must be capable of handling this function and a database needs to be established to store this data. Features and data capture associated with message acknowledgement would need to be defined. The PHIN PCA Guidelines include certain attributes for message acknowledgement, which could be adapted to support this function.

#### 11.4.8 Message system administration

Message creation subsystems must also take into account security provisions such as user access control and originator rights management. This will require a database of user names, passwords, and ORM - Originator Rights Management (set of privileges and rules) profiles linked to the user interface software. The user can primarily be categorized by the domain expertise in relation to the predefined <info.category> and <info.status> values; where a “health” alert communication expert has the privilege only to create “Health” category and “Draft” message status templates. Similarly, only health workers with permissions to issue health alerts can issue “Health” category alerts but within that category of authorized persons the administrative subsystem can further restrict to issuing “Actual” or “Exercise” alerts.

For the purpose of the RTBP pilot, the ORM profiles are not essential because only a handful of the health workers will have the user privileges to create templates and issue alert. Therefore, the developers should have some sort of an authentication mechanism with the full message system administration functions in mind.

### 11.4.9 Message Attributes

RTBP alerting and notification should adopt a design approach based on a fundamental principle of extensibility, meaning that it should be easy to integrate additional functionality into the system over time. Functionality could include the ability to support a range of new end-user devices not included in the initial stages of the project, to enable the introduction of advanced distribution capabilities (e.g., precision geo-targeting and routing of messages), and the ability to support cross-jurisdictional and cascade alerting and notification as a future enhancement to the system.

In support of extensible design, it is advised that RTBP follow the CDC PHIN PCA approach and adopt a set of standardized alerting attributes to support semantic compatibility across systems. These attributes provide a framework for shared vocabulary, predictable system response, and more broadly for identifying policy and procedural issues of interest for the research project.

Following the PHIN PCA approach, ‘Alert Attributes’ are semantic descriptors that are associated with specific functional elements and defined precisely using Common Alerting Protocol (CAP) and the Emergency Data Exchange Language (EDXL) Distribution Element.

#### 11.4.10 Alert format

According to PHIN PCA guidelines, “a degree of standardization of alert format helps to ensure that public health organizations can communicate effectively within their jurisdictions and with other jurisdictions, especially during emergencies.”

Each alert should address a single issue or health event, rather than combining multiple issues and events into one alert.

For the initial stages of the project, alerts will be created using CAP v1.1. Message contents will be contained in the CAP envelope that will be transported using one or more transport protocols appropriate to the message distribution sub-system. Later stages of the RTBP project may include the addition of an EDXL envelope that adds an additional layer of information using the EDXL Distribution Element.

Each RTBP alert message entering the message distribution subsystem must include the following nine attributes:

- Identity of the agency that issued the alert {*agencyIdentifier*}
- Message identifier for tracking purposes {*alertIdentifier*}
- Time and date that the message was sent from the issuing agency {*sendTime*}
- Indication of whether it is an actual alert, exercise, or test {*status*}
- Indication of whether it is an original alert, update, or cancellation of a previous alert {*msgType*}
- Indication of the scope of distribution for the alert (i.e., public, restricted, private) {*scope*}

- The priority of the message (i.e., urgent, high, low) {*priority*}
- Indication of the event or incident type {*event*}
- Contents of the alert message {*message*}

#### 11.4.10.1 Message attribute {*agencyIdentifier*}

Each message must identify the agency that issued the alert. PHIN PCA Guide v1.0 refers to an “Object Identifier (OID)” of the originating agency and the future creation of an OID and ebXML registry for PHIN. However, OIDs are currently managed by PCA at CDC.

CAP v1.1 specifies this as a required sub-element within the alert element as *<alert.sender>*. CAP v1.1 further specifies that it must identify “the originator of this alert,” guaranteed by assigner to be unique globally (may be based on an Internet domain name) and which “MUST NOT include spaces, commas or restricted characters (< and &).”

EDXL Distribution Element specifies this attribute as a required sub-element *senderID* and that it must be used only “once and only once” per message. It further specifies that it must be a “unique identifier of the sender” and indicates it must take the form “actor@domain-name,” where “domain-name” refers to a valid address using the Internet Domain Name System. It must be a properly-formed—escaped if necessary—XML string.

- It is recommended that persons, organizations, and agencies authorized to issue alerts within the RTBP project be assigned unique identifiers based on a valid and appropriate Internet domain name (e.g., RTBP@lireasia.org).
- There is a need to approve an acceptable and reliable naming convention with participants and to establish a registry of persons, organizations, and agencies that are authorized to issue alerts for the RTBP project. Further investigation into PCA’s proposed approach to OID and ebXML registry may be useful for latter stages of the project including a cross-jurisdictional workshop.

#### 11.4.10.2 Message attribute {*alertIdentifier*}

Each RTBP alert message must include a unique identifier.

PHIN PCA Guide v1.0 does not specify an encoding requirement for this attribute; however, it notes, “every alerting program must have a unique namespace and its own protocol for generating unique alert identifiers.”

CAP v1.1 specifies this as a required sub-element within the alert element as *<alert.identifier>*. CAP v1.1 further specifies that it must be “a number or string uniquely identifying this message, assigned by the sender” and “MUST NOT include spaces, commas or restricted characters (< and &).”

EDXL Distribution Element specifies this attribute as a required sub-element *distributionID* and that it must be used only “once and only once” per message. It further specifies that it must be a unique identifier, wherein “that uniqueness is assigned by the sender to be unique for that sender.” It must be a

properly-formed—escaped if necessary—XML string.

- It is recommended that RTBP establish a convention for generating and assigning the attribute {*alertIdentifier*}. This must conform to CAP v1.1 and EDXL Distribution Element standards. Participants and authorized issuers should be encouraged to adopt that convention when issuing alerts over the system.
- There is a need to approve an acceptable and reliable message identity convention within the RTBP system.

#### 11.4.10.3 Message attribute {*sendTime*}

Each RTBP message must include the time and date that it was first issued. PHIN PCA Guide v1.0 specifies that this attribute is to be encoded using ISO 8601 format, which corresponds with CAP v1.1 requirement (see below).

CAP v1.1 specifies this as a required sub-element within the alert element as *<alert.sent>*. CAP v1.1 further specifies that it must be “represented in [dateTime] format (e.g., “2002-05-24T16:49:00-07:00” for 24 May 2002 at 16:49 PDT)” and that “Alphabetic time zone indicators such as ‘Z’ MUST NOT be used. The time zone indicator for UTC MUST be represented as ‘-00:00’ or ‘+00:00.’”

EDXL Distribution Element specifies this attribute as required sub-element *dateTimeSent* and that it must be used only “once and only once” per message. It further specifies that it must include the offset for the time zone from where it was sent and “must be in the W3C form for the XML [dateTime] data type.”

- It is recommended that RTBP adopt the ISO 8601 dateTime standard format, taking into account any other considerations related to the W3C form for XML dateTime. This must conform to CAP v1.1 and EDXL Distribution Element standards.
- It is recommended that the ISO 8601 format be embedded in the message creation sub-system software to eliminate need for individuals to enter this data themselves.
- It is recommended that assignment of the {*sendTime*} attribute should be done automatically by the message creation sub-system at the moment the message is sent to the distribution subsystem. The {*sendTime*} attribute should NOT be assigned by the message creation sub-system in order to avoid confusion in situations where a message is created as a preliminary template or draft.
- There is a need to examine potential issues with time zone differences and identify a reliable source for the dateTime data feed.

#### 11.4.10.4 Message attribute {*status*}

Each RTBP alert message must indicate whether it is an actual alert, exercise, or test.

PHIN PCA specifies enumeration values of “Actual” (referring to a live event), “Exercise” (indicates that designated recipients must respond to the alert as part of an exercise), “Test” (indicates that the

message is related to a technical system test and should be disregarded by recipients).

CAP v1.1 specifies this as a required sub-element within the alert element as *<alert.status>*. CAP v1.1 further specifies that it be represented as one of five designated code values, each with specific meaning and intent:

- “Actual”—actionable by all targeted recipients
- “Exercise”—actionable only by designated exercise participants
- “System”—for messages that support alert network internal functions
- “Test”—technical testing only, all recipients disregard
- “Draft”—a preliminary template or draft, not actionable in its current form

CAP v1.1 recommends that *<alert.note>* sub-element be used to provide an exercise identifier when message is assigned “Exercise” status.

EDXL Distribution Element specifies this attribute as required sub-element *distributionStatus* and that it must be used only “once and only once” per message. This attribute conveys the action-ability of the message with one of the following values:

- Actual—“Real-world” information for action
- Exercise—simulated information for exercise participants
- System—message regarding or supporting network functions
- Test—discardable messages for technical testing only

The status MUST be a properly-formed—escaped if necessary—XML string.

- It is recommended that RTBP adopt the CAP v1.1 code values and definitions for the {status} attribute.
- It is recommended that message creation software provide a menu choice “Draft” in addition to the other status values to enable the creation of preliminary templates.
- It is recommended that message creation software be designed to prevent messages with “Draft” status from being sent to the distribution sub-system.
- There is a need to consider establishing unique identifiers for exercises and simulations that are distinct from actual alerts.
- There is a need to establish clear specifications and rules for using the values “System” and “Test” within the scope of the RTBP project.

#### **11.4.10.5 Message attribute {msgType}**

Each RTBP message must indicate whether it is an original alert, update, or cancellation of a previous alert.

PHIN PCA specifies enumeration values “Alert” (to indicate an original alert), “Update” (to indicate that a prior alert has been update and superseded), “Cancel” (to indicate that a prior alert has been

canceled), and “Error” (to indicate that a prior alert has been retracted).

If {*msgType*} is “Update,” “Cancel” or “Error” then the message attribute {*reference*} must be included in the message to provide a unique identifier of the message being updated, canceled, or issued in error.

CAP v1.1 specifies this as a required sub-element within the alert element as *<alert.msgType>*. CAP v1.1 further specifies that it be represented as one of five designated code values, each with specific meaning and intent:

- “Alert”—initial information requiring attention by targeted recipients
- “Update”—updates and supersedes the earlier message(s) identified in *<references>*
- “Cancel”—cancels the earlier message(s) identified in *<references>*
- “Ack”—acknowledges receipt and acceptance of the message(s) identified in *<references>*
- “Error”—indicates rejection of the message(s) identified in *<references>*

CAP v1.1 requires that *<alert.references>* subelement be used to provide an unique message identifier when message type is “Update”, “Cancel”, “Ack”, or “Error”.

CAP v1.1 suggests that *<alert.note>* sub-element be used to provide an explanation when message type is “Error.”

EDXL Distribution Element v1.0 specifies this attribute as required sub-element *distributionType* and that it must be used only “once and only once” per message. This attribute conveys the function of the message with one of the following values:

- Report—new information regarding an incident or activity
- Update—updated information superseding a previous message
- Cancel—a cancellation or revocation of a previous message
- Request—a request for resources, information or action
- Response—a response to a previous request
- Dispatch—a commitment of resources or assistance
- Ack—acknowledgment of receipt of an earlier message
- Error—rejection of an earlier message (for technical reasons)

EDXL Distribution Element v1.0 requires that *distributionReference* sub-element be used to provide a unique message identifier when message type is “Update,” “Cancel,” “Ack,” or “Error.”

The *distributionType* MUST be a properly-formed—escaped if necessary—XML string.

- It is recommended that RTBP adopt the CAP v1.1 code values and definitions for *<alert.msgType>* within the CAP envelope.
- It is suggested that RTBP adopt EDXL Distribution Element v1.0 code values and definitions for message distribution, mapped appropriately to the CAP v1.1 values for the EDXL envelope (e.g., “Alert” is equivalent to “Report”; “Update is equivalent to “Update).

- It is suggested that it is not necessary for RTBP to implement the code values “Request,” “Response” and “Dispatch” at this time.
- There is a need to establish a procedure and rules for issuing various message types, with particular guidelines for updates, cancellations, and errors.
- There is a need to establish a method for generating and assigning *<alert.reference>* (CAP) and *distributionReference* (EDXL) code values when required.

#### 11.4.10.6 Message attribute {scope}

Each RTBP message must indicate the scope of distribution for the alert (i.e., public, restricted, private).

PHIN PCA Guide v1.0 specifies that “PHIN alerting systems should always use the value ‘Restricted,’ meaning ‘for dissemination only to users with a known operational requirement.’” This is not a required attribute in PCA Guide v1.0, but it is acknowledged that the attribute must be included to produce valid XML messages conforming to CAP/EDXL.

CAP v1.1 specifies this as a required sub-element within the alert element as *<alert.scope>*. CAP v1.1 further specifies that it be represented as one of three designated code values, each with specific meaning and intent:

- “Public”—for general dissemination to unrestricted audiences
- “Restricted”—for dissemination only to users with a known operational requirement
- “Private”—for dissemination only to specific addresses

CAP v1.1 requires that sub-element *<alert.restriction>* be used when the scope value is “Restricted.” The *<alert.restriction>* sub-element is therefore conditional and contains “text describing the rule for limiting distribution of the restricted alert message.”

CAP v1.1 requires that sub-element *<alert.addresses>* be used when the scope value is “Private.” The *<alert.addresses>* element is therefore conditional and contains “the group listing of intended recipients of the private alert message.” CAP v1.1 specifies certain rules for this sub-element: “each recipient SHALL be identified by an identifier or address,” “multiple space-delimited addresses MAY be included. Addresses including whitespace MUST be enclosed in double-quotes.”

There is no corresponding EDXL Distribution Element identified in PHIN PCA Guide v1.0 for the message attribute {scope}. However, the required sub-element *combinedConfidentiality* might serve to provide similar a semantic equivalent for the EDXL envelope. PHIN PCA Guide v1.0 in fact specifies this EDXL sub-element for the required message attribute {sensitive} with enumeration values of “Sensitive” and “NotSensitive”.

- It is recommended that RTBP adopt the CAP v1.1 code values and definitions for *<alert.scope>* within the CAP envelope.
- It is recommended that RTBP adopt a rule whereby all messages issued within the scope of the

project be designated as “Restricted” or “Private.”

- It is recommended that RTBP message creation software provide menu options only for “Restricted” or “Private” messages, with future provision for “Public” messages.
- There is a need to create text to describe the rule for limiting distribution of “Restricted” alert messages conforming to CAP v1.1 sub-element *<alert.restricted>*.
- There is a need to establish a registry of addresses for intended recipients of messages designated as “Private” conforming to CAP v1.1 sub-element *<alert.addressess>*.
- There is a need to consider the use of EDXL sub-element combinedConfidentiality as an equivalent to *<alert.scope>*. If adopted, then it is recommended that the code value “Sensitive” be assigned to all messages.
- There is a need to establish a procedure and rules for assigning RTBP messages as “Restricted” or “Private.”

#### 11.4.10.7 Message attribute {*priority*}

Each RTBP message must indicate the priority of the alert.

PHIN PCA Guide v1.0 does not specify an equivalent message attribute {*priority*} but includes three related message attributes: *severity*, *urgency*, *certainty*. Of these, *severity* is the only required attribute. Code values for these attributes are to follow CAP v1.1 enumeration values for corresponding CAP sub-elements.

CAP v1.1 establishes message priority with the info element using three required sub-elements: *<info.urgency>*, *<info.severity>*, *<info.certainty>*. All three elements must be included to produce a valid CAP-XML document.

CAP v1.1 specifies the following code values for the sub-element *<info.urgency>*:

- “Immediate”—responsive action should be taken immediately
- “Expected”—responsive action should be taken soon (within next hour)
- “Future”—responsive action should be taken in the near future
- “Past”—responsive action is no longer required
- “Unknown”—urgency not known

CAP v1.1 specifies the following code values for the sub-element *<info.severity>*:

- “Extreme”—extraordinary threat to life or property
- “Severe”—significant threat to life or property
- “Moderate”—possible threat to life or property
- “Minor”—minimal threat to life or property
- “Unknown”—severity unknown

CAP v1.1 specifies the following code values for the sub-element *<info.certainty>*:

- “Observed”—determined to have occurred or to be ongoing

- “Likely”—likely ( $p > \sim 50\%$ )
- “Possible”—possible but not likely ( $p \leq \sim 50\%$ )
- “Unlikely”—not expected to occur ( $p \sim 0$ )
- “Unknown”—certainty unknown

There is no corresponding EDXL Distribution Element identified in PHIN PCA Guide v1.0 for the message attribute *{priority}* or for the corresponding CAP sub-elements noted above.

The LIRNEasia HazInfo<sup>20</sup> project established message priority by adopting a bundled approach that used pre-defined code values for each of the CAP sub-elements noted above. Details of this approach are provided in section 5 of this document.

- It is recommended that RTBP adapt the message prioritization scheme developed for the LIRNEasia HazInfo project.
- It is recommended that RTBP message creation software provide users with a limited menu of choices based on this message prioritization scheme to enhance reliability and simplicity.
- There is a need to establish guidelines for assigning priority levels to RTBP alerts.

#### 11.4.10.8 Message attribute *{event}*

Each RTBP message must indicate the event or incident type.

PHIN PCA Guide v1.0 does not specify a message attribute *{event}* but includes two related message attributes: *alertProgram* and *category*. Of these, only *alertProgram* is a required message attribute and is specified using CAP v1.1 required sub-element *<info.event>*. Enumeration values for this attribute refer to specific PHIN alerting programs (e.g., HAN, Epi-X). The attribute *category* is specified using the CAP v1.1 required sub-element *<info.category>* and is always enumerated as “Health.” However, for the general design of a CAP enabled messaging module this element can give the user the option to select from any predefined *<info.category>* element values such as *Geo*, *Met*, *Safety*, *Security*, *Rescue*, *Fire*, etc. An approach would be to maintain a configuration file that specifies whether it is a general implementation (i.e. *config.info.category* = “default”) or a domain specific implementation (i.e. *config.info.category* = “Health”). If configuration value is set to default then the template creation or message creation form control will display all predefined *<info.category>* values; else if set to “Health,” for example, would display only that value blocking the template or message creator from editing it.

CAP v1.1 specifies that all messages contain sub-elements *<info.category>* and *<info.event>*. Sub-element *<info.category>* denotes the general category of the subject event of the alert message and must correspond to a range code values specified in CAP v1.1 standard. For the RTBP project, the code value “Health” is appropriate.

The code value for sub-element *<info.event>* is to provide “the text denoting the type of the subject event of the alert message” and is intended to be more specific than the *<info.category>* sub-element. CAP v1.1 does not provide specific code values.

<sup>20</sup> HazInfo technical report can be found here – <http://www.lirneasia.net/>

There is no corresponding EDXL Distribution Element identified in PHIN PCA Guide v1.0 for the message attribute *{event}* or for the corresponding CAP sub-elements noted above.

- It is recommended that CAP v1.1 sub-element *<info.category>* be specified as “Health” for all RTBP alert messages.
- It is recommended that RTBP message creation software automatically assign all RTBP alerts as “Health” messages using CAP v1.1 *<info.category>*.
- It is recommended that CAP v1.1 sub-element *<info.event>* be included in all RTBP alert messages to ensure CAP-XML compliance.
- It is recommended that RTBP message creation software provide a list of one or more RTBP-designated events corresponding to the foreseeable subject events of potential alert messages.
- There is a need to develop an event list (containing one or more events) suited to the purpose of the RTBP project. There is a need to consider management of an event list registry.

#### **11.4.10.9 Message attribute *{message}***

Each RTBP alert message must include a description of the alert.

PHIN PCA Guide v1.0 refers to this as “the main message text” and specifies CAP v1.1 required sub-element *<info.description>* to convey this information. It is a required attribute in PHIN PCA Guide v1.0.

CAP v1.1 does NOT require messages to include the info sub-element *<info.description>*. The element is specified as “an extended human readable description of the hazard or event that occasioned this message.”

CAP v1.1 also includes an optional info sub-element *<info.headline>* that provides “a brief human-readable headline ... that SHOULD be made as direct and actionable as possible while remaining short. 160 characters MAY be a useful target for headline length.”

In addition, CAP v1.1 includes an optional info sub-element *<info.instructions>* that provides “extended human readable instructions to targeted recipients” that describes “recommended action to be taken by recipients of the alert message.” PHIN PCA Guide v1.0 specifies this sub-element for an optional message attribute *dissemination* intended to provide instructions for sharing message information beyond the initial intended recipient.

- It is recommended that RTBP adopt CAP v1.1 info sub-element *<info.description>* to convey a human readable description of the event that occasioned the alert message.
- It is recommended that RTBP adopt CAP v1.1 info sub-element *<headline>* to convey a brief human readable message under 160 characters describing the event that occasioned the alert message.
- It is recommended that RTBP include consideration of CAP v1.1 info sub-element *<info.instructions>* for future implementation.

- There is a need to develop procedures and guidelines for message texts pertaining to various alerts that will be issued during the RTBP project.
- There is a need to ensure that message delivery software will correctly and reliably render message contents from *<info.description>* and *<info.headline>* sub-elements to correspond with long text, short text, and voice messages.

Note – There are two options for implementing the logic for short and long text messages. The CAP messaging module would provide a feature for the implementers to assign various CAP elements to the various fields of the transport and display technologies. For example, the implementers can assign the *<info.headline>* human-readable element restricted to 160 characters to the message box of an SMS text while a HTML website post could carry both the *<info.headline>* and *<info.description>* element values.

### 11.4.11 Message Prioritization with the HazInfo Project

The following section is an excerpt taken from *Guidelines for HIH Procedures, System Activation, and Testing* v1.2.1 (July 12, 2006)<sup>21</sup> developed for the LIRNEasia HazInfo Project.

The excerpt describes how the CAP sub-elements are pre-assigned code values and bundled to create a reliable and simplified message prioritization scheme.

#### 11.4.11.1 Message Priority

When reporting an event of interest (EOI) an authorized user may request the HIH Executive to issue an **Urgent Priority** warning message when one or more of the following threat conditions are present:

- The life or safety of groups, communities or villages is at immediate risk.
- The danger to the community is impending and widespread.
- The potential impact to the community is catastrophic.
- Local first responders need to be informed of critical, lifesaving information and be advised to activate their local response plans.

The following table contains recommended CAP values for *<urgency>*, *<severity>*, and *<certainty>* elements in an urgent priority message.

Table 72 CAP values for an urgent priority message

CAP <i>&lt;info&gt;</i> element	Value (recommended)	Interpretation
Urgency	“Immediate”	Immediate responsive action should be taken
Severity	“Extreme”	Hazard presents an extraordinary threat to

<sup>21</sup> Guidelines for HazInfo can be found here – <http://www.lirneasia.net/cap-guidelines-hazinfo>

Certainty	“Observed”	life or property The hazard event has occurred or is ongoing (or, > 50%).
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Alternately, an authorized user may request the HIH Executive to issue a **High Priority** warning message when one or more of the following threat conditions are present:

- The life or safety of communities or villages is possibly at risk.
- Neighboring communities or villages have been issued an urgent priority warning.
- Residents of the community may see/hear/smell (detect) signs of the hazard and may perceive a danger or health risk.
- Local first responders need to be informed of the hazard situation to provide information to community members.
- Local first responders must be advised to standby to activate their local response plans.

The following table contains recommended CAP values for <urgency>, <severity>, and <certainty> elements in a high priority message.

*Table 73 CAP values for a high priority message*

CAP <info> element	Value (recommended)	Interpretation
Urgency	“Expected”	Responsive action might need to be taken in near future.
Severity	“Severe”	Hazard presents a significant threat to life or property.
Certainty	“Observed”	The hazard event has occurred or is ongoing (or, > 50%).

An authorized user may request the HIH Executive to issue a **Low Priority** warning message when one or more of the following conditions are present:

- The life or safety of a community might be at risk due to a developing hazard.
- A neighboring community has been issued a high priority warning.
- Residents of the community may see/hear/smell (detect) signs of a hazard or nearby response effort and may be curious.
- Local first responders need to be informed of the hazard situation to provide information to community members.
- Local first responders must be advised to standby for further information.

The following table contains recommended CAP values for <urgency>, <severity>, and <certainty> elements in a low priority message.

*Table 74 CAP values for a low priority message*

CAP <info> element	Value (recommended)	Interpretation
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Urgency	“Expected”	Responsive action might need to be taken in near future.
Severity	“Moderate”	Hazard presents a minimal threat to life or property.
Certainty	“Observed”	The hazard event has occurred or is ongoing (p > 50%).

#### 11.4.11.2 Simplifying entry of priority for the user

One of the configurations would defining the *<info.urgency>*, *<info.severity>*, and *<info.certainty>* mapping to urgent, high, and low priority elements.

### 11.4.12 Auto Generate the Message Attribute {Description}

When creating the CAP template, the user can be given the choice to auto-generate the information for the *<info.description>* through a template designed for the *<info.description>* element, where incident specific values are populated from other elements of the CAP message.

“A *<info.event>* alert has been issued for *<area.areaDesc>* by *<info.senderName>*. Persons in this area are encouraged to *<responseType>*, and *<instruction>* (if) fields. This event is rated as *<info.severity>*, and is *<info.certainty>*. Responsive action should be taken *<info.urgency>*. For more information about this event, visit *<info.web>* or call *<info.contact>*.”

### 11.4.13 Required Software Components

This section outlines the required software components to achieve the objectives of the alerting and notification logic discussed in section 3 and to provide the functionality for the subsystems discussed in section 2. The architecture of the software complies with the layered architecture.

The main software components comprise:

- Message Editor
- Delivery Configuration
- Transport Gateway

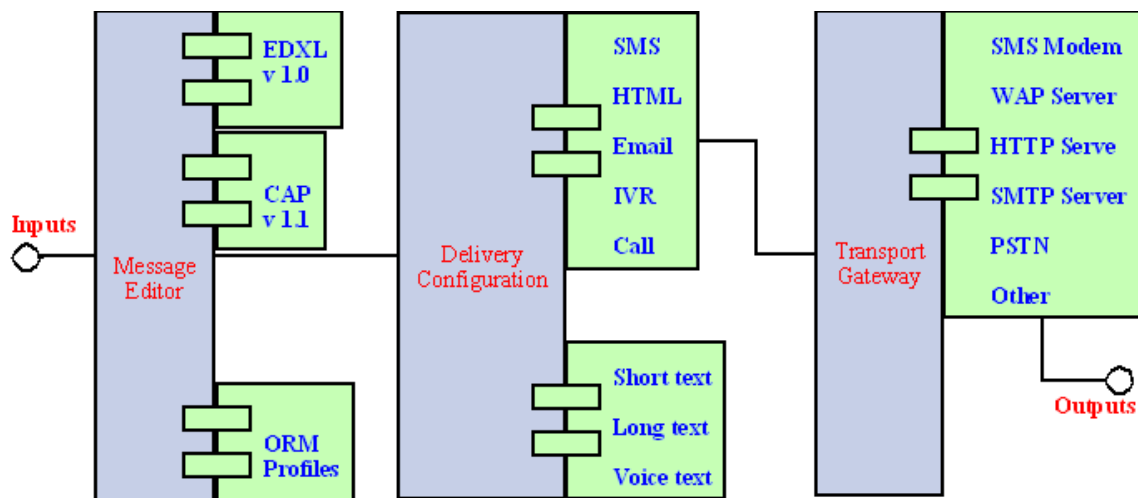


Figure 74: Software components of the EDXL/CAP multi-transport sub-module

#### 11.4.14 Message Editor

The message editor is the main entry point for constructing message templates and issuing alerts. The underlying information data structure and logic for creating message templates and issuing messages are governed by standard CAP v1.1 and EDXL 1.0 XML schemas. The schema rules and control rules for each of the CAP elements are discussed in section 3. When a message or template is created, they are stored as XML files.

The ORM profiles contain the set rules for controlling the various functional aspects of the message editor based on the rules and the privileges assigned to the authorized user. Section 2.5 describes the message administration subsystem for which the ORM profile component provides the functions.

The ORM further acts as the component that provides the controls for issuing either cascade or direct messages. Thus, the ORM contains the records of the recipient lists. In the context of the software, a cascade alert is simply the transmitting of a Long text message to another system either via email or web services. Therefore, the mechanics is no different than a direct alert.

The users will be provided with a series of form controls to develop the templates and issue messages. The use cases for message template creation and issuing is explained in section 7.

#### 11.4.15 Delivery Configuration

It is in the delivery configuration component that defines the delivery type and mapping to the various technologies as described in section 2.3 and section 10. The configuration is done at the system implementation stage before users can even start creating message templates. This requires developing an object relational mapping between the CAP elements and the three types of delivery mechanisms:

long text, short text, and voice text. This object relational mapping is fixed for a particular deployment that is government by the CAP Profile implementers and domain experts. The users are not given the flexibility to alter these during run time. If the policies are to be changed then it must be changed at the system level.

First, the system implementers and experts would define the object relational mapping between the CAP elements and the long text, short text, and voice text as defined in Table 3 in section 2.3. This component would be purely and XML code based and would not require an RDBMS.

Section 9 discusses available XML schemas for each of the transport and display technologies. The object relational mapping would take place between the CAP XML elements and the transport technology XML schemas. Hence, the transport technology XML schemas must be established standards. While all elements of the delivery types would map to the transport technology in most cases only selected elements of that mapped set would be displayed while other elements may be used for control logic.

#### **11.4.16 Transport Gateway**

The transport gateway plug-in is a software object that provides the necessary Application Programming Interface (API) functionality for different technologies to couple with the Messaging Module for carrying the alert messages over different technologies. For the purpose of the project, we will use SMS, WAP, HTML, and Email as transports. Each of the technologies must identify whether they carry short text, long text, or voice messages. The transport gateway plug-in contains the underlying bottom layers of the network stack components to carry the messages through the individual technology networks. The outputs will be the short-text, long-text, and voice messages conforming to the message structure of the individual technologies. For example, an SMS will be configured to carry a short text message; where the header of the SMS will contain the sender, recipient, and date information while the body of the SMS would contain the *<info.priority>*, *<info.headline>*, *<info.web>*, *<info.sent>*, and *<info.effective>* values of the CAP message. The predefined mapping instructions are provided in section 10.

#### **11.4.17 Use cases of the Alert and Notification system**

The required software components, discussed in section 6, are expected to provide functionality to address the necessary use cases. CAP/EDXL sub-module, which is part of the greater scheme of the SHN Messaging Module, is intended for communicating messages between the actors of the system and shall be used to communicate periodic national health status reports as well as instant alerts to communicate adverse health events.

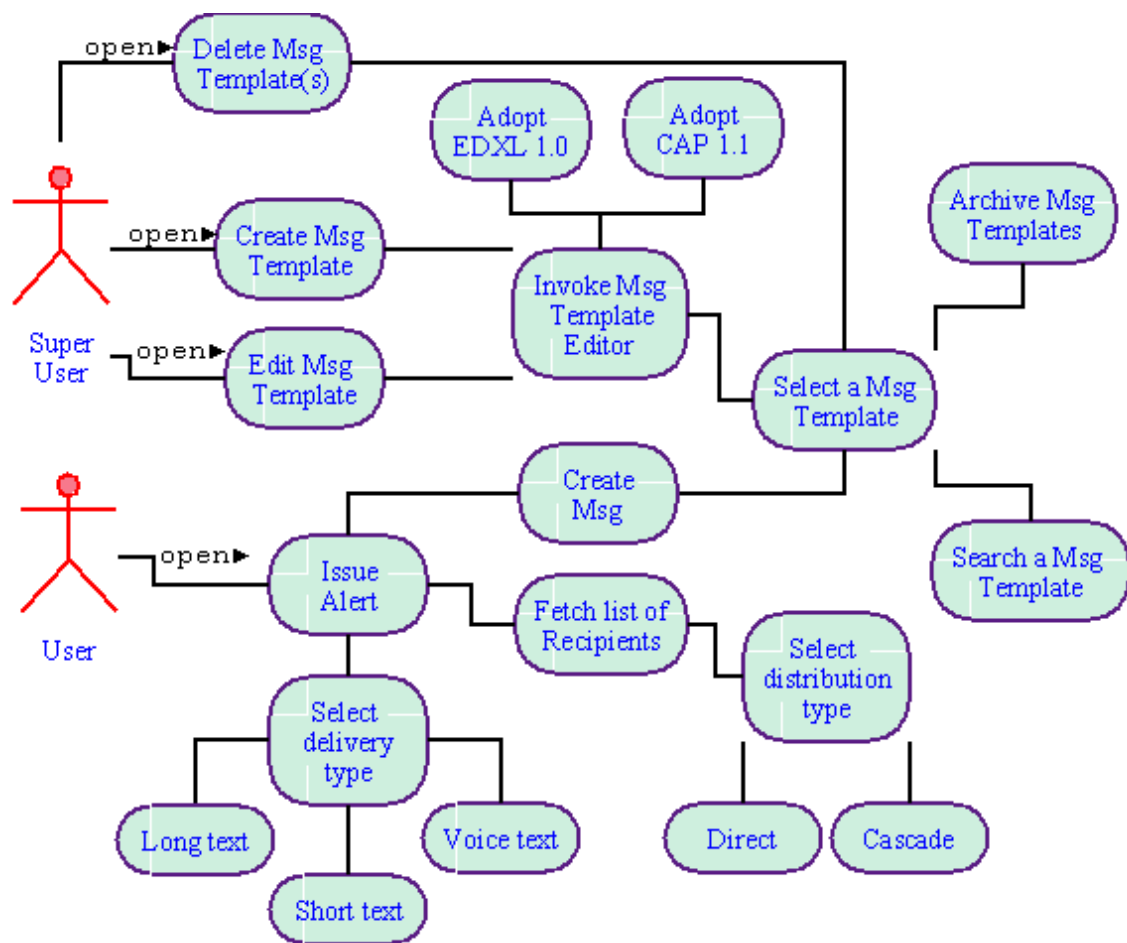


Figure 75: Use case diagram for EDXL/CAP enabled alert and notification

Table 75 Description of the individual elements of Figure 75

Search a template	A control for user to rapidly search a previously saved an EDXL/CAP template; another set of criteria will be defined within the health category to be able to retrieve the required template; user will select from presented drop down lists and enter partial information in the presented text controls to provide the filter criteria for the search. By default user is forced to search a template to avoid creating new messages and to ensure the user applies the appropriate language and structure that has been predetermined and not recreate ambiguous messages.
Archive template	The database of all super user created templates; most likely to be organized by the alert category; for the same of the RTBP these will be all labeled as <i>&lt;info:category&gt; = "Health"</i>
Select a message template	Based on the search criteria a set of results will be presented to the user to select one of the templates. If the required template is unavailable then the user may choose to create a new template from this point.
Invoke message template editor	Once a template is selected, the EDXL/CAP message template editor is invoked for the super user to update the information. The same editor is used to create a new message template.
Adopt EDXL 1.0	If the super users decide to adopt EDXL then the system will provide the associated EDXL attributes and rules in generating the message templates. The template editor will use this knowledge.
Adopt CAP 1.1	If the super users decide to adopt CAP then the system will provide the associated CAP attributes and rules in generating the message templates. The template editor will use this knowledge.
Create a message template	Super user creating the template are forced to enter the mandatory elements and given the option to mark none mandatory elements as mandatory for the user creating the message to enter; the mandatory elements may be defined based on the country profile and implementers' policies.
Edit message template	The users are first forced to search for the desired template through the search a template use case. Then select the desired template for editing and saving upon completion.
Delete message template(s)	Only super users or (i.e. template creators) can remove templates. The super user must first search the desired template through the search template use case and then select one or more templates from the list and through the delete control remove them from the database.
Issue Alert	It is through the issue alert use case that the message senders access message templates, complete the message, select the delivery type (short text, long text, or voice), and distributions mode to issue the message.
Create Message	To create a message the user must first find a template through the search a template use case. Thereafter, complete the message by filling in the voids prior to issuing. The form control will apply the rules to validate the message completeness.

Fetch list of recipients	The recipients may be individuals or selected from a predefined group. The user will be displayed the list of recipients similar to an address book for user to select from. The selected recipients will be populated in the recipient's list control and be further separated by the delivery technology where email addresses are separated from phone numbers.
Select distribution type	The distribution type is either cascade or direct alerts as discussed in section 2.2. Through this use case, the user will pick the distribution type. Based on this criterion the system will apply certain rules accordingly.
Direct	Direct alerting is when a message is sent from the system directly to the recipient, which is a person and the message is intended for the receiving person. The messaging protocol will contain the list of intended recipients. In the case of an SMS and email, the recipient list would contain the mobile phone numbers and email addresses respectively. See section 2.3.
Cascade	Cascade alerting is when a message is sent to another system; i.e. a jurisdiction. The sending protocol would have a general address such as a phone number for SMS or email address for email of the receiving system. It is up to the receiving system to decide whether or not to propagate same of an edited version of the message to the distribution list associated with that system. Eng the Irrigation department may issue an alert to warn the possibility of opening flood gates to release excess reservoir water to the
Select Publish mode(s)	The distribution types: short message, long message, and voice message will be presented to the user to select one or more of the choices.
Long Text	A full CAP message with all CAP elements in tact, Section 2.2 describes this concept.
Short Text	Parts of the CAP message that can fit in to a small display screen as well as constrained by the delivery capacity. The short message will be an incomplete message just to get the attention of the recipient with instruction or link to the full CAP message. Section 2.2 describes this concept.
Voice Text	Mainly the <i>&lt;info.header&gt;</i> and <i>&lt;info.description&gt;</i> elements of a CAP message intended for voicing out the alert via an IVR or simple phone call. This concept is discussed in section 2.2.

### 11.4.18 Entity Relationships

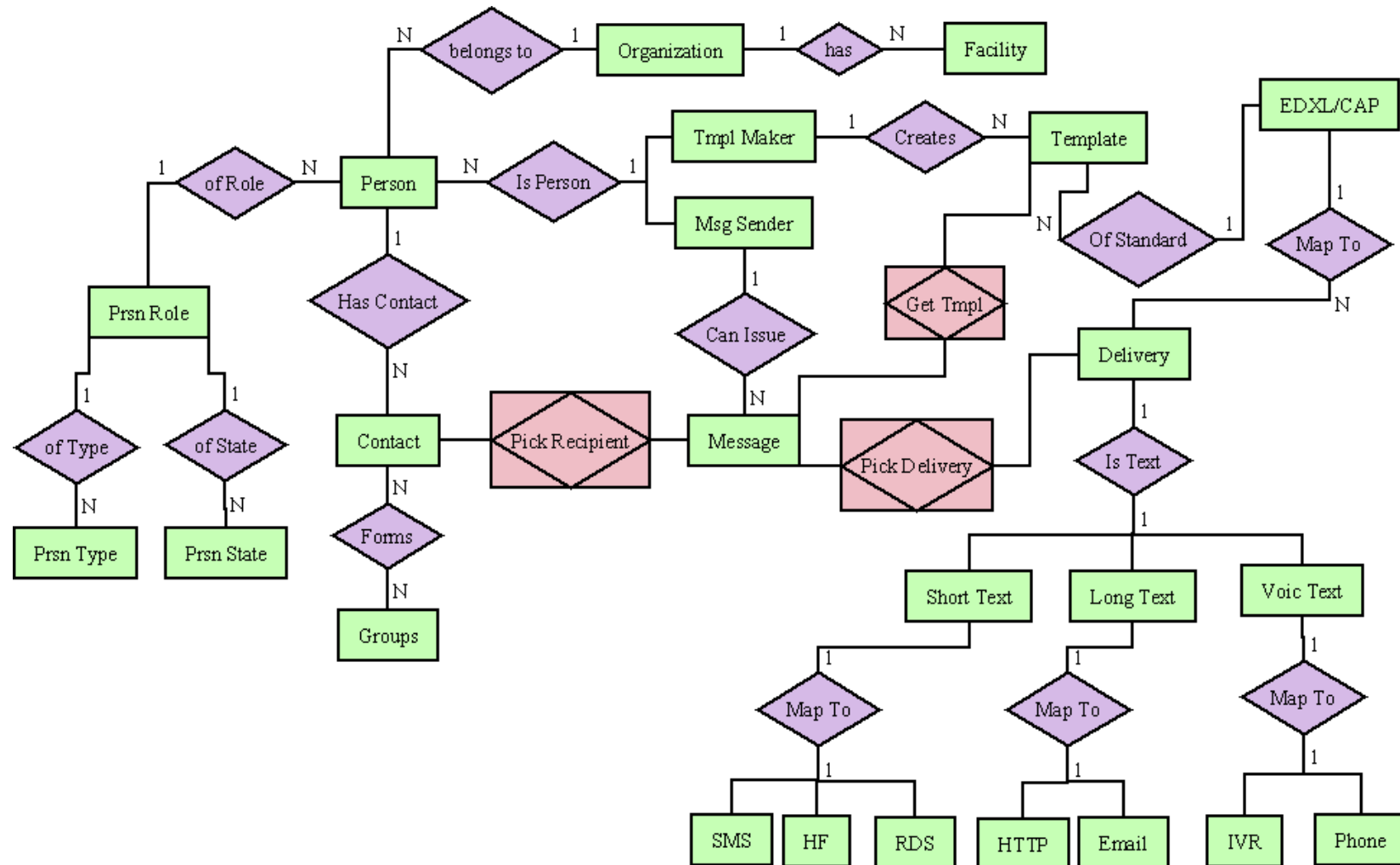


Figure 76: Entity relationship diagram for the CAP sub-module schema

This section describes the relationships between the entities that makeup the data structure for the alert and notification system. While some parts of this relational data structure is made of RDBMS tables the others are pure XML files.

To begin with, the *person* entity holds the user information of the person's name and other information that are made available by the general person table of the SHN\_BSM module. These persons are authorized with permissions to create templates and issue messages. The authorized persons are labeled as a "user" in the *person roles* table. Some users would be granted permissions to create templates while others will be granted permission to simply issue alerts. The restrictions can be further partitioned categorically such that a particular user may be given permission to issue alerts with respect to a subset of the hazard categories defined by the predefined values of the *<info.category>* CAP element.

The message template creators, message senders, and message recipients are further distinguished by *person types*. The *person* state denotes the active stature of the person; where the state can take on several transitional states; where a person may go from inactive, to probations, to active.

Through the *person status*, the users can be identified as to whether they are active or inactive in the system. Although Figure 76 shows two entities: Tmpl Maker (Template Maker) and Msg Sender (Message Sender) they don't necessarily have to be implemented as two different tables but can be implemented as two separate person roles. These two roles are shown in the diagram for illustration purposes only.

Each person's (or users) *contact* information is store in the system. The contact information can be a telephone number, email address, website, or blog that is used to populate some of the CAP elements such as the *<alert.recipients>* list and *<alert.sender>* details. Contact *groups* (i.e. recipient lists) can be created in advance to minimize the time on retrieving sets of recipients.

Persons are also associated with an *organization*. This fulfills the ORM requirement when issuing direct and cascade alerts. Moreover, the *<alert.identifier>* would use the information on the organization registry to auto create the identifier based on a predefined formula. The *<alert.senderName>* would be assigned the name of the organization through the alert was issued where the relationship is established through the person entity with role = user.

Message templates developed for future use are stored as XML files in the system. The template saved names along with information such as the *<info.category>* and the XML file name are stored in a table for template creators and alert issuing users to search when they want to retrieve a template to modify or remove it and message senders to search for the right template to generate the message to issue the alert.

While templates can be of various styles, the *CAP* templates use the predefined CAP elements and the respective knowledge. In order to accommodate three different delivery types: short text, long text, and voice the implementers must decide the set of elements that must go in to each delivery type. For example, a short message sent over SMS does not have the space to carry a *<info.description>* CAP

element value but will be assigned the *<info.headline>* CAP element value. The *delivery medium* and the CAP entity will provide the knowledge of the mapping on the set of elements that should be used in each of the delivery types. Each of the predefined delivery types will be stored as XML files on the server.

It is assumed that each of the technologies SMS, Email, HTTP, etc. can be defined through a structured XML file. The object relational mapping between the delivery types and the various technologies will be stored in a file that can be retrieved to assign the CAP values at the time of issuing the message.

## 11.4.19 Recommendations for Transport Technology Data Structure

### 11.4.19.1 Short Message Service

A typical SMS message submits XML DTD, which can be used as the data structure to map the CAP elements to the SMS message elements. It is possible to adopt a SMAP or MMAP message structures to define the SMS data structure.<sup>22</sup>

```
<?xml version="1.0" encoding="ISO-8859-1"?>
  <!DOCTYPE message SYSTEM "SMSmessage.dtd">
  <message>
    <submit>
      <da><anumber>+358991234567</anumber></da>
      <da><anumber>+358997654321</anumber></da>
      <ud> Merry Christmas !</ud>
      <timing>
        <time>
          <year> 2000 </year>
          <month> 12 </month>
          <day> 24 </day>
          <hour> 18 </hour>
          <minute> 0 </minute>
          <second> 0 </second>
          <timezone> -2 </timezone>
        </time>
      </timing>
      <messageID> 1 </messageID>
    </submit>
  </message>
```

### 11.4.19.2 Hyper Text Mark-up Language

XSLT and CSS are the more popular styling and mapping methods that can be used to map the XML tags in the CAP message to display in a web page where the CAP message tags and values can be displayed in a table with two columns. Also adding in some logic to eliminate CAP tags that are empty and converting the *<info.web>* values to hypertext links and values related to the *<resource>* tags also use appropriate logic to enhance the functionality.

<sup>22</sup> Use XML to Send SMS - <http://www.ibm.com/developerworks/xml/library/x-tipsms1.html>

### 11.4.19.3 Email

Email Templates includes support for XML. XML Documents can be searched for elements and attributes that can be inserted into your message. A simple example –

```
<email>
  <from>rafe@rafe.us</from>
  <to>someone@example.com</to>
  <cc>someoneelse@example.com</cc>
  <bcc>rafe@rafe.us</bcc>
  <subject>This is the subject</subject>
  <body>This is the body of an email message.</body>
  <attach>c:/doc/alert.xml</attach>
</email>
```

<from> element would be equivalent to the <alert.sender> and <subject> would be equivalent to the <info.event> or <infor.headline> elements and can be implemented either way. Given that <info.event> is a mandatory element, it can be mapped to the email <subject>.

### 11.4.19.4 Interactive Voice Response

VoiceXML (VXML) is the W3C's standard XML format for specifying interactive voice dialogues between a human and a computer. A Simple example –

#### Main.vml

```
<?xml version="1.0"?>
<vxml version="1.0" application="app-root.vxml">
  <form id="say_goodbye">
    <field name="answer" type="boolean">
      <prompt>Shall we say
        <value expr="application.bye"/>?
      </prompt>
      <filled>
        <if cond="answer">
          <exit/>
        </if>
      <clear namelist="answer"/>
    </filled>
  </field>
</form>
</vxml>
```

#### app-root.vml

```
<?xml version="1.0"?>
<vxml version="1.0">
  <var name="bye" expr="'Ciao'"/>
```

```

<link next="operator_xfer.vxml"> <grammar>
operator </grammar> </link>
</vxml>

```

### 11.4.20 Mapping of Delivery to Technologies

The delivery types have been established as long text, short text and voice text.

Table 76 Mapping delivery types to technologies displays

<b>Technology</b>	<b>Delivery Type</b>	<b>CAP Attributes with Message format</b>
SMS	Short text	<pre> &lt;info.headline&gt;+”: ”+ &lt;area.areaDesc&gt; +”, “+”Priority: “+ &lt;info.value&gt;+”, “+&lt;info.event&gt; +” by ”+&lt;info.senderName&gt; +”. “Msg: ”+&lt;alert.identifier&gt;+” sent on ”+&lt;alert.sent&gt;+” is a “+&lt;info.status&gt;+” “+&lt;info.type&gt;+”. See web: “+&lt;info.web&gt;+ ” Call: “+&lt;info.contact&gt; . </pre>
HTTP/WAP	Long text	<pre> &lt;alert&gt; ....&lt;/alert&gt; (full cap message with CAP tags in column 1 without the “&lt;” symbols and values in column 2. </pre>
Email	Short text	<pre> [subject] &lt;info.headline&gt;+” for ”+ &lt;area.areaDesc&gt; [body]&lt;info.headline&gt;+” for ”+ &lt;area.areaDesc&gt; +”...“+ &lt;info.valueName&gt;+” “+ &lt;info.value&gt;+” “+&lt;info.event&gt; +” issued by ”+&lt;info.senderName&gt; +”. Msg:”+&lt;alert.identifier&gt;+” sent ”+&lt;alert.sent&gt;+” is a “+&lt;info.status&gt;+” “+&lt;info.type&gt;+”. More info “+ &lt;info.web&gt;+” “+&lt;info.contact&gt; </pre>
	Long text (XML file attachment)	<pre> [Subject] &lt;info.headline&gt; [Attachment] alertmsg.xml [body]&lt;info.headline&gt;+” for ”+ &lt;area.areaDesc&gt; +”...“+ &lt;info.valueName&gt;+” “+ &lt;info.value&gt;+” “+&lt;info.event&gt; +” issued by ”+&lt;info.senderName&gt; +”. Message ID:”+ &lt;alert.identifier&gt;+” sent ”+&lt;alert.sent&gt;+” is a “+&lt;info.status&gt; +” “+&lt;info.type&gt; +”. More info “+&lt;info.web&gt;+” “+ &lt;info.contact&gt; </pre>
IVR	Voice text	<pre> &lt;info.headline&gt; ...&lt;pause&gt;&gt; ... &lt;info.description&gt; </pre>

### 11.4.21 Delivery/Receipt User stories with Examples

These user stories are in relation to the delivery type and to what the user receives as content and available functionality.

#### 11.4.21.1 Short Message Service

- As a recipient of an SMS CAP text on the mobile phone, the user will hear the ring tone

indicating a new message has arrived. Following that, he or she may choose to view the SMS text.

- The message recipient, being an average human, should be able to read the message and understand it clearly.
- The alert/sit-awareness message recipient, initially, must
  - first, see the headline that is in human readable form giving a first-hand idea of the expected content
  - second, see the area for which the CAP message is applicable, priority of the message (i.e. urgent, medium, or low), event (i.e. “disease outbreak”, “cyclone warning”, etc), who issued the alert (which will be different from the technology associated sender information such as the owner of the mobile SIM number)
  - the second part of the message must indicate the time the message was issued, status (actual, test, exercise, etc.), type of the message (alert, update, error, etc), and reference to sources for detailed/additional information (web, phone, etc)
- Given that the message will be received on a mobile phone, the user should be able to click on the web link in the message that should ask them if they want to invoke GPRS to view the content of that web page on their mobile phone; similarly the user should be able to use the mobile phone number in the text to call that voice hotline
- As any other SMS text, the user may choose to apply any normal SMS function to that message such as storing, deleting, forwarding, etc.

Example of a typical message viewed on a 16 character long mobile phone screen:

DENGUE OUTBREAK IN  
EFFECT for Kurunegala  
District of priority HIGH  
Disease outbreak issued by Dr.  
P. Hemachandra (Regional  
Epidemiologist).  
Msg: kuru-rdhs-123456 sent on  
2009-03-01T08:00:00+5:30 is a  
Exercise Alert.  
More info web:  
[http://www.scdmc.lk/cap/alert/  
kuru-rdhs-123456](http://www.scdmc.lk/cap/alert/kuru-rdhs-123456)  
phone: +94372222278

#### 11.4.21.2 Hyper Text Mark-up Language

- Very likely the user will first receive a SMS text alert first, and will then want to view the full message on a PC (laptop or desktop) through an HTTP browser (Fire Fox or Internet Explorer) or on a mobile hand held device through a WAP browser.

#### 11.4.21.3 Mobile Phone WAP Browsers/RSS reader

- Option (1): If recipient is using the same mobile hand-held device on which the SMS text was received to view the CAP message over the WWW, then they would click on the URL displayed as a hyper-link in the SMS CAP message to access the WAP site (this feature is available in almost all mobile hand-held terminal devices)
- Option (2): Retype the URL in the WAP browser and view the CAP message through the browser, most likely as a raw XM file
- Option (3): Subscribe to the “recent alerts” XML file (e.g. <http://www.scdmc.lk/alerts/cap/recentalerts.xml>) through an RSS reader such as the Google RSS reader that can be installed on the mobile phone.

#### 11.4.21.4 Laptop/Desktop HTTP Browsers/RSS reader

- To view the complete CAP message over the WWW on a laptop or desktop, there are four options (1) – type the URL (most likely received through the SMS CAP message) in the HTTP browser (would receive a page similar to - <http://earthquake.usgs.gov/earthquakes/catalogs/eqs7day-M5.xml>), (2) - Go to the Sahana application to first log in and then view the CAP message through the CAP Aggregator (see image in “module workflow” - [http://wiki.sahana.lk/doku.php/cap\\_aggregator](http://wiki.sahana.lk/doku.php/cap_aggregator)), (3) – install the Fire-Fox Plug-In<sup>23</sup> to receive the CAP message as a pop-up (see example image at the bottom of this page - [http://wiki.sahana.lk/doku.php/cap\\_firefox\\_addon](http://wiki.sahana.lk/doku.php/cap_firefox_addon)), and (4) – Subscribe to the “recent alerts” XML file (e.g. <http://www.scdmc.lk/alerts/cap/recentalerts.xml>) through any available RSS reader such as the Google RSS reader
- In all four options, without loss of generality, we can assume the recipient (user) is within the CUG, otherwise, they would not receive an SMS to use option (1) or receive the URL to subscribe through options 2, 3, and 4.
- When option (1) is used the user should be presented through a CSS with a list of all active recent CAP messages with a minimal set of the CAP fields: `<info.headline>`, `<area.areaDesc>`, `<info.valueName>`, `<info.value>`, `<info.event>`, `<info.senderName>`, `<alert.identifier>`, `<alert.sent>`, `<info.status>`, and `<info.type>` but clearly formatted in human readable form (e.g. <http://earthquake.usgs.gov/earthquakes/catalogs/eqs7day-M5.xml>).
- Once the user clicks on one of the listed alerts they will be presented through another CSS with all non-empty (i.e. not null) CAP element values (e.g. <http://earthquake.usgs.gov/earthquakes/recenteqsww/Quakes/us2010tdan.php>)
- The XSLT delivering the web publication of the XML with a common URL (e.g. <http://www.scdmc.lk/alerts/cap/recentalerts.xml>) must confirm the acceptability of the CAP Aggregator, CAP Fire-Fox plug-in, and RSS Readers as an input.
- User will configure the CAP Aggregator, CAP Fire-Fox Plug-In, and/or RSS Reader as per the features provided by those third party tools.

#### 11.4.21.5 Email

- There are two ways the email message will be constructed a) short-text email with the content

<sup>23</sup> CAP Fire-Fox Plug-In can be downloaded here - <http://code.google.com/p/sahanacap-firefox-addon/>

of the necessary and sufficient CAP elements but not the full CAP message and b) the same short-text email message with the CAP XML file included as an attachment

- The body of the email should be structured in a human readable form

Example of the typical message body

Health Actual Cancel effective for Udubaddawa-MOH!

A low priority notifiable disease incidence issued by Dr. W.G.C.Sampath

Headline: Escalating Chickenpox in Munamaldeniya

Message: nwpdhs-1281593537 from [rtbp-alert-srv@scdmc.lk](mailto:rtbp-alert-srv@scdmc.lk) sent at 2010-08-17 01:08:35 is a Actual, Restricted (RE, MOH, MOIC, PHI, PHM, Other FS) Cancel.

This Moderate category - Health - event is Expected and is Observed.

Description: 1 cases of chickenpox for 06-14 age group(s) and all genders were reported in Munamaldeniya, this alert is cancelled.

Response Type: Monitor

Instruction(s): This is to notify PHI, MO, and MOH of the incidence NO ACTIONS required.

Alert is effective from: 2010-08-12T11:41:00+05.30 and will expire on: 2010-08-20T11:41:00+05.30

For more details use the following sources -

Web: [http://www.scdmc.lk/index.php?mod=msg&act=view\\_recent\\_alerts](http://www.scdmc.lk/index.php?mod=msg&act=view_recent_alerts)  
call: +94372222278

- The subject of the email will <Headline> and <Area> tags concatenated  
Escalating Chickenpox in Munamaldeniya for Udubaddawa-MOH

## 12 APPENDIX C- User reference documents

### 12.1 *mHealthSurvey user manual*

#### 12.1.1 Introduction

The Real-Time Biosurveillance Program (RTBP) is an m-Health pilot project aiming to answer the question: “Can software program that analyze health statistics and mobile phone applications that collect and report health information potentially be effective in the early detection, intervention, and prevention of disease outbreaks?” This pilot aims to study the technology, human, and policy predicaments in introducing the RTBP to Sri Lanka and India.

This document’s objective is to explain how to install and handle the Mobile Application “*Application Name*” to the field healthcare workers.

##### 12.1.1.1 Outline

The healthcare worker (ex.VHN or Suwacevo) has to carry the mobile phone with health application installed, to the villages or health facilities at the time of health visit. They have to fill the health survey form and send the data to the RTBP server through GPRS.

The application has two parts:

- Local setting – Application has provision to store the local setting like healthcare workers profile and their working location. First, the lookup values such as the location types, health worker type, disease, symptom, and sign lists must be downloaded from the server through GPRS.
- Health survey – Healthcare worker has to fill the health survey form and sends data to RTBP server. In case of problem in GPRS or signal, the form will store the data in the mobile (persistence storage). Later after getting the signal, the healthcare worker has to resend the stored data to RTBP server.

##### 12.1.1.2 Features

The “Application Name” has following features, which enables the easy and efficient way of usage to the healthcare workers.

- The User Interface consists of J2ME GUI components like Forms, Buttons, Canvas, Textbox, Text fields, Alert boxes and Lists.
- User has the options to change the settings both locally and remotely.
- Healthcare workers are provided to create, edit and delete their profiles and locations.
- Single phone has the provision to create and access multiple healthcare workers profiles.
- To save time from typing the values through keypad, popup menus are created.
- Compared to WAP portal, this application takes less downloads and very less bandwidth.

## 12.1.2 How to use this Application

### 12.1.2.1 Need to follow

- Before you start survey please check that the mobile has sufficient charge. If not, you have to charge your mobile and then take survey.
- Make sure the signal is available when you start working on “Server connection,” ”Profile,” ”Location.” Without signal, you cannot work on these forms.
- While doing “Download,” do not press the cancel or exit button until you get “Successfully download” message.

### 12.1.2.2 How to open our “Health Survey Form”

There are different ways to open the “M-Health Survey’.

- Opening the application from Memory Card (→ indicate ‘Choose’)  
**Menu → Applications → Memory Card → RTBP → Health Survey**

### 12.1.2.3 Types of forms available in “m-Health Survey”

The “M-Health Survey” has following menus,

- Health Survey
- Offline Survey
- Server Connection
- Profile
- Location

Before start working on the Health survey, do the following steps and its details are given below

- Connect the server
- Set your (Healthcare worker) profile(s)
- Download the location(s) you are (Healthcare worker) working on

## 12.1.3 Server connection

### 12.1.3.1 Server connection Instruction

It is a simple process. Just select the “Server connection” menu from “m-Health Survey”. Now the list will be downloaded automatically and you will get a status message as “Server connected successfully”

### 12.1.3.2 Error and exception on Server connection



Figure 77: Main menu of the application

### ***Network Error! Try after some times***

Generally, this error occurs when you are not having network coverage or GPRS failed. So please try this process once you have proper network coverage.

## **12.1.4 Profile**

### **12.1.4.1 Profile Menu Options**

- Save – **To save the entered data to server**
- Reset – Clear the textbox, display a new form
- Back – return back from the current form

### **12.1.4.2 Profile Instruction**

Here you have to provide your personal details for the registration process. These instructions will help you to fill up the profile page:

**Step 1:** Choose the “Profile” menu from the “m-Health Survey”

**Step 2:** The following fields are available in the profile and mandatory fields are marked with an asterisk (\*). If you leave these fields as blank then it will give you warning message as “***Fill the Required Values (\*)***”.

- ID: (\*) → Here you have to type your Healthcare Worker’s ID.
- Retype ID: (\*) → Here you should retype your Healthcare worker’s ID for confirmation.

If the “ID” and “Retype ID” values are not same, it will give you an error message as “***ID is mismatching***”.

- First Name: (\*) → Type your first name.
- Last Name: → Type your last name, if any. You can type your initial instead.
- Type: (\*) → Here we have three options. i.e VHN, DDHN and Health Inspector from there please choose one option.

To Choose, press the enter key and use down arrow to choose the option and again press the enter key. Now the chosen option will display

Figure 78: Profile registration form

Phone: → Give your contact number. It is not mandatory.

E-Mail: → Enter your email ID. It is also not mandatory.

**Step 3:** Now to “save” your record please press the left side first key, you will get 3 options

- Save – Save the filled data to server
- Reset – If you want to enter a new profile data press this option now all the profile for fields are cleared and you will get a blank application
- Back – If you want to skip from the current application press this option, your application will be skipped and will display the “main form” window.

**Step 4:** After you press “save,” you will be asked, “Allow network access?” You should press the enter key for “yes.” If the network access is available at that time, your details will be saved and it displays a message as “Successfully saved.” Otherwise, you will get an error message as **“Network Error! Try after some time.”** It means your data was not saved. In such case, you have to give your information again, once you get the signal.

### 12.1.5 Error and Exception on Profile

#### *Fill the Required Values (\*)*

Mandatory fields are marked with an asterisk (\*). If you leave those fields as blank, it will give you warning message as **“Fill the Required Values”**. To avoid this error you need to fill all the mandatory fields.

#### *ID is mismatching*

If the “ID” and “Retype ID” values are not same then it gives you an error message as “ID is mismatching”. To avoid this error, you need to give same value for ID and Retype ID fields.

#### *Network Error! Try after some times*

Generally, this error occurs when you are not having network coverage or GPRS failed. So please try this process once you have proper network coverage.

## 12.1.6 Location

### 12.1.6.1 Location Menu options

- Save – To save the entered data to server
- Reset – Clear the textbox, display a new form

### 12.1.6.2 Location Instruction

Figure 79: Location(s) retrieval form

Here you have to fill up your location type and location name To download your villages. Eng location type = “PHI” and location name = “bopitiya-phi”

**Step 1:** Choose the “Location” menu from our “m-Health Survey”

**Step 2:** It has two fields, there are - Location Type and Location Name

**Step 3:** Choose location type from the drop down box.

**Step 4:** Enter the location name

**Step 4:** Press “send” button to send the information to server.

**Step 5:** Now it will ask, “Allow network access?” You should press the enter key for “yes.” If the network is available at that time, your details will be saved and display a message as “Location Successfully Downloaded.” Otherwise, you will get an error message as “Network Error! Try after some times.” In such case, you have to download the location once you get the signal.

### ***Error and Exception on location***

#### **12.1.6.3 No locations found**

If the location type and location name combination is not available in the server then you will get this error.

### ***Fill the Required Values (\*)***

Mandatory fields are marked with an asterisk (\*). If you leave those fields as blank, it will give you warning message as “Fill the Required Values”. To avoid this error you need to fill all the mandatory fields.

### ***Network Error! Try after some times***

Generally, this error occurs when you are not having network coverage. So please try this process once you have proper network coverage.

## **12.1.7 Health Survey**

### **12.1.7.1 Health Survey Menu Option**

Next – This option will be available on the first page of health survey and used to go to the next page.

The image shows a mobile application interface for entering patient records. The form is titled "Enter Patient Record" and contains several fields with labels and values. The "Date" field shows "05:29:00 PM" and "Tue, 15 Sep 2009". The "Location(\*)" field has a dropdown arrow and the value "Vadukapatti". The "Health worker ID" field has a dropdown arrow and the value "Test1". The "Patient First Name(\*)" field has a text input with "Kavitha". The "Patient Last Name" field has a text input with "Ramu". The "Note" field has a text input with "12, West Street". The "Gender(\*)" field has a dropdown arrow and the value "Male". The "AgeGroup(\*)" field has a dropdown arrow and the value "1-5". Below the form, there is a text instruction "Press Next button to go next page" and two buttons labeled "Back" and "Next".

Figure 80: Health Survey Form one (demographics)

Update – Used to save the data to server.

### 12.1.7.2 Health Survey Instruction

Once the process on Profile, Location and server connection has been completed, you can start working on our health survey. The following picture shows our health survey details:

Fields available:

- Date
- Location
- ID
- Patient First Name
- Last Name
- Notes
- Sex (\*)
- Age Group (\*)
- Search Disease
- Disease
- Search Symptoms
- Symptoms (\*)
- Search Signs
- Signs
- Status

Figure 81: Health Survey Form two (Diagnosis)

**Step 1: Date (\*)** - Here it displays the patient symptom reporting date and time to health worker. By default, it is set to current date and time automatically. If you want to edit the field, press the “enter” button to place the cursor on that field and change the value and then press “save” button.

**Step 2: Location (\*)** - Here it will display the list of villages that you have downloaded already using the location form. Here you cannot edit the village name. To choose a village press the enter button and now it will display the options, using up or down arrow place the cursor on an option and again press the enter button. Now the chosen village will be displayed.

**Step 3: ID (\*)** - It displays the healthworker ID automatically here. You cannot edit it but should select the one relevant to you.

**Step 4: Patient’s First Name (\*)** - Enter the Patient’s first name with their initial. This is optional if you need the health record anonymous.

**Step 5: Patient’s Last Name** - Enter the patient’s last name here; this field is not mandatory.

**Step 6: Note** - This can be used to enter additional information about the patient

**Step 7: Gender (\*)** - Select the patient gender from the list. This field is a mandatory field. To choose a Sex press the enter button and now it will display the options, using up or down arrow place the cursor on an option and again press the enter button. Now the chosen Sex will be displayed.

**Step 8: Age Group (\*)** - Select the age group from the drop down list. This field is a mandatory field. To choose an Age Group press the enter button and now it will display the options, using up or down arrow place the cursor on an option and again press the enter button. Now the chosen Age Group will be displayed.

The first page is completed here. To go to the next page please press the option button it will display 'next' button, press that. Now you can see the next page.

**Step 9: Search Disease** - If you enter the first letter of the disease, it will display a list of disease starts with that letter. You can choose any one from this list. If the disease is not available in the list, you can use the "others" option.

**Step 10: Disease** - You will get a result of your search here and please choose the disease from the drop down box. To choose disease we have to use up and down scroll button and place the cursor on an option and then press the enter button, then go to Symptoms option.

- **Others ::** If the disease is not available in the list, you can choose the "others" option from the disease box and enter the disease name in the 'search disease' text box .
- **Unknown ::** If you are not able to diagnosis the disease name of the patient, choose this "unknown" option from the disease list box

**Step 11: Search Symptoms** - When you select a disease, the related symptoms will be displayed here. You can Add, Edit, Delete the symptoms. Each symptom has to be comma separated. If you have not selected a disease from the list, then no symptoms will be displayed here. You have to enter the symptoms.

In this case, when you enter the first letter of the symptom, it will automatically display the list of symptom starts with that letter in the "symptoms dropdown box". You can choose any one from this list. The selected symptom will be displayed in this text box. If the symptom is not available in the list, you can directly type the symptom here.



Figure 82: Search and select symptoms

### 12.1.7.3 Symptoms (\*)

When you enter the first letter of the symptom in the "search symptoms box", it will automatically display the list of symptom starts with that letter. You can choose any one from this list. The selected symptom will appear in the search symptom box. If the symptom is not available in the list, it will not

display any items.

#### 12.1.7.4 Search Signs

When you select a disease, the related signs will be displayed here. You can Add, Edit, Delete the signs. Each sign has to be comma separated. If you have not selected a disease from the list, then no sign will be displayed here. You have to enter the signs.

In this case, when you enter the first letter of the sign, it will automatically display the list of signs starts with that letter in the “signs dropdown box”. You can choose any one from this list. The selected sign will be displayed here. If the sign is not available in the list, you can directly type the sign in this text box.

#### 12.1.7.5 Signs (\*)

When you enter the first letter of the sign in the “search sign box”, it will automatically display the list of sign starts with that letter. You can choose any one from this list. The selected sign will appear in the search sign box. If the sign is not available in the list, it will not display any items.

#### 12.1.7.6 Status

This drop down box has three values such as **Treated, Referred and Unknown**. This field is not a mandatory. To choose a status press the enter button and now it will display the options, using up or down arrow place the cursor on an option and again press the enter button. Now the Chosen status will be displayed. If you do not know the case status, you can select ‘Unknown’ from the list.

Once you have filled the required fields, you can save the data. If there is no signal, the data will be stored in the “Offline Survey” form. While doing survey if you want to go back to the first page from the current page press the option button and use back button.

### 6.3 Error and exception on Health Survey

#### *Fill the Required Values (\*)*

Mandatory fields are marked with an asterisk (\*). If you leave those fields as blank, it will give you warning message as “Fill the Required Values”. To avoid this error you need to fill all the mandatory fields.

#### 12.1.8 Offline Survey

##### 12.1.8.1 Offline Survey Instruction

If you do not have signal when doing survey, the data will be stored here. After getting the signal, just press the “Offline Survey” form. Now the data will send to the server and the offline survey form will be empty.

##### 12.1.8.2 Error and exception on Offline Survey

***Network Error! Try after some times***

Generally, this error occurs when you are not having network coverage. So please try this process once you have proper network coverage.

**12.1.1 Basic Instructions****12.1.1.1 8.1 Need to follow**

- Keep your mobile out of the reach of small children.
- Do not use the options on Security code, PIN code and PUK code.
- Keep the device dry, if your device does get wet, remove the battery, and allow the device to dry completely before replacing it.
- Do not drop, knock or shake the device. Rough handling can break internal circuit boards and fine mechanics.
- Do not use harsh chemicals, cleaning solvents or strong detergents to clean the device.
- Do not store the device in hot and dusty areas.
- If the device is not working properly, report to the team immediately.

**8.2 Install SIM card and battery**

- Always switch the device off and disconnect the charger before removing the battery.
- Don't change the battery. Always use original Nokia batteries.
- The SIM card can be easily damaged by scratches or bending, so be careful when handling, inserting, or removing the card

**12.1.1.2 Charge the battery**

- Check the model of any charger before use with this device. This device is intended for use when supplied with power from the AC-3 or AC-4 charger.
- Do not leave a fully charged battery connected to a charger, since overcharging may shorten its lifetime.
- If the battery is completely discharged, it may take several minutes before the charging indicator appears on the display or before any calls can be made.

**12.1.1.3 Warning**

User only batteries, chargers and enhancements approved by Nokia for use with th  
The use of any other types may invalidate any approval or warranty, and may be dan

- Connect the charger to wall socket
- Connect the lead from the charger to the socket on the bottom of your device



If the battery is completely discharged, it may take a few minutes before the charging indicator appears

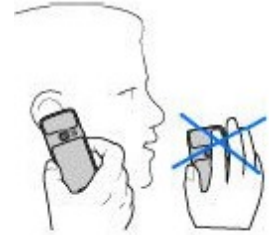
on the display or before any calls can be made.

The charging time depends on the charger used. Charging a BL-5c battery with the AC-3 charger takes approximately 2 hours and 45 minutes while the device is in the standby mode.

#### 12.1.1.4 8.5 Antenna

Your device has an internal antenna.

**Note:** As with any other radio-transmitting device, do not touch the antenna unnecessarily when the device is switched on.



#### 12.1.1.5 Keypad lock

- To prevent accidental key presses, select Menu, and press \* within 3.5 seconds to lock the keypad.
- To unlock the keypad, select Unlock, and press \* within 15 seconds.
- To answer a call when keyguard is on, press the call key. When you end or reject the call, keypad automatically locks.

#### 12.1.1.6 Time and Date

To change the clock type, time, time zone and date setting, select Menu → Settings → Time and Date → Time → Time, Date, Zone or Auto update of Date and Time

#### 12.1.1.7 Your Device – Nokia 3110C

The device may prompt you to set the time and date. Enter the local time, select the time zone of your location in terms of the time difference with respect to Greenwich Mean Time (GMT), and enter the date.

## ***12.2 TCWI user manual***

### **12.2.1 1. Introduction**

This manual is intended as a quick introduction for public health officials and epidemiologists – the end-users of T-Cube Web Interface (TCWI). It is relevant to the specific version of TCWI tailored to the requirements of the Real-Time Biosurveillance Program (RTBP), conducted as a pilot in India and Sri Lanka. The TCWI as well as the underlying data representation and analytic technologies have been developed by the Carnegie Mellon University Auton Lab, in Pittsburgh, Pennsylvania, the United States of America.

TCWI is a front-end for the public health databases collected through RTBP. It allows for visualization, statistical analysis and navigation through data. It uses modern computer science, statistics and machine learning technologies to support public health analysts and epidemiologists in their daily duties, including monitoring for disease outbreaks, outbreak investigations, and reporting.

The underlying technology provides the users of TCWI with unique abilities to very quickly navigate through and mathematically analyze large amounts of data even if it spans highly multidimensional spaces of multiple diseases, locations, symptoms, syndromes, and demographic factors. The users of TCWI benefit from it by becoming able to concurrently monitor many more hypotheses about the status of public health much more thoroughly than it was possible before. The data can be comprehensively mined for statistically significant increases of counts of specific subpopulations reporting specific symptoms, with respect to baselines inferred from historical trends. The results of such automated massive screenings are presented to the users in a form of the list sorted according to their statistical significance. The users can then navigate through the list and easily drill-down into details of the corresponding data for additional hints and explanations. A skilled operator can use TCWI to support maintenance of high levels of awareness of current epidemiological situation and of ongoing processes that affect monitored populations, enabling fast and reliable identification of emerging problems and creating opportunities for implementing focused and effective responses to crises.

The following sections briefly review the essential functionality provided by TCWI. The ideal user of TCWI should be fundamentally computer literate and be familiar with fundamental methods of analysis of public health data and with the objectives of such analyses.

While RTBP would provide their respective users with a web link (URL), other first-time users may access a demonstration version of the TCWI available on the Auton Lab site (<http://www.autonlab.org/T-Cube/>) for the purpose of hands-on experimentation with the features and functions described in this manual.

**Real Time Biosurveillance Program**  
with T-Cube Timeseries Analysis and Visualization from Carnegie Mellon University, Auton Lab

[Home](#) [Tutorial](#) [Data Analysis](#) [Feedback](#) [Contact](#)

**Welcome to the T-Cube Web Interface**

Please do not click on the Back/Forward/Refresh buttons during using this interface.

File loading completed successfully.

**Time Series** | Maps | Pivot Tables | Poor Performers

▼ **File Upload/Clear Panel - Click to show/hide.**

Select the file you want to upload (type: .csv, .fds). Specify the date attribute and, optionally, the count attribute.  
The attribute names should not contain spaces. No '.' or '(' or ')' characters should be there for the attributes or their values.

Date: 
 Count: 
 Location:

Figure 83: Front panel of the T-Cube Web Interface.

Figure 83 shows the starting panel of the TCWI with the project header and tabs for panels containing specific analytic components: **Time Series**, **Maps**, and **Pivot Tables** (note: tab labeled “Poor Performers” is irrelevant to the RTBP project). Each analytic component is described in a separate section of this manual: Time Series Analysis, Maps (Spatio-Temporal Analysis), and Pivot Tables, respectively.

Immediately below the header, there are links for specific sections of the TCWI. Figure 83 shows the **Data Analysis** section of the interface. In this manual, we will focus on the data analysis section. The **Feedback** section can be used to send direct feedback to the TCWI developers. The **Tutorial** section points to an older version of this manual and it will be updated soon. For now, please refer to this document as the current reference manual.

## 12.2.2 Time Series Analysis

Time series analysis component of TCWI supports both univariate (Analysis Panel) and multivariate temporal analysis (Massive Screening Panel). Each of the five panels under Time Series Analysis is described below.

### 12.2.2.1 2.1 File Upload/Clear Panel

This panel allows the users to select data for analysis. The data can be either loaded from disk on the local machine (advanced usage) or it can be preloaded on the server (typical usage).

### 12.2.2.2 Using Pre-loaded Data (Typical Usage)

To use a pre-loaded data, just click on the **Choose Data File** to expand a drop-down list of available data files and pick one for analysis. This tutorial uses **lk\_flat\_table** data as an example (at the moment of writing this revision of the manual we did not have access to an equivalent set from India, but the functionality of TCWI will be identical when used on data collected in India). This data contains a total of 69,000 reportable disease cases from multiple regions in the country of Sri Lanka collected starting

December 16, 2006 and ending on July 10, 2009. It spans the following fields: **loc\_name**, **age\_grp**, **disease**, **gender**, **sign**, and **symptom**. Note that the original data contained weekly aggregates for each combination of **loc\_name** and **disease**. We have semi-synthetically converted this data into daily resolution with more demographic attributes to match the scheme and level of detail of data being currently collected in through the RTBP project.

### 12.2.3 Loading External Data (Advanced Usage)

The users of TCWI can load their own data instead of using the pre-loaded data sets. This mode of usage is not expected or considered typical in the context of the RTBP project, since the relevant data will be prepared for use and frequently updated through automatic processes set up by the maintainers of the system. We explain it here for the sake of completeness.

TCWI accepts external files in the comma-separated values (csv) format. The first line of it contains names of the data dimensions. The subsequent lines contain the actual data, each record denoting either an individual disease case (in the purely transactional format of data), or it represent a cumulative count of disease cases matching the specific combination of values of dimensions represented in the record (the cumulative count format of data). A top fragment of an example of a TCWI-compatible file in the cumulative count format is shown below. It has four dimensions named *date*, *lk\_city*, *disease*, and *count*. Each record reveals the number (*count*) of specific reportable *disease* cases reported in Sri Lanka region labeled with its main city (*lk\_city*) on a given day (*date*). If the count dimension is not available, TCWI data loader will assume that each record represent a single case (that is that its count value equals 1), and so that the data is provided in the purely transactional format.

```
date,lk_city,disease,count
DEC-16-2006,Colombo,Dengue_fever,7
DEC-16-2006,Colombo,Dysentery,1
DEC-16-2006,Kandy,Dengue_fever,1
DEC-16-2006,Kandy,Dysentery,2
DEC-16-2006,Matale,Viral_Hepatitis,1
DEC-16-2006,Nuwara_Eliya,Viral_Hepatitis,1
DEC-16-2006,Galle,Dengue_fever,1
DEC-16-2006,Hambantota,Typhus_fever,1
DEC-16-2006,Matara,Dengue_fever,3
DEC-16-2006,Matara,Leptospirosis,1
DEC-16-2006,Vavuniya,Dengue_fever,1
DEC-16-2006,Kurunegala,Dengue_fever,2
DEC-16-2006,Kurunegala,Typhus_fever,1
DEC-16-2006,Puttalam,Encephalitis,1
```

To load an external data set, use the **Browse** button (cf. Figure 83) to interactively select the file to load from the disk on the local machine. Once the location of the file is specified (for instance, C:/mydata/myfile.csv), the user needs to identify which of its dimensions represents the date dimension and enter its name in the field next to **Date** (in the above example, the user would have entered “date”). Similarly, if the individual records of data represent multiple counts (as in the example above), the user needs to provide the name of the count dimension by entering it in the field next to **Count** (that field is named “count” in the above example). Purely transactional data, in which each record represents a single unique event, does not require the count dimension and therefore the **Count** entry field can be

left empty.

If the data contains a spatial dimension (in the example above, the spatial column was *lk\_city*), then the user must specify the type of map to be loaded using **Location** drop-down list.

Once all required information for loading external data is specified, click on the **Load Data** button to load data into TCWI. Depending on the current workload of the TCWI server and the complexity and size of the dataset being loaded, this operation may take some time and patience is advised. The investment in waiting time will be returned many times by the resulting speed of responses to user and algorithm queries against the loaded data.

It is not a requirement, but a good habit, to clear computer memory of data that is no longer in use, before loading a new data set. To accomplish that click on **Clear Data** button at any time, and then proceed to loading new data as needed.

Note that TCWI expects the external data to meet the above described format requirements (specifically, all dimensions should be categorical, except for the count and date dimensions), and it should not contain any missing values. The interface will signal an alert if an attempt is made to load an incompatible data set.

### 12.3 Query Selection Panel

Query selection panel incorporates drill-down functionality to filter data by selecting subsets of values of individual dimensions. It also enables interactive visualization of multiple time series. Below we briefly introduce two basic modes of its operation. This description is not comprehensive, but the functions not addressed here are intuitive and accessible via obvious user interactions.

#### 12.3.1.1 Filtering Data by Selecting Subsets of Values of Individual Dimensions

Figure 84 shows an example view of the query selection panel involving the kind of data typically used within the RTBP project. Using value filtering, the user can select a subset of values for each dimension of data, and the corresponding time series labeled as **Current Query** will be automatically updated in the time series analysis window, as shown in Figure 87. For convenience, TCWI automatically visualizes the time series resulting from the all-inclusive query called **All Data**. It reveals the temporal distribution (by day) of all disease case records stored in the currently loaded data. Any other, more specific query, will result in a subset of **All Data**.

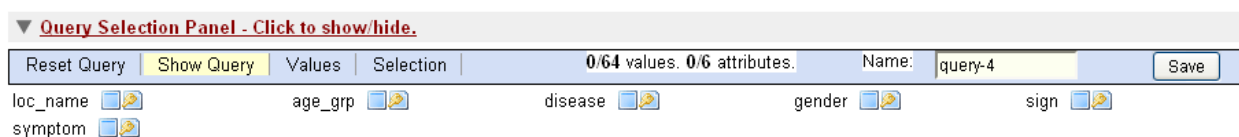


Figure 84: Starting view of the Query Selection Panel.

There are two modes in which the user can select the subsets of values of individual dimensions: **list view** and **tile view**, accessible by clicking on one of the small icons next to each dimension name

(Figure 84). In the **list view** (see Figure 86) the values of the selected dimensions are presented in the checklist form and the user can select any subset of values. **Tile view** mode (Figure 85) offers more extensive view, in which the users can filter for specific values using regular expressions.

Figure 85: List view of the Query Selection Panel.

Figuer 86: Tile view of Query Selection Panel.

Each time the user updates their choices in the query selection panel, the TCWI extracts the daily counts of disease cases corresponding to the user-selected set of values, and the resulting time series is shown in the visualization window under the name of **Current Query**. The user can optionally save the time series corresponding to the current query by giving it a unique name by entering it in the **Name** text box. The time series visualization window will then add it under the new name to the list of available series. For example, in Figure 87, the *red* time series corresponds to temporal distribution of counts of *Dengue fever* cases in *Colombo* and is named “colombo-dengue”. It was obtained by manually selecting Colombo and Dengue\_fever values of the *loc\_name* and *disease* dimensions through the query selection panel. Similarly, the *green* time series corresponds to the total number of patients in all regions and diseases. The user has named this series “all-values”. The **Current Query**, shown in *blue*, represents in this example the daily number of Dengue fever cases collected across all data – this matches the current selection of values and dimensions in the query selection panel.

Note that in the case of the *lk\_flat\_table* dataset, the dimensions named *sign* and *symptom* are available to the user in a composite form. Each disease case can be associated with multiple signs and symptoms, and therefore each individual value of a sign as well as symptom variable is represented internally as a separate binary dimension. In order to avoid cluttering the TCWI panel with multiple

binary dimensions of data, it collapses their groups together. When the user selects one value of such a dimension for their query, all records for which that value is present will be reflected in the result. If the user selects two distinct values of e.g. *symptom* the response to such query would include all records mentioning both of the two symptoms. This is different than in the case of regular (not composite) dimensions, where selecting two values leads to concatenating the records of data which match either of the selected values, so that the resultant is a sum of the two subsets matching the individual values. On the other hand, two or more values selected out of a composite attribute on the other hand would produce the joint part (the product) of the individual value matching subsets – only records matching both of them will be reported. Currently, only *sign* and *symptom* are represented in the composite form. Future release of TCWI will allow the users to select one of the two types of representations for each qualifying attribute.

### 12.3.2 Visualization of Time Series

Figure 87 shows the Time Series Analysis panel used for visualization. It shows a couple of time series previously queried for, extracted, and named by the user. Their display status can be toggled on-and-off using the check boxes next to their names in the legend to the left of the graph.

The horizontal axis of the main time series visualization window denotes time at a daily resolution, arranged from the oldest (left) to the newest entries (right). The vertical axis is primarily used to reference the values of the daily counts corresponding to the displayed time series. Its secondary purpose is to reference the magnitude of alerts generated by the statistical algorithms for event detection, discussed later. The scale for daily counts is shown at the left side of the main time series window, while the scale for alerts is on the right. The scaling of counts axis can be controlled via the **Scaling** dropdown menu. The scale of the magnitude of alert signal can be toggled between linear and logarithmic display (note that no alert signal time series are shown in Figure 87, this functionality will be explained later).

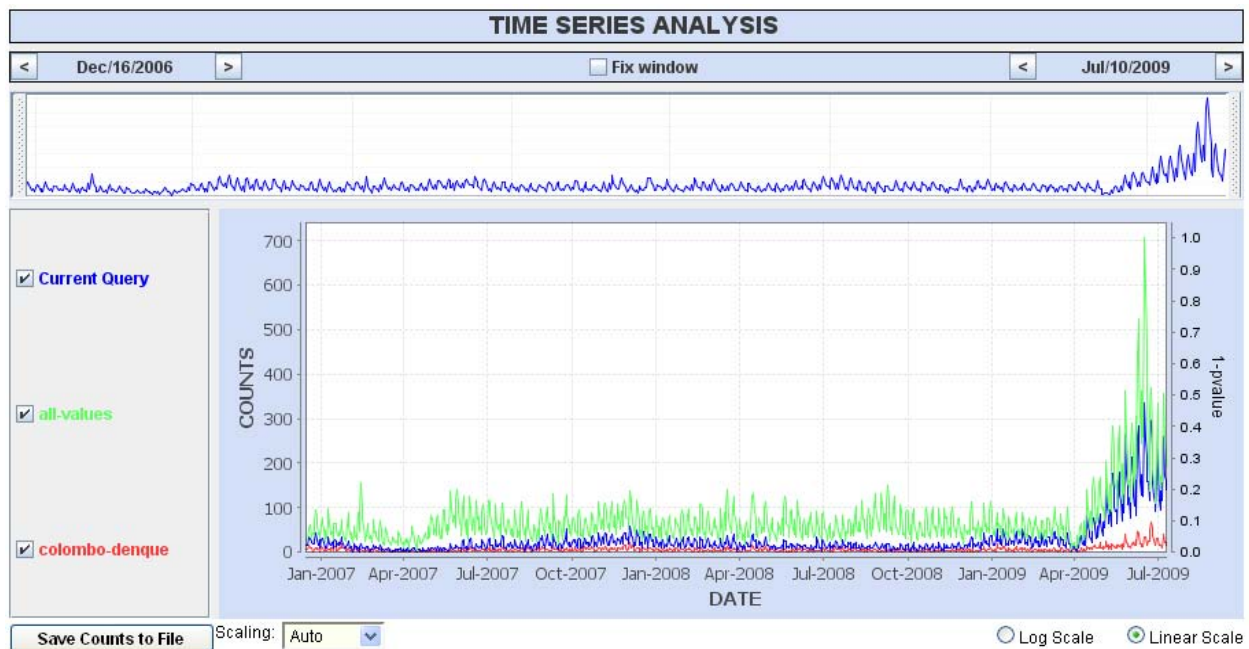


Figure 87: Visualization of time series.

The user can change the temporal range of time series currently being viewed in the main window by either changing the dates on the top of the window (Dec/16/2006 and Jul/10/2009 in Figure 87), or by dragging with the mouse the bars right below the dates. The upper smaller time series window always displays the full temporal range of the cumulative daily counts of all records in the current data. The movable bars in it depict the current selection of the temporal field of view of data being displayed in the main window. The users can fix the current width of the temporal field of view by checking the **Fix window** box. When it is checked, the field of view can be dragged left and right by dragging the right bar with the mouse.

The users can save the time series currently in the field of view to a local csv (comma-separated-values) file using **Save Counts to File** button. Saved files can then be further processed by external software. An upcoming revision of TCWI will enable the users to look up the raw data and save its subset corresponding to a query to a disk file. It will allow performing follow-up analyses outside of TCWI.

The appearance of the individual time series plots can be adjusted by mouse-clicking on their respective names in the legend. The users can change the color, thickness, type, and stroke of each plot (Figure 88).

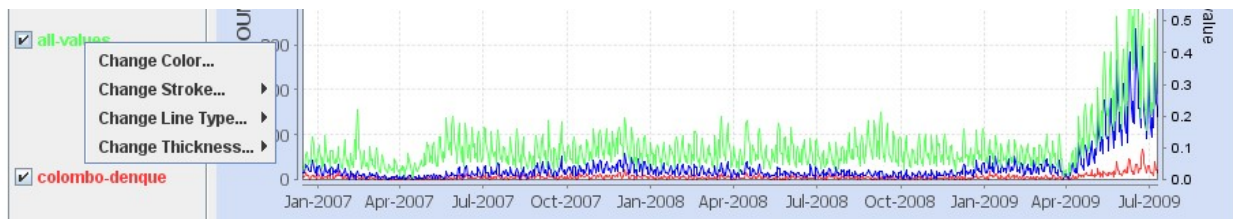


Figure 88: Changing the appearance of the time series plots.

## 12.4 Analysis Panel

This panel provides an interface with a number of the univariate statistical analysis algorithms that can be applied to any of the currently visualized time series. The currently implemented analytic algorithms are briefly explained in the following subsections.

The **Analysis Panel** can be activated by selecting one of the time series listed by name in a small window under the **Select Target** heading (Figure 89). The panel implements a dialog allowing the users to:

- Select the time series for analysis (from the list under **Select Target** header),
- Select the method of analysis (**Choose Method**),
- Set parameters of the analysis (the set of parameters is specific to each particular algorithm),
- Indicate whether the result should be stored separately, or the analysis is just an update of prior result (**Create new** vs. **Update**),
- Assign or reassign a name to the result of the analysis (**Series name**),
- Select the option to automatically update the result upon a change to the target time series (**Auto update on target change**).

The Analysis Panel also allows the users to remove the selected time series from the list of currently considered and visualized series by using the **Delete Series** button, or to change its name (**Rename** button and text entry window). Note that the **Current Query** and **All Data** series cannot be deleted or renamed.

▼ **Analysis Panel - Click to show/hide.**

Select Target:

- Current Query
- all-values
- colombo-dengue

Delete This Series

Create New Update

---

Choose Method: Moving Average

Series name: ma-1 Target: colombo-dengue ☐ Auto update on target change

Window size: 7 Estimation type: Retrospective(Default)

Submit

Figure 89: Analysis Panel

### 12.4.1 Time Series Modeling and Forecasting Functions

TCWI currently implements a small set of select univariate forecasting functions. They are useful in smoothing noisy data, and in predicting the counts of disease that should be observed on a given day using historical data. A forecast can be useful under assumption that the modeled processes are predictable and that the selected forecasting algorithm can capture their dynamics. In health surveillance applications, forecasting functions are often used to compute baselines for detection of statistically significant discrepancies between the predicted and actually observed counts of disease cases.

#### 12.4.1.1 Moving Average

Moving average is a simple and popular method of smoothing “bumpy” time series. Given e.g. a time series of daily counts of disease cases selected for smoothing, for a search time step (each day in our case) the moving average algorithm computes the average daily count over the past few days (excluding “today”). The extent of smoothing can be controlled by choosing the number of days to average over (**Window size**). Note that in most practical applications related to public health it is advisable to select window sizes among multipliers of 7 days. That accounts for typically strong day-of-the week effects present in data.

The **Window size** is the only parameter of the basic moving average algorithm. The basic algorithm is offered as default among other variants and named **Retrospective (Default)** in the **Estimation type** pull-down menu.

Alternatively, the moving averages can be computed for each day using only data observed on the same weekdays from the past (that is, if the analysis is performed for a Tuesday, only data from Tuesdays in the past will be considered in computing the forecast for this Tuesday). That can be accomplished by selecting **Moving Average (day of week)** from the **Estimation type** list. In this context, the **Window size** parameter still determines of how many such days from the past should be taken into consideration in computing the daily moving average estimates. This algorithm is often useful in practice to model longer-than-a-weeklong trends in data that is subjected to a strong day-of-the-week bias.

#### 12.4.1.2 Regression

The forecast produced using the day of week algorithm explained above can be correct if the modeled time series is stationary (that is, if its daily counts distribution does not change over time, except due to random fluctuations). Running the moving average algorithm using **Regression (day\_of\_week)** estimation type allows to account for linear non-stationarities (trends) in data. For each day, it takes the daily counts from the number of past identical weekdays (specified under **Window size**), fits a linear regression model to this data, and sets the today's value of the resulting time series to the value predicted from that model. Running the moving average algorithm using **Regression (day\_of\_week, last\_week\_mean)** extends that approach to take into account the mean count of the last week of data as a separate covariate in the linear model.

Note that both moving average and regression-based algorithms can be used to forecast expected counts of disease cases pertinent to time series selected by the users for monitoring. In turn, these forecasts can be compared against the currently observed actual volumes of disease cases to verify if they may be significantly excessive with respect to expectations, and therefore indicative of a potential disease outbreak. The extent of discrepancy between the actual and forecast daily counts can be easily computed using time series arithmetic operations (Section 2.3.2) by subtracting the original target time series from the time series resulting from application of one of the moving average algorithms.

#### 12.4.1.3 Moving Sum

Moving Sum algorithm is analogous to the above-described moving average, except that daily counts selected for consideration are simply added together instead of being averaged.

#### 12.4.1.4 Linear Trend

Linear trend method fits a linear regression model to the target time series. Users can optionally use day of week feature to compute a set of seven models, each independently dealing with data from one day of the week. The users can also de-trend their time series by computing the linear trend and subtracting it from the target time series. A de-trended time series is then created and it can be used in further processing.

#### 12.4.1.5 Arithmetic Operations

The users can perform fundamental arithmetic operations (add, multiply, divide, and subtract) on any two target time series. The result becomes a new time series added to the Time Series Analysis panel. An example use scenario of this functionality is to compare results of a forecast against the true data. To experiment with that, create a forecast time series using moving average function with an estimation type of your choice. Then, apply **Subtract** operator selecting the forecast series as the **Target** (this can be accomplished by clicking on the forecast time series name on the list under **Select Target** header), and choose the original time series for which you have computed the forecast as **Target 2**. Hitting the **Submit** button will produce a time series of the daily forecast errors.

## 12.4.2 Temporal Anomaly Detection Functions

### 12.4.2.1 Temporal Scan

Temporal scan is a bi-variate algorithm for detecting anomalies in time series. It therefore requires the users to specify two time series as inputs: the **target** and the **baseline**. It is sensitive to statistically significant changes in counts of target time series that cannot be statistically explained by the corresponding changes in the baseline.

Fundamental procedure of the temporal scan algorithm executed for one period (day) of analysis aggregates four sets of counts. One set is the sum of target time series counts observed during the period identified as current (user-selectable **Temporal scan window size**). The other set is the sum of target counts corresponding to the period of reference. The remaining two aggregates are the identical counterparts computed for the baseline time series. The results of aggregation can be put in a 2-by-2 contingency table such as the one shown in Table 1.

*Table 77: Example of a contingency table obtained for a single test in the Temporal Scan.*

<i>Counts</i>	Current	Reference
Target	23	847
Baseline	95	11,550

Table 1 shows example results of aggregation of target and baseline counts for one day of analysis. Looking at the proportion of target and baseline counts observed during the period of reference, and comparing it to the same proportion observed currently, one can notice that currently it is substantially elevated. TCWI uses Fisher's exact test of significance to quantify the extent of surprise in the observed increase. The result is a p-value – an estimate of the probability that the observed counts can be a result of a random fluctuation of data. The lower the p-value, the slimmer the chance for the observed elevated current counts to be just accidental. The p-value computed for data in Table 1 is close to  $8 \times 10^{-8}$ , a very small number indicating that the observed increase is highly significant and very hardly explainable as an effect of the random chance.

Temporal scan algorithm executes the above-prescribed procedure independently for all days in the scope of analysis. The interface offers a few different methods of computing the reference counts (selectable from the **Estimation type** pull down list). Most **Estimation type** options have been introduced above in Section 2.3.1 in the context of forecasting functions. The **Retrospective (Default)** method uses all the data outside the “Current” period as “Reference”. The **Prospective** method aggregates as reference the counts over the number of days, specified in the **Estimation window size** dialog, that immediately precede the current window (excluding the current window). Forecasting-like estimation types explained in Section 2.3.1 are also allowed as the methods of reference counts estimation in temporal scan. In addition, the **Univariate** variant does not require separate time series to be designated baseline. Instead, temporal scan uses the global average of target series counts as the outside counts of reference, turning the algorithm into a univariate anomaly detector. It may become handy when the baseline events are rare, their frequency not exceeding the counts of the target series, and the attainable reference information may therefore be rendered unreliable.

The users can execute temporal scan aiming at any kind of departure from expected, or strictly constrain the detector to alert for either increased or decreased counts. That is controlled with the **Scan option** through which the users specify whether to use a **Two-sided** test (detects all discrepancies, without differentiating between increases and decreases of activity), or **Upper tail** (focuses on monitoring for increased activity), or **Lower tail** (targets decreases in activity).

Users can also define the threshold of sensitivity of the alerting procedure. It is set to 0.05 by default, but it can be manually adjusted. The days for which the p-value obtained from temporal scan procedure was lower than that threshold are considered days of alert. The users can also apply False-Discovery-Rate (FDR) algorithm to automatically adjust the sensitivity threshold, guarding against the multiple hypothesis effects. The FDR-selected thresholds are usually more conservative than the manually selected ones, leading to fewer alerts being raised. Note that FDR does not affect the individual p-values computed using the Fisher's test. It only selects an alternative threshold to pick potentially fewer of results from the top of the ranked list of sorted from the most to the least statistically unusual.

Figure 90 shows the results of executing the temporal scan algorithm using the familiar *colombo-dengue* as the **target** and *all-values* as the **baseline** time series. We expect it to produce low p-values on days when temporal changes in the number of dengue fever cases reported in Colombo region could not be explained by similar fluctuations in all kinds of disease activity recorded across the country of Sri Lanka (other scenarios may involve comparing Colombo cases of dengue against the counts of all other reportable diseases recorded in Colombo, or the Colombo dengue activity against the temporal distribution of country-wide aggregates of dengue cases).

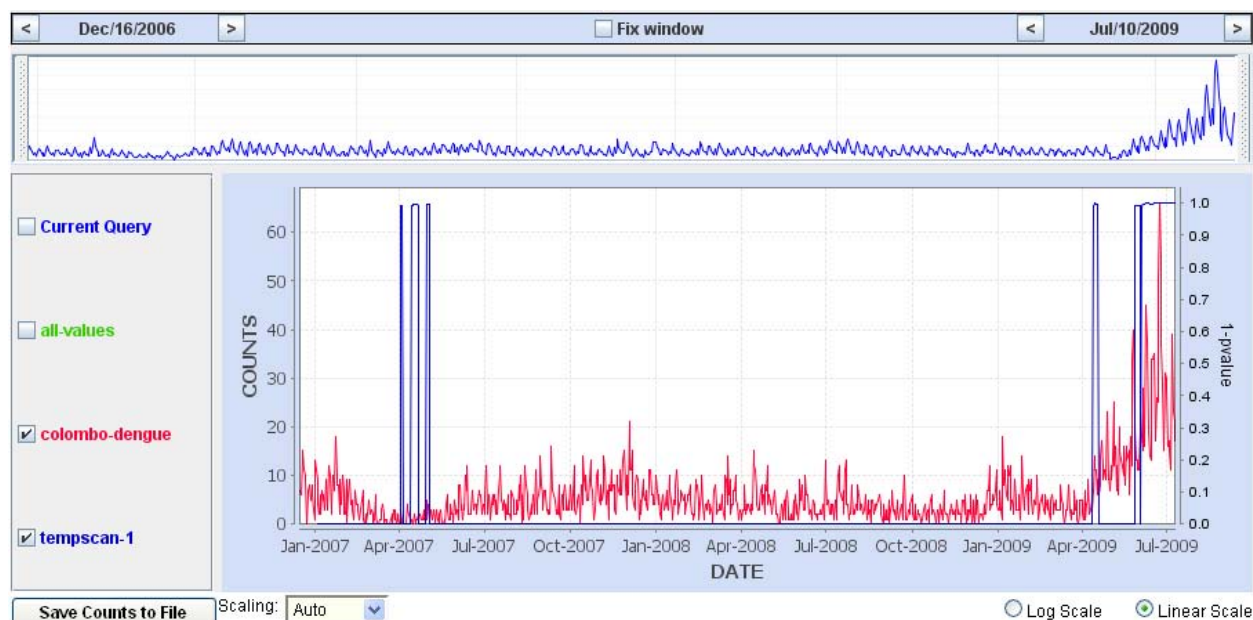


Figure 90: Example result of executing temporal scan on Colombo dengue fever data.

The result of executing temporal scan is a time series of p-values. After completion of the computations, this time series is automatically visualized in the time series visualization window. The plot depicts complement of p-values ( $=1.0 - \text{p-value}$ ) for all days on which the resulting p-value was lower than either the user-selected or, when activated, the FDR-based sensitivity threshold. In Figure

89, days like that are marked with blue spikes, and there is no signal shown on days when the p-values were greater or equal to the threshold. It is often convenient to toggle the display of the p-values to the logarithmic scale to see more minute differences between the individual alerts.

Here are a few recommendations for setting temporal scan parameters. Temporal scan window size should be set to a multiplier of 7 days to remove weekly trends from data. Until substantial amounts of historical data is collected, we recommend using Prospective estimation type with estimation window size set to 35 days (5 weeks) and temporal scan window size set to 7 days. Longer scan windows enable detection of slower growing or generally longer-term problems. Longer estimation window sizes lead to taking into account more historical data when making forecasts. That will be a desirable strategy when the data collection process and therefore the data quality have stabilized. To reduce the false positive rate, always apply FDR correction. Given that the most common use of TCWI analytics would involve detecting unusual increases in disease case counts, we recommend performing primarily the upper tail tests. The lower tail tests would detect unusual decreases in certain disease counts. That may be useful in monitoring effects of responses to public health threats or in evaluating effects of longer-term policy changes. . Also, use the last day scan option to find alerts related specifically to the latest date in the data.

#### 12.4.2.2 CUSUM

CUSUM (Cumulative Sum) control chart is a popular method for monitoring temporal processes primarily for changes in level. It is robust against short-term and presumably random fluctuations. It is being widely used in the practice of disease surveillance. TCWI implements the basic uni-variate CUSUM algorithm. For each consecutive time step, it computes the excess of target time series counts over the expectation. The expectation is computed over the number of past days specified using **Cusum Period (in days)** dialog, as a sum of the mean counts over that period. If the counts observed today exceed the sum of mean and  $K$  standard deviations ( $K$  is the tolerance multiplier setting specified by the user), the cumulative sum is incremented with the value of the observed difference and the algorithm moves to processing the data from the next time step. Initially, the cumulative sum is set to zero. Whenever the cumulative sum exceeds a user-selected threshold,  $H$  standard deviations, and whenever the sum goes below zero, it is set back to zero, and the accumulation process starts over at the next time step. As a result, TCWI currently produces and displays a time series of the cumulative sum. The upcoming version of software will also produce a time series of alerts marking the days when the cumulative sum exceeded the running threshold. The optimal settings of the CUSUM algorithm parameters depend on the amount of variance in data and of desired sensitivity. Greater values of the tolerance multiplier and threshold lead to fewer alerts and therefore to detecting only more spectacular changes in the level of counts of disease. Selecting longer periods of aggregation (via estimation window parameter) typically leads to more stable estimates of variance used to determine the running threshold and tolerance, but that may also lead to undesirable suppression of sensitivity of CUSUM to temporally local fluctuations of variance in data. It is advisable to experiment with a few different sets of parameter values to empirically determine the most suitable set point.

#### 12.4.2.3 Change Scan

The Change Scan method is similar to temporal scan in that it uses the 2-by-2 contingency to

accumulate counts of disease cases and to evaluate statistical significance of the observed departures from the expected. The main difference is that Change Scan compares counts observed before and after the day of analysis, while temporal scan focuses on counts “inside” and “outside” the current period of analysis. Therefore, the change scan is well suited for detecting days of change of the level of the monitored time series, similarly to CUSUM algorithm. However, unlike CUSUM, Change Scan is bi-variate – it allows using baseline time series as the reference of comparison against the monitored target. It also allows for estimating reference counts in various ways, accessible through the **Estimation type** selector, and it can be set to focus on detecting either positive or negative changes, or both kinds of them, analogically to temporal scan.

#### 12.4.2.4 Peak Analysis and Range Analysis

Peak analysis method can be used to explain peaks observed in the target time series. User specifies the peak date and the algorithm screens the data for dimensions and their specific values, which jointly contribute to at least 90% of the counts observed in the peak. It is often useful in explaining characteristics of data that might correspond to a disease outbreak.

Range Analysis performs similar computations, but with respect to a range of consecutive dates, instead of a single “peak” day.

#### 12.4.2.5 Massive Screening Panel

The above-described forecasting and anomaly detection methods are useful and applicable when the users know a priori which specific time series queries are of interest. This includes the above examples of monitoring of dengue cases in Colombo. However, when dealing multidimensional data, the number of possible unique projections of it onto subsets of dimensions and subsets of their values (and therefore the number of the extractable time series), can be very large. Analyzing them one-by-one in a sequence could become a quite tedious task.

Massive screening approach applies to exactly such scenarios in which the analysts need to concurrently monitor multiple time series. It exhaustively checks all individual time series resulting from conjunctive queries fitting in the user-selectable scope of search, and reports the findings in the form of a list of time series sorted according to the statistical significance of temporal anomalies found in them. The elements of the resulting list are clickable links to results visualized in the Time Series Analysis window. The suggested usage pattern is to first execute a massive screening of the desired subset of data, and then to inspect results starting from the most statistically surprising, one-by-one, possibly drilling down the data for further explanations using interactive visualization capabilities of the Query Selection Panel, or the explanatory analysis functionality such as Peak or Range Analysis functions described above.

Massive screening provides the analysts with the ability of comprehensive monitoring of multidimensional data without having to make many assumptions regarding the expected impact of anticipated disease outbreaks. It allows for bringing their attention to specific patterns in data such as subpopulations of patients who appear in recent data at unusually high frequencies, which might

otherwise go unnoticed.

Implementation of massive screening in TCWI uses the previously described methods of temporal scan and change analysis as the core anomaly detection methods.

The users select **Start Date** and **End Date** parameters to specify the period of analysis, and **Scan window sizes** to specify temporal granularity of the “Current” windows in the scan. **Pvalue threshold** parameter is used to decide what level of statistical discrepancy warrants an issuance of the alert. The higher the p-value threshold, the higher the sensitivity of event detection procedures, and the more alerts would be generated. The lower the p-value threshold, the more conservative filtering of the results, and the fewer the alerts. **Estimation type** selector allows the users to define the method of estimating “Reference” counts in the 2-by-2 contingency table used to determine p-values. **Scan Option** allows the users to select the type of the significance test (two-sided vs. one-sided upper- or lower-tail). **Last Day Only** flag is used to complete the analysis only for the selected **End date**. This can be used for prospective surveillance when the users are only concerned if there are any alerts today. Current implementation of the massive screening algorithm allows the users to pick up to three dimensions and any subsets of their values for screening. The algorithm will try every query within the scope of this selection, derived as a conjunction of individual values taken from one, two, or three dimensions (if the users selected three attributes for screening).

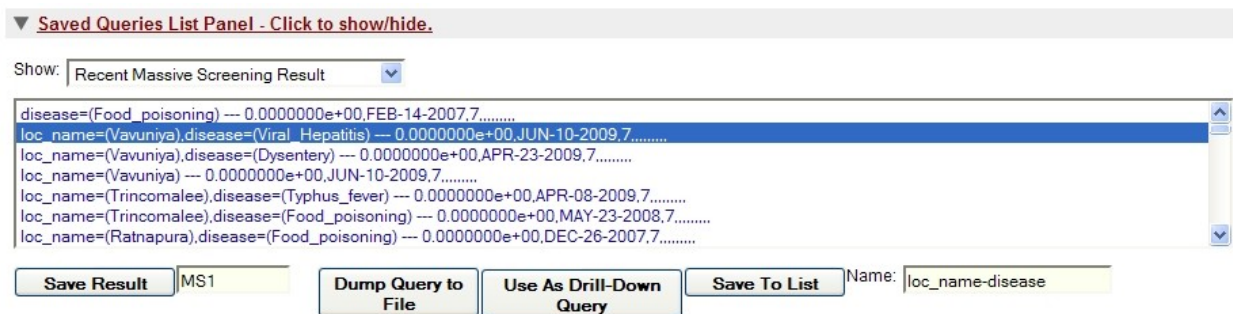


Figure 91: Saved Queries List Panel

There are a few additional parameters that could be applied to control massive screening algorithm, but they are not fully applicable to the current shape and contents of the RTBP datasets. We will keep monitoring their utility as more data becomes available and either include full description in the next revision of this manual, or eliminate the corresponding functionality from TCWI.

Figure 90 shows the result of running temporal scan using default parameter values, except for the **Scan option** set to **Upper tail**, and selecting “loc\_name” and “disease” as dimensions for analysis. The list appears under **Saved Queries List Panel** described below. The top alert is for disease “Food\_poisoning” on February 14, 2007. The p-value of the Fisher’s exact test conducted for that day was lesser than the numeric precision of the computer representation. Equally extremely significant score was associated with a few more results shown on the top of the list.

The second result shows an alert about Viral\_hepatitis in Vavuniya that would have been issued on June 10 2009. Clicking on it brings up the corresponding data to the time series visualization panel.

Figure 91 shows the screenshot presenting that result as well as the complete set of parameters used to arrive at it. The time series legend has been expanded by adding three items: **MS Baseline** is the temporal distribution of the data corresponding to query used as the baseline in the temporal scan procedure (in this example, we chose **All Data** to serve as the baseline, but the users can select any other baseline query to use in massive screening). The **Result Query** depicts time series of the target that is counts of viral hepatitis cases reported in Vavuniya. The 7-day long temporal scan window corresponding to the alert of June 10 is highlighted with yellow background. Zooming in onto the period of interest, we can see the results in more detail (Figure 92). We can see the number of the hepatitis cases ramping up significantly in early June.



Figure 92: Inspecting one result of the massive screening with temporal scan.

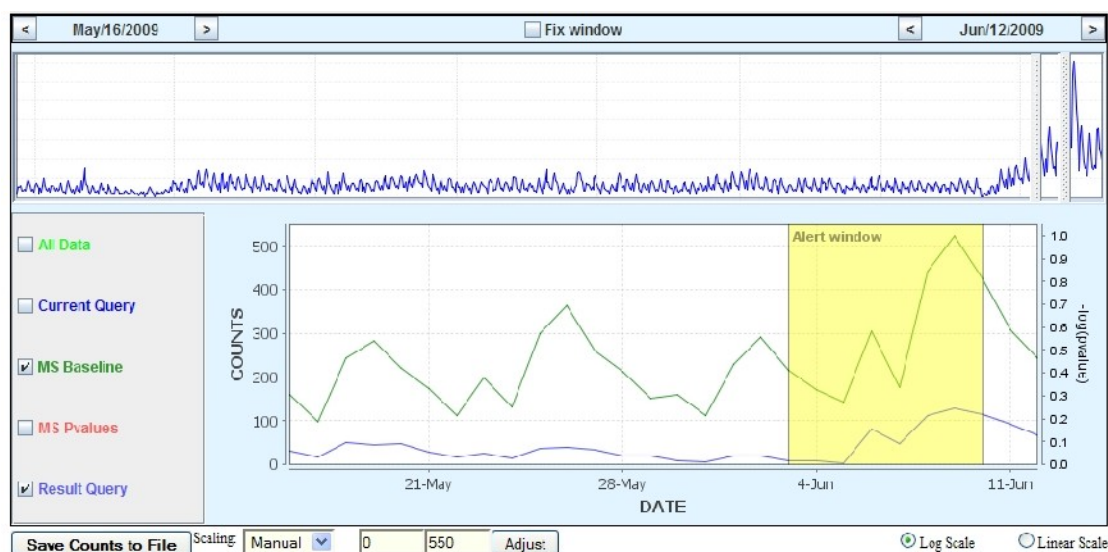


Figure 93: Zooming in on the results from Figure 10.

### 12.4.3 Saved Queries List Panel

This panel allows manipulation of the results generated by massive screening. **Save To List** button saves the results for future retrieval with a specified name. **Save Query** button saves the query as a .csv file on a local disk. **Use As Drill-Down Query** button allows to stage the next run of massive screening within the scope of data corresponding to the specific item on the finding list. If we do that with our hepatitis in Vavuniya finding, the **Use Drill-Down Query** selector in the Massive Screening Panel will be automatically populated with the query corresponding to our finding. Now, let us unselect the disease and loc\_name dimensions from the massive screening list, and instead select age\_grp and hit the **Run Screening** button again. Now, the algorithm will screen through all age groups of reported hepatitis cases from Vavuniya and sort them by the most statistically significant increase in the corresponding patient counts. Figure 94 shows the time series of patients over 45 years old, which happens to be the age group most significantly affected in this outbreak of viral hepatitis in Vavuniya region.

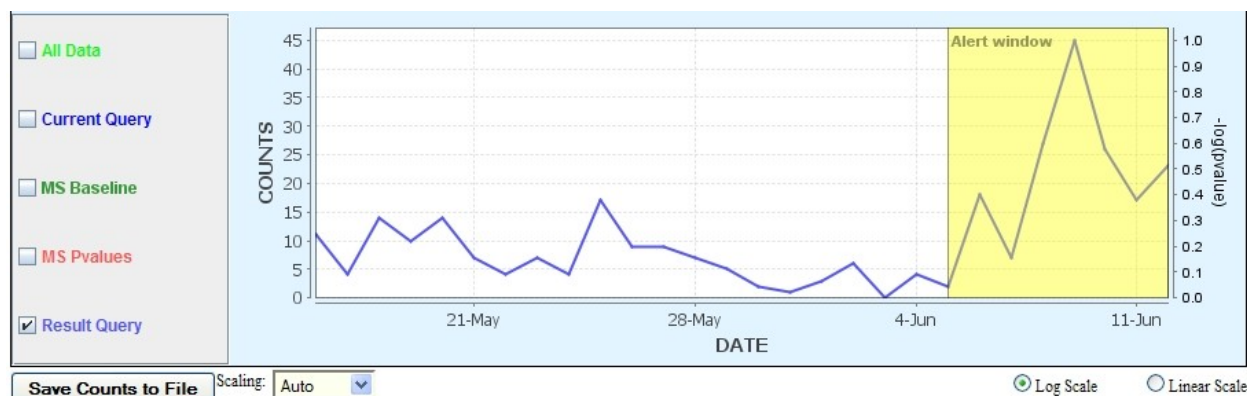


Figure 94: Drill down using another run of massive screening reveals that people older than 45 years seem to be the age group most spectacularly affected by the June 2009 viral hepatitis outbreak in Vavuniya

### 12.4.4 Spatio-Temporal Analysis

The **Maps** component of TCWI can be used to detect and analyze spatio-temporal patterns in data. **Maps** panel can process data that contains a spatial attribute. In the discussed lk\_flat\_table data, it is named “loc\_name” and its values correspond to individual regions of Sri Lanka. In order to initialize the **Maps** panel, specify the spatial attribute name and click on **Load Map** button to view the map. Once the map is loaded, **Clear Map** resets the **Maps** panel.

#### 12.4.4.1 Map Visualization

Figure 95 shows the geographic distribution of all disease cases over the complete period of time covered in the lk\_flat\_table data on the background of the Sri Lanka map. Figure 96 presents the corresponding temporal distribution of the visualized disease cases. Center of each circle corresponds to a Sri Lanka region, while its radius indicates the total number of patients for the date range shown in Figure 96. Try changing the date range using slider bars in time series window. Rendering of data on the map will be updated to reflect the volume of disease reports per region corresponding to the adjusted temporal scope. The legend in the bottom left part of the map display window presents the size to volume correspondence used in the map diagram.

#### 12.4.4.2 3.2 Time Series Visualization

Temporal distribution of data is shown right under the map display. Its operation is analogous to the same panel under the Time Series tab. The green line shows the 7-day moving average. Animation is a new function that allows the users to watch spatial and temporal changes in the displayed data. Adjust values of **Scan window size** and **Slide window by** parameters (Figure 96) to adjust the resolution and speed of animation.

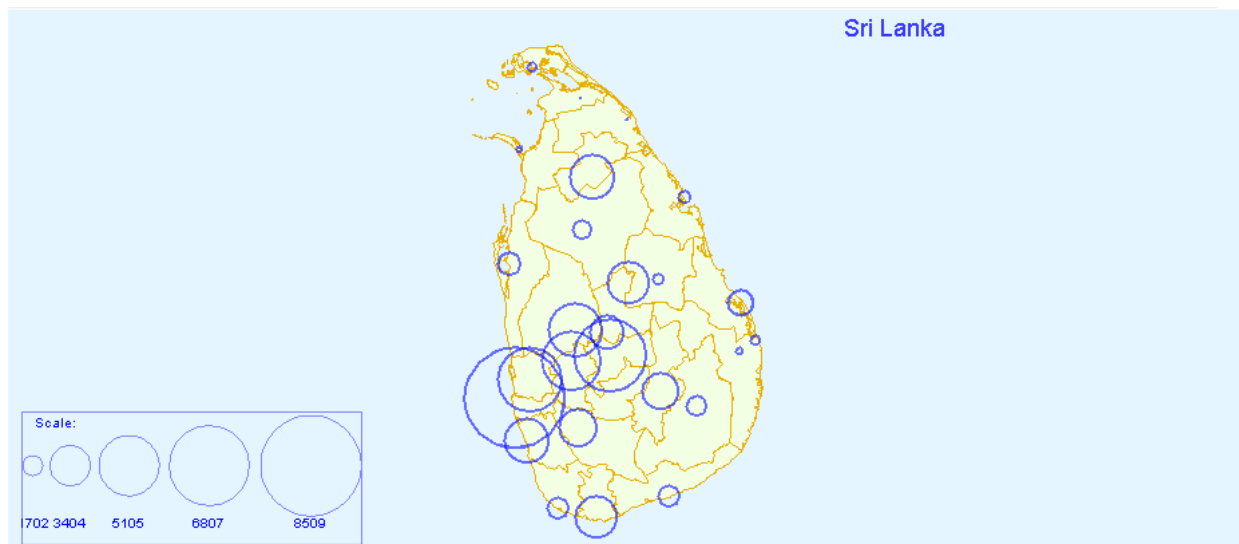


Figure 95: Map visualization.

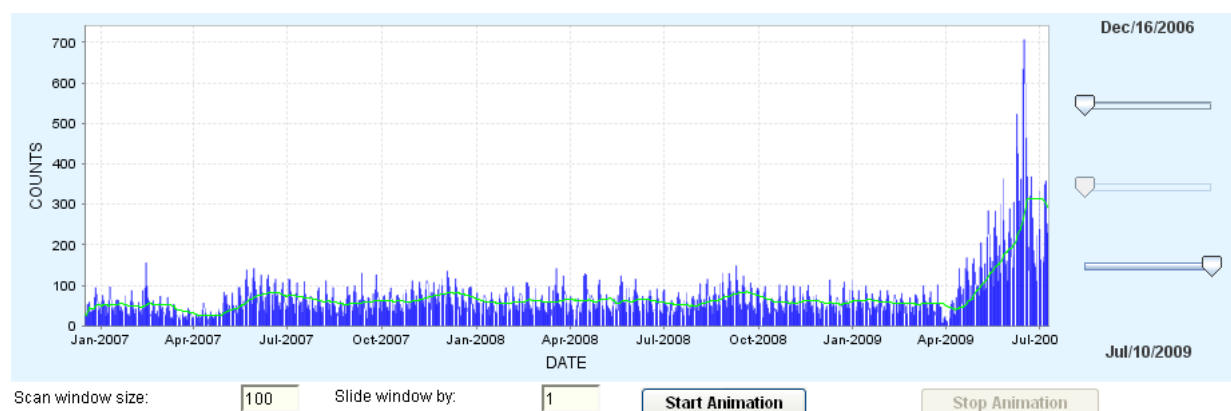


Figure 96: Time series view under the Map tab.

### 12.4.5 Attribute Selection Panel

The time series in Figure 96 shows the total daily counts of all disease cases. To display the time series corresponding to specific values of specific dimensions of data use the **Attribute Selection Panel**. Functionality of this panel is generally similar to that of **Query Selection Panel** described before. Activating of the **Auto Filter** modifies the dialog of the user-driven dimension-value selection such that only the actually present in data combinations of dimensions and their values are available for selection, given the already selected subsets. Selecting one of the dimensions and hitting the Submit/Reset button leads to splitting the currently visualized data into time series and circles on the map, separately colored for each of the individual values selected for this dimension.

Figure 99 shows how to display time series corresponding to *Dysentery* patients aging up to 5 years old recorded in regions of *Badulla* and *Batticaloa*. Note that after selecting the values, the user must press “Submit/Reset button” to update the time series and map visualizations.

▼ **Attribute Selection Panel 1 - Click to show/hide.**

**Submit/Reset**

☐ Auto Filter

<input checked="" type="checkbox"/> loc_name	<input checked="" type="checkbox"/> age_grp	<input checked="" type="checkbox"/> disease	<input type="checkbox"/> gender	<input type="checkbox"/> sign
<div> <div>Ampara</div> <div>Anuradhapura</div> <div>Badulla</div> <div>Batticaloa</div> <div>Colombo</div> </div>	<div> <div>0-1</div> <div>1-5</div> <div>15-19</div> <div>20-24</div> <div>25-29</div> </div>	<div> <div>Dengue_fever</div> <div>Dysentery</div> <div>Encephalitis</div> <div>Enteric_fever</div> <div>Food_poisoning</div> </div>		

☐ symptom

Figure 97: Attribute Selection Panel under the Map tab.

## 12.5 Spatial Scan

TCWI implements a variant of the Multivariate Bayesian Spatial Scan algorithm for spatio-temporal analysis of public health data. This spatial scan method computes the overall probability of a disease outbreak anywhere in the scope of data selected by the user in the **Attribute Selection Panel** dialog, separately for each day in the scope. It is reported as the Spatial Scan Global score in the upper right

corner of the map display window. The displayed value corresponds to the current last day of analysis. The users can inspect the specific values of the global score for other days by moving the end date slider bar located to the right of the time series window. The daily global scores are visualized with a red line in the upper part of the time series diagram.

The spatial scan algorithm also computes for each day, the probability of an outbreak occurring at each geographic location. The results are visualized on the map as circles filled with a color depending on the value of the respective probability estimate.

Figure 98 shows the dialog for setting the parameters controlling the spatial scan algorithm. **Temporal window size** acts as a smoothing parameter and it must be set to a value lower than seven. This value should reflect the expected disease outbreak duration. **Max group size** is the anticipated maximum number of regions affected by an outbreak. Based on initial experiments performed using *lk\_flat\_table* data, we recommend setting the **Temporal window size** to 7 and the **Max group size** to the value approximately equal 25% of the total number of distinct locations represented in the data.

Temporal window size:  Max. group size:

Min. threshold:

Figure 98: Selecting the Spatial Scan parameters

Figures 14 and 15 show results of running the spatial scan against counts of Leptospirosis cases using the end date of August 5, 2008. The global score (0.9612) in the top right of Figure 99 indicates that the chance of a Leptospirosis outbreak anywhere in the country on that day exceeds 96%. The shaded circles centered at each region (heat map legend is placed at the top left side of Figure 99) depict spatial distribution of outbreak probability. The blue circles still indicate the total number of Leptospirosis cases in each region. In Figure 100, the red time series plot depicts the temporal distribution of past global. Once the review of results of the spatial scan run is complete, the users can **Clear Scan Results** using the button shown in Figure 98.

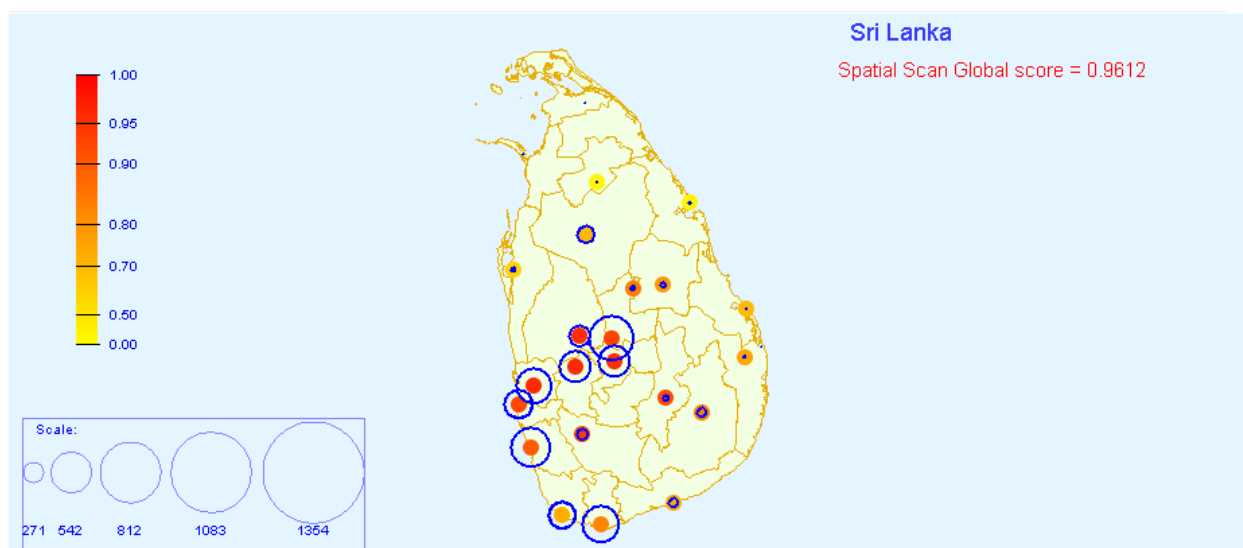


Figure 99: Detecting an outbreak of Leptospirosis with Spatial Scan (map view).

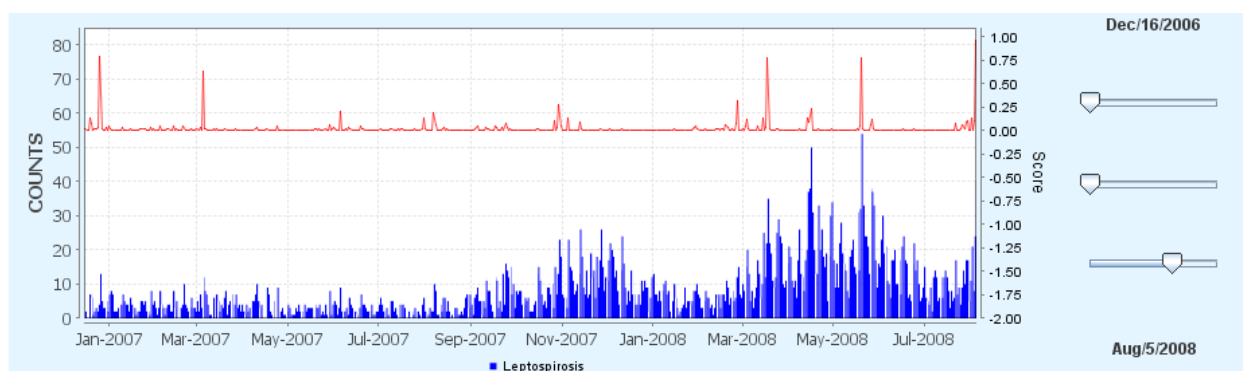


Figure 100: Detecting an outbreak of Leptospirosis with Spatial Scan (time series view).

### 12.5.1 Summarization of Data with Pivot Tables

**Pivot Tables** tab offers an interactive data summarization capability. TCWI provides an efficient algorithm for aggregating multidimensional data of counts of events (such as the numbers of reported disease cases) into a two-dimensional matrix view. Figure 101 depicts an example pivot table computed for the `lk_flat_table` data using two dimensions: *disease* and *age\_grp*. Each cell in the table shows the total number of recorded cases of specific disease (row) among patients in the specific age group (column). The table also shows the marginal sums (by row, by column, and the total number of cases).

[Start Over](#) >> disease -- age\_grp

Attributes: gender loc\_name sign symptom

Rows: disease

Columns: age\_grp

	0-1	1-5	15-19	20-24	25-29	30-34	35-39	40-45	6-14	Above_45	Total
Dengue_fever	1260	1342	1310	3937	2609	2648	2591	2664	1366	6693	26420
Dysentery	665	713	715	2146	1427	1376	1434	1395	729	3623	14223
Encephalitis	25	23	23	72	49	61	47	62	29	132	523
Enteric_fever	167	196	166	495	350	322	350	355	157	852	3410
Food_poisoning	175	138	137	435	323	343	298	356	174	765	3144
Human_rabies	3	1	3	14	11	3	9	6	1	17	68
Leptospirosis	427	523	475	1384	1025	973	965	984	501	2420	9677
Typhus_fever	131	96	128	359	249	268	241	234	125	603	2434
Viral_Hepatitis	460	459	453	1377	887	919	960	901	501	2290	9207
Total	3313	3491	3410	10219	6930	6913	6895	6957	3583	17395	69106

Figure 101: An example 2-way Pivot Table

Construction and editing of pivot tables can be done by dragging and dropping icons with the individual dimension names between the “Attributes,” “Rows” and “Columns” lists. The dimensions in the “Rows” and “Columns” lists are used to create rows and columns of the table, respectively, while those that remain in the “Attributes” list are ignored. Multiple attributes can be put in “Rows” and “Columns” to create nested tables. To move from table shown in Figure 101 to the one shown in Figure 102, just drag the icon denoting “gender” to the “Row” list. Now, the rows are split by disease and gender, and each cell of the table contains counts of either male or female patients diagnosed with a specific disease, and belonging to a specific age group.

The users can always clean the current table and start over by clicking the **Start over** link (Figure 101). Left clicking on any data cell of the table will produce a pop-up window with a time series plot of the data represented by that cell. The temporal range of data can be adjusted by changing the dates at the bottom of the page. Figure 103 shows the time series for male patients aged 30-34 years old having been diagnosed with typhus fever.

Attributes: loc\_name sign symptom  
 Rows: disease gender  
 Columns: age\_grp

		0-1	1-5	15-19	20-24	25-29	30-34	35-39	40-45	6-14	Above_45	Total
Dengue_fever	Female	633	646	693	1961	1327	1322	1300	1359	686	3397	13324
	Male	627	696	617	1976	1282	1326	1291	1305	680	3296	13096
Dysentery	Female	333	365	371	1074	683	647	755	729	346	1776	7079
	Male	332	348	344	1072	744	729	679	666	383	1847	7144
Encephalitis	Female	13	13	12	32	34	29	28	35	19	55	270
	Male	12	10	11	40	15	32	19	27	10	77	253
Enteric_fever	Female	88	91	91	224	172	154	164	163	87	382	1616
	Male	79	105	75	271	178	168	186	192	70	470	1794
Food_poisoning	Female	82	71	64	210	158	166	161	179	98	392	1581
	Male	93	67	73	225	165	177	137	177	76	373	1563
Human_rabies	Female	1	1	3	6	4	2	4	3	1	8	33
	Male	2	0	0	8	7	1	5	3	0	9	35
Leptospirosis	Female	207	273	243	692	491	466	506	472	233	1203	4786
	Male	220	250	232	692	534	507	459	512	268	1217	4891
Typhus_fever	Female	70	54	67	158	120	129	121	111	67	305	1202
	Male	61	42	61	201	129	139	120	123	58	298	1232
Viral_Hepatitis	Female	217	227	211	667	442	453	448	456	243	1145	4509
	Male	243	232	242	710	445	466	512	445	258	1145	4698
Total		3313	3491	3410	10219	6930	6913	6895	6957	3583	17395	69106

Figure 102: Example 3-way pivot table.

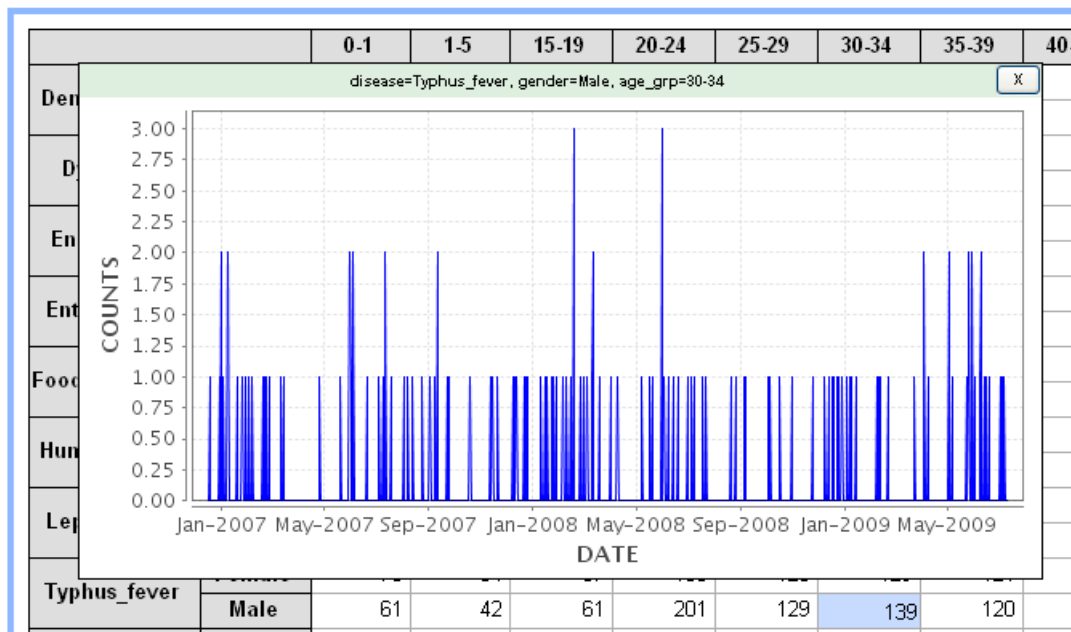


Figure 103: Example Time Series view under Pivot Table tab.

Left-clicking on any row or column name of a pivot table will produce a pie chart visualizing the distribution of data split according to the values of the counterpart row or column dimensions. Figure

104 shows the distribution of age groups for female patients diagnosed with dengue fever.

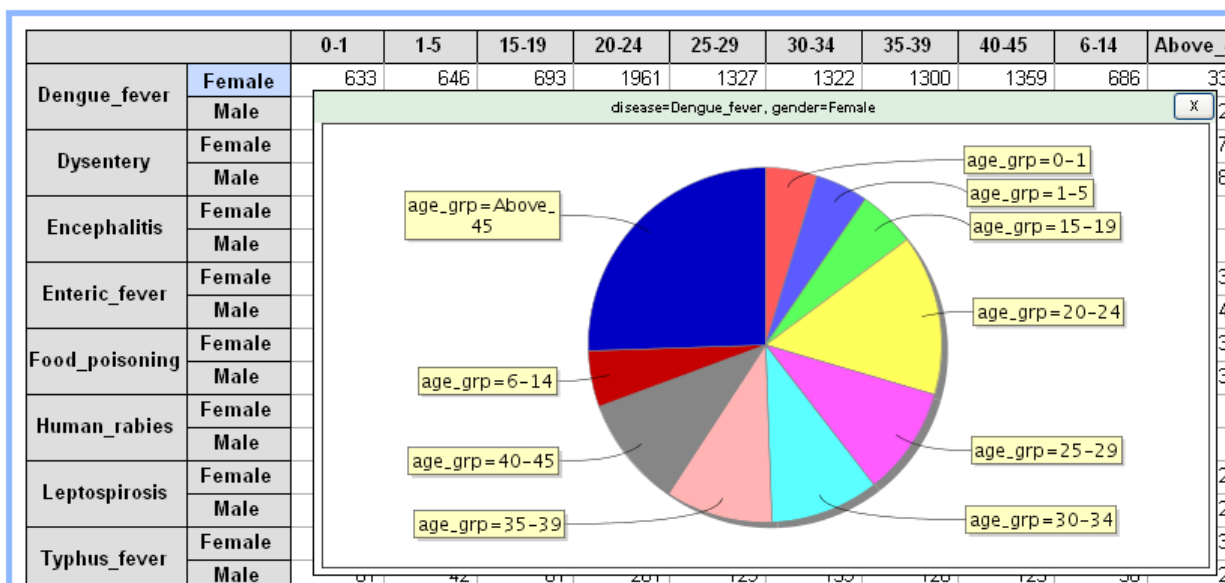


Figure 104: Example pie chart under the Pivot Table tab.

Each cell in a pivot table reflects the aggregate counts of disease cases computed over a specific period of time. It is shown and it can be edited at the bottom of the page. If either or both of the dates are changed, TCWI will quickly re-compute counts for all cells in the current pivot table.

## 12.5.2 Future Work

We have mentioned above a few minor extensions of the capabilities of TCWI scheduled for inclusion in the next release of the software (expected in mid-December 2009). The next release is also intended to include the following major extensions:

- Ability to browse the original transactional data. We are working on an interface that will allow users to see the individual original records of disease cases loaded to TCWI, besides the aggregated counts shown currently in the form of time series. This will support detailed drill downs and other basic database operations not easily accessible through TCWI.
- Background screening and alerting capability. Currently, TCWI offers a variety of analytic functions available for interactive use. The background screening and alerting will enable setting up scripts for user-determined analyses to be automatically executed at user-defined periods of time. It is of practical importance to execute screening for emerging patterns at regular intervals in order to maintain situational awareness among stakeholders of RTBP, even if the TCWI operators are not always present at their consoles to invoke the analyses manually. The results of scheduled analyses will be stored for inspection by the users, and the automatically generated alerts will be made available for distribution to the designated recipients.

## 12.6 Sahana Alerting Broker user manual

### 12.6.1 Introduction

This guide is intended for users of the Sahana Messaging/Alerting Module, who wish to send and process alerts based on the Common Alerting Protocol (CAP). This guide specifically covers the CAP alerting section. Those of you not familiar with the CAP standard should refer to the “[CAP Cookbook](#)”.

### 12.6.2 Messaging/Alerting Module

The Messaging/Alerting Module is a Sahana Module that is used for the sending and receiving of messages and/or alerts to recipients. At the time of writing, the module allows for the generic sending and receiving of messages as Short Messages via the Short Messaging Service (SMS), sending messages as Email, conducting SMS based surveys and sending CAP alerts. The CAP alerting section, which falls under the scope of this guide, is accessed via the Alert and Templates subsections.

We shall use an example of a *Government Health Department; specifically the Epidemiology Unit* use of the CAP Messaging/Alerting Module for the purpose of notifying disease situational reports.

Although not mentioned in this guide, it is possible to control the access of modules and functions through the *Sahana Security Administration Module* (but not mandatory and is at the discretion of the implementers) . Please refer to the user guide on the security administration module (abbreviated as secadmin): <http://wiki.sahana.lk/doku.php/doc:secadmin:english>.

The Sahana Administrator can setup user accounts, define roles, and authorization points through the secadmin. For the purpose of messaging/alerting, the security administrator should setup a *super-user* account and a *user* account. The super user's roles are mainly defining the CAP profile, establishing operational guidelines/policies, and setting up CAP message templates. The user's roles are issuing messages either directly or with the aid of a predefined template and monitoring responses.

In our example, health officials would be the main users and super-users of the messaging/alerting module. The alert recipients will be 1) Closed User Group (CUG) of health officials and 2) Public. The super users would be the National and Regional Epidemiologist, per say, and the users would be the epidemiology unit staff and District/Divisional Health Services office staff.

It is possible to issue public alerts but not efficient via the technologies such as SMS/Email that are used in the Sahana messaging/alerting module. Once a channel is established to issue Cell Broadcast (CB) alerts, for example, then authorized users may push public alerts directly through the messaging/alerting module to mobile handsets of the public. For the purpose of our example, we will assume the scenario where a public alert is generated but, first, sent to main-stream-media (like TV and

Radio) and Cellular Network Operators (GSM/CDMA) to rebroadcast the message over their networks to the public.

### 12.6.3 Templates

The system allows users to create CAP templates and store them in the system. These can then be used when creating CAP alerts/messages, which allows the message to be populated based on the relevant template.

#### 12.6.3.1 Create Template

**Alert Template**

**Key:** \* - Fields tagged with a star ( \* ) are mandatory and must be filled.

**Basic Information**

Name  \*

Figure 105: Create template

The user can create a new template, by clicking the Template-New menu item in the left menu bar of the Messaging Module. In the Basic Information section, a user can enter the name of template and save it via the 'Save' button. The user can then update the template by going to the Update section.

#### 12.6.3.2 View Template List

The user can go to the View Template List section, by selecting Template->View in the menubar. This will take the user to a list of templates available in the system

**Templates List**

List

Name	Type	Version	Author
<a href="#">tsunami-temp</a>			admin
<a href="#">xyz</a>			sahana
<a href="#">aaaa</a>			sahana
<a href="#">newmmmm</a>			sahana

Figure 106: View list of templates

When the user clicks on a template, it will show a 'View' screen for the selected template

Template View
<p>Template Information</p> <p><b>Message ID :</b> er7vmsg-80  <b>Message Name :</b> latersttemp  <b>Mime Type :</b>  <b>Alert Version :</b>  <b>Author :</b> sahana  <b>Message Type :</b> temp</p> <p><a href="#">Update</a> <a href="#">Delete</a></p>

Figure 107: View template

In our example, we shall create two templates: 1) CUG health officials 2) public. Super-user should use steps 3.1 to generate two templates with the names: “CUG-health-dis-outbreak” and “Pub-health-dis-outbreak.” These would be listed in two separate rows in the table shown in Figure 106. If one was to click on the name “CUG-health-dis-outbreak” the next screen (Figure 107) would show messages message-id with a system generated unique identifier comprising a sequence of alphanumeric character, message name as CUG-health-dis-outbreak, and message type as “temp.” At this point if the super-user wants to change the name of the template, then the super-user should click delete to discard that template and repeat the step in section 3.1 to create a new template with desired new name.

### 12.6.3.3 Update Templates

The Update Template section can be viewed by clicking on the 'Update' link in the View Template screen, as described in section 3.2. This will take the user to a set of CAP fields, which can be filled in by the user. This is similar to the description of filling in a CAP alert, described in section 4.1 below. Once the user is done filling in the CAP Alert Template, he/she can save the Template by clicking on the Update button below.

The template can then be used to pre-populate fields when creating a New Alert, as shown in section 4.1 below. The difference between a message template and an alert message is that most of the CAP fields are not populated and some are set to indicate that it is a template such as the message status being set to “draft.” The unpopulated fields are specific to the issued message and must be populated at the time of issuing the message; for instance, the message identifier that refers to the particular message issued is auto populated at the time of creating a message from a template. There is no concrete rule etched in stone as to how implementers should define the set of elements that can be pre-populated in a template. Therefore, the software has opened all fields leaving it up to the implementers to set their own policies and standard operating procedures.

**Creating CAP**

Alert Information Resource Area

Message Identifier  ? HELP

Sender  ? HELP

Status  ? HELP

Message Type  ? HELP

Source  ? HELP

Scope  ? HELP

Optional

Code  Enter space separated set of codes

References

incidents

Figure 108: Upload template message

Follow the steps described in section 4.0 to enter the CAP template values and save. Here we will give you the values that would be entered in the templates for the two examples (see Table 1 and table 2). We leave all fields blank or to be populated at the time of issuing the messages and only enter the list of values given below

Table 78: “CUG-health-dis-outbreak”:

Alert : Status = “ <b>Draft</b> ”	Alert : Message Type = “Alert”
Alert : Source = “Epidemiology Unit”	Alert : Scope = “Restricted”
Alert : Restriction = “Health Officials/Workers”	
Info : Language = “English”	Info : Category = “Health”
Info : Event = “Disease Outbreak”	Info : Audience = “Health officials/workers”
Info : Description = “A disease outbreak has been issued for <areaDesc> by <senderName>. Health Officials and Health Workers in these areas are encouraged to <responseType> responsive actions and <instruction>. This event is rated with <Priority> priority and responsive actions should be taken <urgency>. For more information about this event visit <URI> or call <contact>.”	
Info : Instruction = “Contact the respective Regional Epidemiology Unit”.	Info : Headline = “A disease outbreak is in effect”
Info : Web = “ <a href="http://www.epid.gov.lk/restricted/alert/c">http://www.epid.gov.lk/restricted/alert/c</a> ”	Info : Contact = “+941125551212”

ap”	
Resource : Resource Description = “restricted website”	Resource : url = “ <a href="http://www.epid.gov.lk/restricted/alert/cap/">http://www.epid.gov.lk/restricted/alert/cap/</a> ”

Table 79: “PUB-health-dis-outbreak”:

Alert : Status = “ <b>Draft</b> ”	Alert : Message Type = “Alert”
Alert : Source = “Epidemiology Unit”	Alert : Scope = “Public”
Info : Language = “English”	Info : Category = “Health”
Info : Event = “Disease Outbreak”	
Info : Description = “A <disease name> disease outbreak has been issued for <Area Description> by <Sender Name>. Public in these areas are encouraged to <Response Type> responsive actions and <Instruction>. This event is rated with <Priority> priority and responsive actions should be taken <Urgency>. For more information about this event tune in to your local TV and Radio stations or visit <URI> or call <contact>.”	
Info : Instruction = “Report any suspected cases to the nearest hospital or clinic”	Info : Headline = “A disease outbreak is in effect”
Info : Web = “ <a href="http://www.epid.gov.lk/public/alert/cap/">http://www.epid.gov.lk/public/alert/cap/</a> ”	Info : Contact = “+941125551212”
Resource : Resource Description = “public website”	Resource : URI = “ <a href="http://www.epid.gov.lk/public/alert/cap/">http://www.epid.gov.lk/public/alert/cap/</a> ”

## 12.6.4 Alerts

This module allows the user to create and view new alerts, and send them via SMS or Email.

### 12.6.4.1 4.1 New Alert

Key: \* - Fields tagged with a star (\*) are mandatory and must be filled.

New Alert

Select Mode ☒ CAP ☐ EDXL

Figure 109: New alert: select mode

Selecting Alert->New allows the user to create a new alert. Alerts can be of type CAP or EDXL – currently CAP is supported. The type of the alert can be selected via the Select Mode radio button:

Once the mode is selected, the User can enter the name of the alert she wants to create, in the Name field (Figure 110).

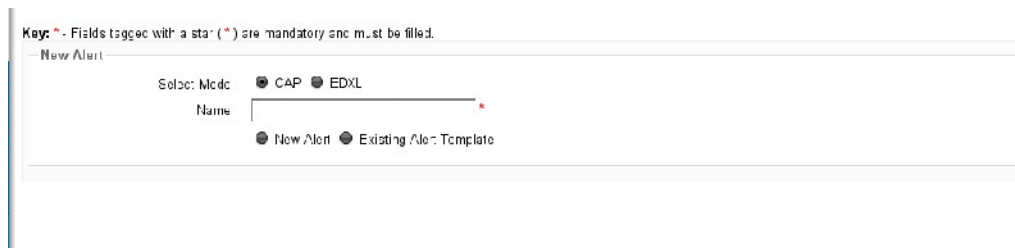


Figure 110: New alert: enter name and type

Along with the name, the user can select to create a new alert from scratch, or use an existing template that was created in the Templates section. The user can do this by selecting either the New Alert or Existing Alert Template radio button respectively.

We may choose to use a naming convention that helps us identify the message in the future for any audits. Let us assume we want to send a public alert on dengue outbreak. We may use the following name: “pub\_health\_dengue\_10\_08\_2009”. If more than one alert on the same dengue event is issued on the same day, one may choose to separate the names by add in sequence number 001, 002 to the end; e.g. pub\_health\_dengue\_10\_08\_2009\_001. This is not essential since the message identifier will vary between the two messages and one may distinguish them apart from message identifier field. The main purpose of the alert name is to help the user locate the message from the data base in the future; hence, a general name may be preferred.

For both types of alerts selected above, the User is given a set of Metadata fields that describe the alert, along with a unique system-generated Alert ID. The user can fill in the required fields and proceed by clicking on Next.

**Key:** \* - Fields tagged with a star (\*) are mandatory and must be filled

**New Alert**

Select Mode: ☒ CAP ☐ EDXL

Name:  \*

☒ New Alert ☐ Existing Alert Template

---

**Creating New Cap Alert**

**New Cap Alert**

Message Identifier:  ? HELP

Date Created:  [calendar icon]

Sender:  ? HELP

File Type:

File Version:  ? HELP

Figure 111: Alert metadata

The user is then taken to a Tab-separated New CAP alert Form. The form is separated into four tabs that have various form elements to build a CAP message. Form elements marked with a red asterisk are compulsory/mandatory elements, whilst all others are optional. Once the user is done filling in the fields, they would click the 'Update' button to save the CAP message, or the 'Clear' button to clear the filled elements.

If the user selected the Existing Alert Template button, then upon completing the fields in Figure 111 and clicking Next, the user will be taken to a screen listing all the template names, same as in Figure 106 – List View Templates. Once the user selects the desired template by clicking the appropriate name, they will be navigated to a screen shown in Figure 112 but with pre-populated values that were originally entered at the time of creating the template.

✓

Submission Successful

•

Data Saved Successfully

Creating CAP

AlertInformationResourceArea

Message Identifier

Actual-124807C193

? HELP

Sender

? HELP

Status

Actual

? HELP

Message Type

Alert

? HELP

Source

? HELP

Scope

Public

? HELP

Optional

Code

Enter space separated set of codes

References

incidents

Update

Clear

Figure 112: Create CAP alert tab

Some elements such as Status, Message Type and Scope, shown above, have a drop down list with pre-populated values.

**Creating CAP**

**Alert** **Information** **Resource** **Area**

Language:

Category:

Event:  \* ? HELP

Priority:

Urgency:  \* ? HELP

Severity:  \*

Certainty:  \*

**Optional**

Sender Name:

Headline:

Description:

Audience:

Response type:

*Figure 113: Create CAP - Information tab*

The Information Tab, shown above, captures the information related fields of the CAP message. The Priority drop down contains pre-selected values for the Urgency, Severity and Certainty fields, and will fill them in based on its selection. If the Priority field is set to Unknown, it will then allow users to select custom values for the Urgency, Severity and Certainty fields, from a list of pre-populated values available for each of them.

The screenshot displays a web form titled "Create CAP - Information" with the following fields and controls:

- Response Type:** A dropdown menu currently showing "Shelter", with an "Add" button and a "None" option. A "Clear" button is also present.
- Effective:** A text input field with a placeholder example: "(e. g., 2002-05-24T16:40:00-07:00 for 24 May 2002 at 13: 40 PDT)".
- Onset:** A text input field with a placeholder example: "(e. g., 2002-05-24T16:40:00-07:00 for 24 May 2002 at 13: 40 PDT)".
- Expires:** A text input field with a placeholder example: "(e. g., 2002-05-24T16:40:00-07:00 for 24 May 2002 at 13: 40 PDT)".
- Instruction:** A large text area for entering instructions.
- Web:** A text input field.
- Contact:** A text input field.
- Cap Message Info - Event Code:** A section containing:
  - ValueName:** A text input field.
  - Value:** A text input field with an "Add" button.
  - A "Clear" button.
- Cap Message Info - Parameter:** A section containing:
  - ValueName:** A text input field.
  - Value:** A text input field with an "Add" button.
  - A "Clear" button.

At the bottom of the form are "Update" and "Clear" buttons.

Illustration 114: Create CAP – Information tab showing message information

The Area page allows the user to add Area and Geographic information to a CAP message. When the user starts entering a location in the Area Description field, the system provides an in-place lookup of available locations already available in the system – the user can then select one of these locations to fill the field.

**Creating CAP**

Alert Information Resource **Area**

Area Description **Sri Lanka** **Add**

Polygon

X

Y  **Add Point**

Circle

X

Y

Radius  **Add Circle**

Geocode

Value Name

Value  **Add Geocode**

Other

Altitude

Ceiling

Figure 115: Create CAP - location lookup

If the location a user requires is not entered in the system already, then the user can add a new location by clicking the 'Add' button to the right of the Area Description box. This would allow the user to enter a location, which would then be added simultaneously to the Area Description field and the system location table as well.

**Add new location**

Name  ? HELP

Category  ? HELP

Type  ? HELP

Description  ? HELP

Shape  ? HELP

X Vector  ? HELP

Y Vector  ? HELP

Z Vector  ? HELP

ISO Code  ? HELP

**Save Location**

Creating CAP

Alert Information Resource **Area**

Area Description **Sri Lanka** **Add**

Polygon

X

Y  **Add Point**

Circle

X

Y

Radius  **Add Circle**

Geocode

Value Name

Value  **Add Geocode**

Figure 116: Create CAP - add new location

Once the user is done filling in the fields available in various tabs, the user can click the 'Update' button, which creates the CAP alert.

Now to complete the message we would enter the following values. In Table 3 and Table 4 we specify the new values and the changes made to values in Table 1 and Table 2 such as completing the Info : Description field, while the other pre-populated values in the template will remain the same; hence, refer to Table 1 and Table 2 for those values. Fields such as the Message Identifier and Sent (submitted time and date) are generated by the system and the user is discouraged from changing those fields. Once again, this is up to the implemented operating procedures. Such values that are system generated are not listed in Table 3 and Table 4. Thus, Table 3 and Table 4 shows values that are entered or changed by the user.

Table 3 illustrates a message sent to all the Medical Officer of Health in Kurunegala District of Sri Lanka and Table 4 illustrates a message sent to the public in Kurunegala District of Sri Lanka, which will be given the names: MOH-health-dengue-10-08-2009 and pub-health-dengue-10-08-2009, respectively. Reader may wonder why we use “health” as part of the naming string, this is because other departments, such as the irrigation department for flood warnings, may use the same messaging/alerting module implementation; hence, the work “health” helps identify the category of the alert.

Table 80: “MOH-health-dengue-10-08-2009”:

Alert : status = “ <b>Actual</b> ”	Alert : Sender = “ratnayake@epid.gov.lk”
Alert : Incident = “health-20090810104000”	Info : Response Type = “Execute”
Info : Priority = “Urgent”	Info : Urgency = “Immediate”
Info : Severity = “Extreme”	Info : Certainty = “Observed”
Info : Sender Name = “Dr. Ratnayake, Provincial Director of Health”	
Info : description = “A DENGUE disease outbreak has been issued for Kurunegala District by Dr. Ratnayake, Provincial Director of Health. Health Officials and Health Workers in these areas are encouraged to Execute responsive actions and consult with their respective Regional Epidemiology Unit. This event is rated with URGENT priority and responsive actions should be taken Immediate. For more information about this event visit <a href="http://www.epid.gov.lk/restricted/alert/cap">http://www.epid.gov.lk/restricted/alert/cap</a> or call +941125551212.”	
Info : Effective = “2009-08-10T16:00:00+05:30”	Info : Expires = “2009-08-20T23:30:00+05:30”
Area : Area Description = “Kurunegala District”	

Table 81: “pub-health-dengue-10-08-2009”:

Alert : status = “ <b>Actual</b> ”	Alert : Sender = “ratnayake@epid.gov.lk”
Alert : Incident = “health-20090810104000”	Info : Response Type = “Monitor”
Info : Priority = “Urgent”	Info : Urgency = “Immediate”
Info : Severity = “Extreme”	Info : Certainty = “Observed”
Info : Sender Name = “Dr. Ratnayake, Provincial Director”	
Info : description = “A DENGUE disease outbreak has been issued for Kurunegala District by Dr. Ratnayake, Provincial Director of Health. Public in these areas are encouraged to Monitor and Report any suspected cases to the nearest hospital or clinic. This event is rated with Urgent priority and responsive actions should be taken Immediate. For more information about this event tune in to your local TV and Radio stations or visit <a href="http://www.epid.gov.lk/pub/alert/cap">http://www.epid.gov.lk/pub/alert/cap</a> or call +941125551212.”	
Info : Effective = “2009-08-10T16:00:00+05:30”	Info : Expires = “2009-08-20T23:30:00+05:30”
Area : Area Description = “Kurunegala District”	

### 12.7 4.2 View Alerts

The view alerts menu item under Alerts, is the central point to View alerts and Send them. When a user clicks on the View Alerts menu item, he/she is presented with a list of Alerts in the system

Alerts List			
List			
Name	Type	Version	Author
<a href="#">firstcap</a>	text		mifan
<a href="#">earthquake</a>	text		mifan
<a href="#">myfirstcap</a>	text		nuwan
<a href="#">capalert</a>	text		nuwan
<a href="#">Sivaganga</a>	sivaganai	1	nuwan@rtbp.ret
<a href="#">newlertmh</a>	xxx	123	nuwan
<a href="#">ddd</a>	text		sivagargaddhs@health.gov. n
<a href="#">aas</a>			mm
<a href="#">Kurunegala District</a>	xxx	1	
<a href="#">cno-cap</a>	text		nuwan@lirneasi.net
<a href="#">testing123</a>			mifan
<a href="#">myalerts</a>	cap	1.1	mmm
<a href="#">alerthou</a>			

Figure 117: View list of alerts

The User can then click on an Alert, which takes him/her to the Alert View, as shown below in Figure 118. The Alert View shows the basic information about a CAP alert, and gives the user the option to Send or Update and Alert.

Alert View	
Alert Information	
<b>Message ID :</b>	Actual-1246440944
<b>Message Name :</b>	Kurunegala District
<b>Minne Type :</b>	xxx
<b>Alert Version :</b>	1
<b>Author :</b>	nuwan@lirneasi.net
<b>Message Type :</b>	cap
<a href="#">Send</a> <a href="#">Update</a> <a href="#">Delete</a>	

Figure 118: View alert

### 12.7.1.1 Send Alerts

The starting point to send CAP alerts is the View Alerts list, described in section 4.2 above. When the required Alert is clicked and the Alert View is visible, the User is given the option to 'Send a message, as shown in the image above.

When the user clicks on 'Send', a Select Contacts page is show, as below.

Select Contacts

Recipient List

7774997283 mifan@email.com

Contacts

- Groups
  - Respere
- Individuals
  - Mifan
  - Nuwan\_W
  - Mifan\_M

Next -> Alert Type

*Figure 119: Select contact*

The user can pre-select multiple contacts from the Contacts tree - the selected contacts are shown in the Recipient List box. Contacts that are added via the Messaging Module's Add Contact will be visible in the Contacts tree. Alternatively, the user can enter multiple mobile numbers and email addresses directly into the Recipient List box, separated by a 'comma (,)'. Once this is done, the user can proceed by clicking the 'Next->Alert Type' button.

Select Delivery Type

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

Next -> Transform Message

*Figure 120: Select delivery type*

This allows the user to select the Delivery Type of the alert. Currently the system supports Short-Text SMS, Short-text Email and Long-text Email as the delivery mechanisms (refer to the [software requirement specifications](#) to learn of the different delivery types). The user has the option of selecting one or more of these delivery types. The user can then proceed by clicking the “Next->Transform Message' button.

The screenshot shows a web interface titled "Send Message". It contains two sections, each with a "Converted CAP Output" header. The first section is for "Short SMS" and the second is for "Short Email". Both sections display a sample message: "A Dengue outbreak is in effect for / ... Nuwan Waidyanatha. Msg: Actual-1246440944 sent 2009-07-01 03:07:57 is a ActualAlert. More info nuwan@limeasi.net". Below the sample message in each section is a "Send Message" button.

Figure 121: View converted message and send

In the final screen, as shown above, the user is shown the transformed CAP message relevant to the selected delivery types. The user has the option here of changing any values of the shown message, just before it is sent out. When the user clicks the 'Send Message' button, the message is delivered via the selected delivery medium, provided the various servers and configuration have been made by the system administrator.

### 12.7.1.2 Update Alerts

From the View Alerts screen, described in section 4.2, the users can select to update an existing alert. This can be done by selecting the 'Update' link, found at the bottom of a View Alert section. The Update alert will open the list of fields for the specified alert, with populated fields filled in – the user can change values or enter new values as necessary, navigating via the given tabs – this is similar to the New Alerts section, described in section 4.3. When the user is done with the form, selecting 'Update' will save the changes to the Alert.

### 12.7.2 Resources

- CAP Cookbook: [http://www.incident.com/cookbook/index.php/Main\\_Page](http://www.incident.com/cookbook/index.php/Main_Page)
- Gow, G. and Waidyanatha, N. (2009). CAP Alerting for Sahana Messaging Module: real-time biosurveillance program software requirement specifications. Web link - <http://limeasia.net/wp-content/uploads/2009/06/sahana-cap-msg-mod-v02.pdf>

## ***12.8 mHealthSurvey standard operating procedures***

The standard operating procedures given below are for the users of the mHealthSurvey mobile application, namely the health workers participating in the data collection and digitization process of the real-time biosurveillance program (RTBP). These standard procedures are recommended guidelines and are not rules that will be strictly enforced but users are encouraged to abide by the procedures as much as they can.

### **12.8.1 Acquiring a mobile phone**

- A mobile phone will be given to those health workers participating in the RTBP pilot
- The PHC/Sarvodaya should provide the name and contact information of the health workers participating in the project
- The health worker receiving a mobile phone will be asked to sign a document indicating they have received the mobile phone and that the main purpose of the mobile phone is for the purpose of the RTBP and should not be misused or abused.
- If the mobile phone is lost or stolen, the project is not required to replace the mobile phone.
- If the mobile phone is damaged, then the health worker should notify RTBI/Sarvodaya and return the damaged mobile phone to receive a replacement.

### **12.8.2 Getting connected to the network**

- User must obtain the mobile network access SIM card on their own under their own name. Thereby, the project cannot be held accountable for misuse of the phone or excess expenses incurred on personal communications.
- If the user already has a SIM card they may continue to use the same and the project will pay a fixed fee for the utilization with respect to the project work.
- The project may opt to purchase the SIM in the project's name for the user and pay the utilization fees, as in the case in Tamil Nadu. This option would require setting additional procedures for controlling the usage and payments. If the user abuses the usages and the project cannot cover the costs then the project faces the risk of the cellular operator discontinuing the service and jeopardizing the data collection.
- Once the SIM has been activated, the user should contact the provider customer service to activate GPRS and Internet connectivity
- The project will pre-load or to-pup the user's phone with a fixed amount that is more than sufficient for the communications requirements of the project.

### 12.8.3 Installing the mHealthSurvey

- A copy of the application download instructions can be obtained from the designated supervisor/program coordinator at the PHC/Sarvodaya. It is also available on the web – <include link>
- If required, contact Mr. Janakiraman/Ms. Pubudini Weerakoon to get assistance with downloading the application. Contact details are in Table 1 below.
- If the user encounters difficulties with entering the URL, then they may request that Mr. Janakiraman/Ms. Pubudini Weerakoon to SMS the URL (web link). The prospective user may click on the link in the SMS, which should direct them to the web site hosting the application.
- A second option is for the user to bookmark the application download link in the mobile phone itself. A third option is to write down the URL on paper.
- In the pilot stage of the RTBP, the installation process of the mHealthSurvey does not offer a user authentication process to ensure the person downloading the application is an authorized user. Therefore, the download instructions including the access information to the web link for downloading the application should not be publicized to avoid any tampering.

### 12.8.4 Initializing the mHealthSurvey

After installation, follow the instructions in the *User Manual* to configure the application such as downloading the list of disease, symptoms, and signs and registering the profile and locations.

- If the user had setup the profile before and the user is prompted with a message indicating the user profile already exists, then the user must contact Sarvodaya/RTBI for the database administrator to remove the previous instance of the profile in order. Thereafter, proceed with registering the Profile.
- If the user has downloaded the list of locations but wants to renew the list, then simply rerun the same steps of acquiring the list of locations.

### 12.8.5 Submitting Patient records

Once the mHealthSurvey has been installed and the application initialized, the user is ready to begin sending patient case data.

- Health workers submitting patient data through the mHealthSurvey mobile application or Sahana BSM Case Management web application should integrate the data recording and submission as part of the patient care process; i.e. immediately after examining the patient that patient's case record must be entered in to the application and sent.
- If the health worker encounters problems with the mobile phone or the mHealthSurvey application, it is only in this situation that the health worker should note patient records on paper to submit the data once the technology is operational.

### 12.8.6 Application maintenance

- Health workers should refrain from unnecessarily deleting the application as this would result in re-installation and initialization.
- It is recommended that the user run the download list at least once every few weeks to renew the list of disease, symptom, and signs.

### 12.8.7 Mobile Phone maintenance

- Monthly connection tariffs and utilization fees must be paid on time to ensure uninterrupted providers service
- The battery must be charged frequently to ensure uninterrupted operation of the mobile phone

### 12.8.8 Reporting Bugs and problems

If the health worker encounter a bug/fault in the mHealthSurvey or is unable to perform a particular function, the following procedures should be applied

- The fault should be, first recorded in the Journal, indicating the function that was attempted, exact steps (work flow) before encountering the problem, the fault, and any error messages the application may have displayed.
- The fault should be reported to RTBI/Sarvodaya via voice, SMS, or email, with particulars of contact details for the RTBP staff is given in Table 1 below.
- The fault should be discussed with the field coordinator or research assistant during the monthly meeting to ensure the

### 12.8.9 Contact information

- Health workers should be provided with a list of important contact information and should they should store this information in their mobile as well as a printed copy.

Table 82: Contacts for health workers

Role	Name	Email	Mobile Phone	Fixed Phone
Super User	Suma Prashant/ Pubudini Weerakoon	<a href="mailto:suma@tenet.res.in">suma@tenet.res.in</a>	+91-9941541788 +91-9717763888	(011)-9144-22570428
General Complaints	Janakiraman/ Pubudini Weerakoon	<a href="mailto:janu@tenet.res.in">janu@tenet.res.in</a>	+91-9747010875	+91-9747010875
mHealthSurvey training and general support	Pubudini Weerakoon / Janakiraman	<a href="mailto:janu@tenet.res.in">janu@tenet.res.in</a>	+91-9747010875	+91-9747010875

mHealthSurvey Technical Support	Sheena Radar Vincy Push pa Mary	<a href="mailto:vincy@tenet.res.in">vincy@tenet.res.in</a>	+91-9790865253	(011)-9144-2257042
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## 12.9 TCWI standard operating procedures

**Purpose:** Give the epidemiology units--PDHS-REU (Sri Lanka) and DDHS-IDSP (Tamil Nadu)--a set of guidelines for carrying out the operations of the two main detection analysis scenarios: 1) Investigating a suspected or ongoing disease outbreak, and 2) routine monitoring of notifiable/communicable (high priority) disease.

**Scope:** These instructions or standard operating procedures for investigating known disease outbreaks and monitoring high priority (i.e. communicable diseases or notifiable disease) are for the RTBP (Real-Time Biosurveillance Program) users, namely health officials belonging to the Deputy Director of Health Services Integrated Disease Surveillance Program (DDHS-IDSP) and the Provincial Director of Health Services Regional Epidemiology Units (PDHS-REU) staff members. The DDHS-IDSP and PDHS-REU should apply the *Scenario B* for monitoring the 21 disease in Sri Lanka and 11 diseases in Tamil Nadu. *Scenario A* is for investigating any event of ongoing or potential disease outbreak.

**Background:** Reader should be familiar with the basics of accessing T-Cube Web Interface (TCWI), loading data, manipulating time series, maps, and pivot tables as described in the manual. It is recommended that the user go through the main manual and the exercises described in that manual before engaging in the activities described in this document.

### Detection analysis Scenarios

#### *Scenario A: Investigating a suspected or ongoing disease outbreak*






Assume you have been notified or have come to learn of increased cases of a particular disease and want to investigate that particular disease, then follow the steps described in this section but do not restrict yourself to just these steps. You may use all other features available in TCWI as well.

#### Time Series Analysis (Temporal Scan)

After loading the data, click on the **Query Panel** to expand (Figure 122). Click the blue square next to label **Disease**, which will display the list of diseases. Click in the check box (i.e. mark with ✓) of the particular disease you wish to investigate (e.g. *Common-cold*). Rename the query name, in the text box located next to label **Name** (e.g. *common-cold*) and click Save. Scroll down to Time Series Analysis display. De-select (i.e. unchecked) **All Data** and **Current Query**. Now you should see the saved query (e.g. *common-cold*) as shown in Figure 123.

▼ **Query Selection Panel - Click to show/hide.**

Reset Query Show Query Values Selection 1/252 values. 1/6 attributes. Name: comm-cold Save

disease  location  age\_grp  gender  sign 

☐ Chicken\_Fox  
☐ Cholera  
☐ Cirrheterul  
☐ Cold  
☒ Common\_Cold  
☐ Conjunctivitis  
☐ Constipation


symptom 

Figure 122: Expanded Query Panel with attributes

The time series plot for the selected disease (e.g. *common-cold*) compared with the time series plot of **All Data** may not show any disparities for you to identify any significant increases or decreases in disease counts. Therefore, it is recommended that you run **Temporal Scan** to find periods in time where there are statistically significant differences of the selected disease (e.g. *common-cold*).

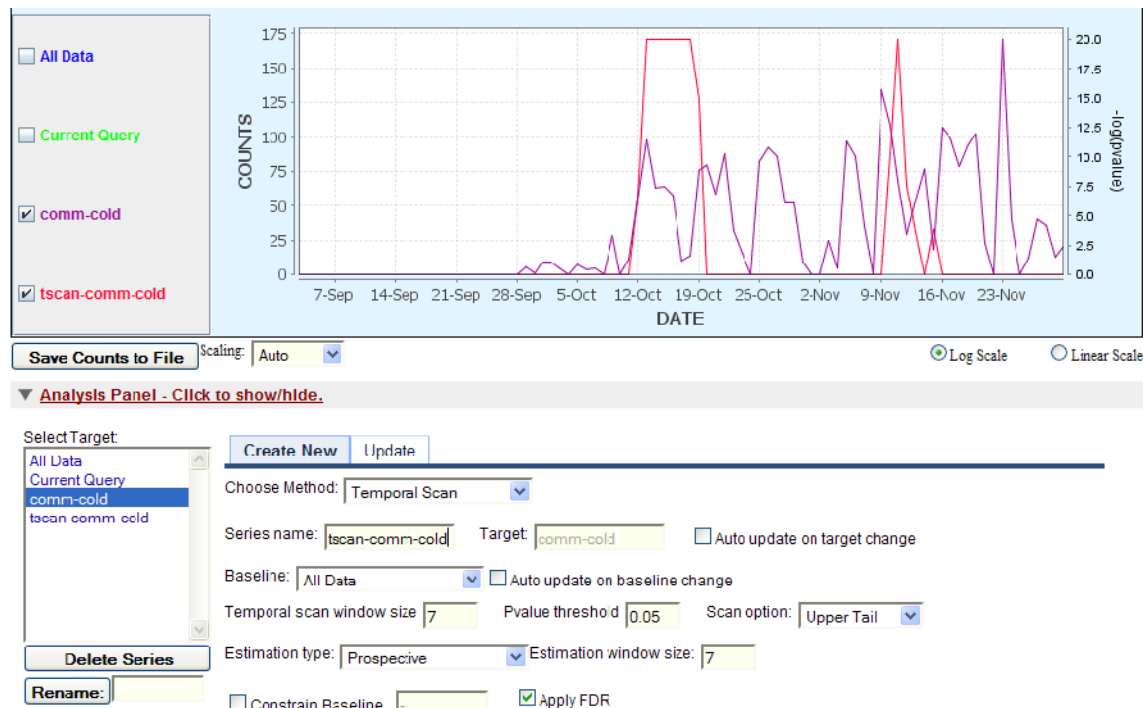


Figure 123: Time Series display showing saved query and temporal scan results with Analysis Panel

First set the parameters in the **Analysis Panel** (see Figure 123). In **Select Target** box, click on the saved query, in this case *common-cold*. Immediately, the parameters in the analysis panel will be displayed. Leave all default values as they are but change the following parameters - **Choose Method** = *Temporal Scan*, **Baseline** = *All Data*, **Scan Option** = *Upper Tail*, **Estimation Type** = *Prospective*, **Estimation Window Size** = 7, Apply False Detection Rate (FDR) =  $\sqrt{\phantom{x}}$  (check). Change the **Series Name** to one that you can be identified (e.g. *tscan-comm-cold*). After all parameters are set and the series name is changed, click **Submit** to execute temporal scan. Once the process is complete and

graphs are displayed, click on **Log Scale** located at the bottom right corner of the plots.

The Temporal Scan scores are shown by the plot in red with legend label *tscan-comm-cold*. Figure 123 shows two periods: Oct 12-19 and Nov 9-16 with high scores of disease under investigation, in this case *common-cold*. The plot of the disease under investigation (*common-cold*) is in purple.

### Map analysis (Spatial Scan)

Please do not click on the Back/Forward/Refresh buttons during using this interface.

Map Display has been initialized

Time Series **Maps** Pivot Tables Poor Performers

Please select the spatial attribute in your dataset.

Dataset 1 location

Figure 124: Loading the map for spatial scan

Navigate in to the Map section, set the **Dataset 1** = *Location*, and click **Load Map** (Figure 124). After several seconds, the map will be displayed with blue circles around the locations where data is available.

▼ **Attribute Selection Panel 1 - Click to show/hide.**

Split By -  
Select attribute -

☐ Auto Filter

☒ disease ☐ location ☐ age\_grp ☐ gender ☐ sign

Cholesterol  
Cold  
**Common Cold**  
Conjunctivitis  
Constipation

☐ symptom

Temporal window size: 7 Max. group size: 6

Min. threshold: 0.0

Figure 125: Spatial Scan attribute selection panel

Scroll down to the **Attribute Selection Panel** and click on the link to expand the panel (see Figure 125). Check (✓) the box associated with the Disease list, which will show all diseases highlighted in blue, indicating all of them to be selected. Scroll through list and click on the disease under investigation (e.g. *common-cold*), which will be the only disease highlighted in blue shown in Figure 125. Click on the **Submit** button at the top of the **Attribute Selection Panel**. Almost, immediately the map and the time series plot will change, reflecting the counts of the submitted query with the disease under investigation; i.e. *common-cold* chosen in our example.

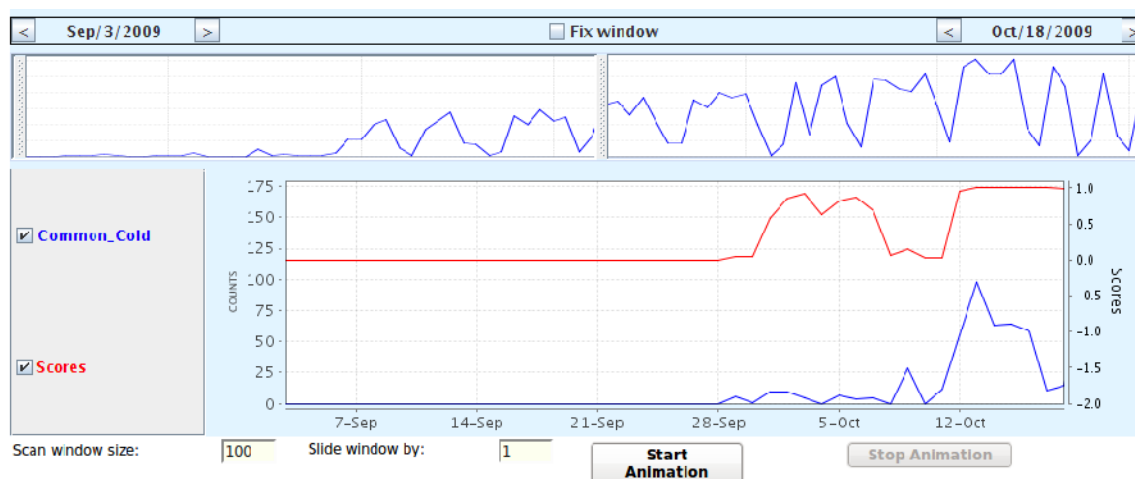


Figure 126: Spatial scan score and time series plot for disease under investigation

Change the **Temporal Window Size** = 7 and **Max Group Size** = 6 (Figure 125). After the parameters are set, click on **Run Spatial Scan**. The results will comprise the map with global score and time series window with global scores. Figure 126 shows the time series for the chosen example: *common-cold* (in blue) and the score (in red). The date slider has been moved to Oct/18/2009, which shows a high score of 0.9964 between Oct 12 and Oct 18. Also, shows another period Sep 09 to Oct 07 with a high score ranging from 0.700 to 0.8500.

Figure 127 shows the corresponding map with the global score of 0.9964. One area (around the Hospital in Katupotha) has a count of about 270 (blue circle) and score of 0.833 (orange). Place mouse pointer inside the circle and click to view the name of location and corresponding counts. List will also show the counts of neighboring villages. From the color scheme, we may conclude that the neighboring areas are also showing relatively high counts of the disease under investigation

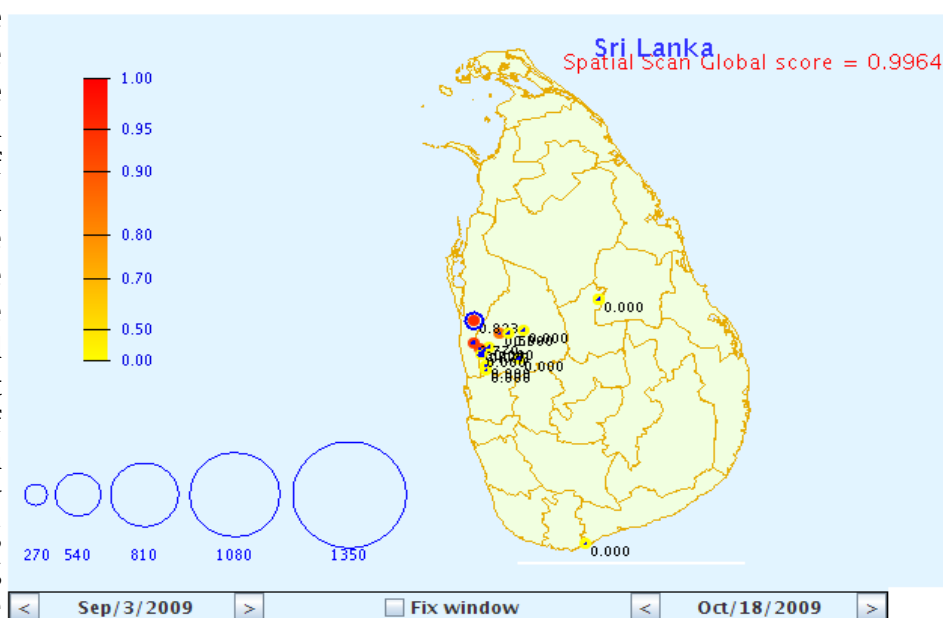


Figure 127: Spatial Scan map with counts and scores of disease under investigation (*common-cold*). By changing the date slider or date arrows, the user can see the colors in the respective areas to change proportional to the score.

#### Scenario A: *Monitoring high priority (notifiable/communicable) diseases*

Tamil Nadu and Sri Lanka monitor a set of diseases termed as notifiable disease that are currently communicated through the S/P form and H-544 form, respectively. This section illustrates the steps for carrying out the disease surveillance procedure. This procedure should be conducted frequently (daily or weekly).

### Time Series Analysis (Massive Screen)

After loading the data, click on the **Massive Screening Panel** to expand (Figure 128). Let all default values be as it is but change the following: **Scan Window Size** = 7,14,21,28 **Estimation Type** = *Prospective*, **Scan Option** = *Upper Tail*, **Check** (✓) **Last Day Only**, and **Baseline** = *All Data*.

The screenshot shows the 'Massive Screening Panel' with the following settings:

- Analysis Panel - Click to show/hide.** (Expanded)
- Massive Screening Panel - Click to show/hide.** (Expanded)
- Temporal Scan** (Selected), **Change Analysis** (Unselected)
- Scan window sizes:** 7,14,21 (Input field)
- Pvalue threshold:** 0.05 (Input field)
- Estimation type:** Prospective (Dropdown)
- Estimation window size:** 7 (Input field)
- Start Date (mm/dd/yyyy):** 09/03/2009 (Input field)
- End Date (mm/dd/yyyy):** 11/30/2009 (Input field)
- Scan Option:** Upper Tail (Dropdown)
- Last Day Only** (Checked)
- Constrain Baseline** (Unchecked)
- Rank Pvalues** (Unchecked)
- Rank Alternate Pvalues** (Unchecked)
- Most significant window only** (Unchecked)
- Use Hierarchical Attribute** (Unchecked)
- Use Drill-Down Query** (Unchecked)
- Baseline:** All Data (Dropdown)
- Select attributes (upto3) and specific values(optional) to run massive screening. You will be able to select specific values only if the attribute is selected.)**
  - disease** (Checked): Dengue Fever, Dental Carries, Diabetes, Diabetes mellitus, Diarrhoea
  - location** (Checked): Ammanamulla, Bogahapitiya, Bopitiya, Deegalla, Dunakadeniya
  - age\_grp** (Unchecked)
  - gender** (Unchecked)
  - sign** (Unchecked)
  - symptom** (Unchecked)
- Run Screening** (Button)

Figure 128: Massive Screening Panel setting of parameters and values

Click the blue square next to label **Disease**, which will display the list of diseases. Click on the particular set of disease you wish to monitor (e.g. *dengue*, *Diabetes*, *Diarrhea*). To select multiple disease hold the **CTRL** button and click on the desired diseases. Similar to Disease, click on the blue square next to label **Location**. This will select all the locations to generate the alerts. Finally click on **Run Screening**, which will almost immediately generate a list of alerts as shown in Figure 129.

Click once more on the **Massive Screening Panel** to shrink it, then you can see the **Time Series** and **Recent Massive Screening Results** close to each other. Click on the button **Log Scale**. De-select (or unchecked) the legend labels *All Data*, *Current Query* and *MS Baseline*, which will leave you with the *MS Pvalue* and *Results Query* displayed in the **Time Series** window. When you select an alert (or Massive Screening Result) the plot will change.

Figure 129 shows the example of the results *disease* = *Diarrhea*, *location* = *Narammala*, and *Pvalue* = 0.02. We are mostly interested in alerts that have a Pvalue closer to zero; where Pvalue = 0.02 is considerably high. Alert window (yellow in Figure 129) shows where T-Cube would have generated the alert as early as Nov 10.

The list of Massive Screening results are ordered according to significance with the top most results with Pvalue closer to zero. User should go through the list to find any results that are of interest. Then click on that to view the time series. Thereafter, use the Map to view the spatial clustering of the disease, which is similar to executing the Map Analysis (Spatial Scan) procedure described in the previous section. In this case, the disease under investigation will be the disease name listed in the Massive Screening result, which in our example is Diarrhea.

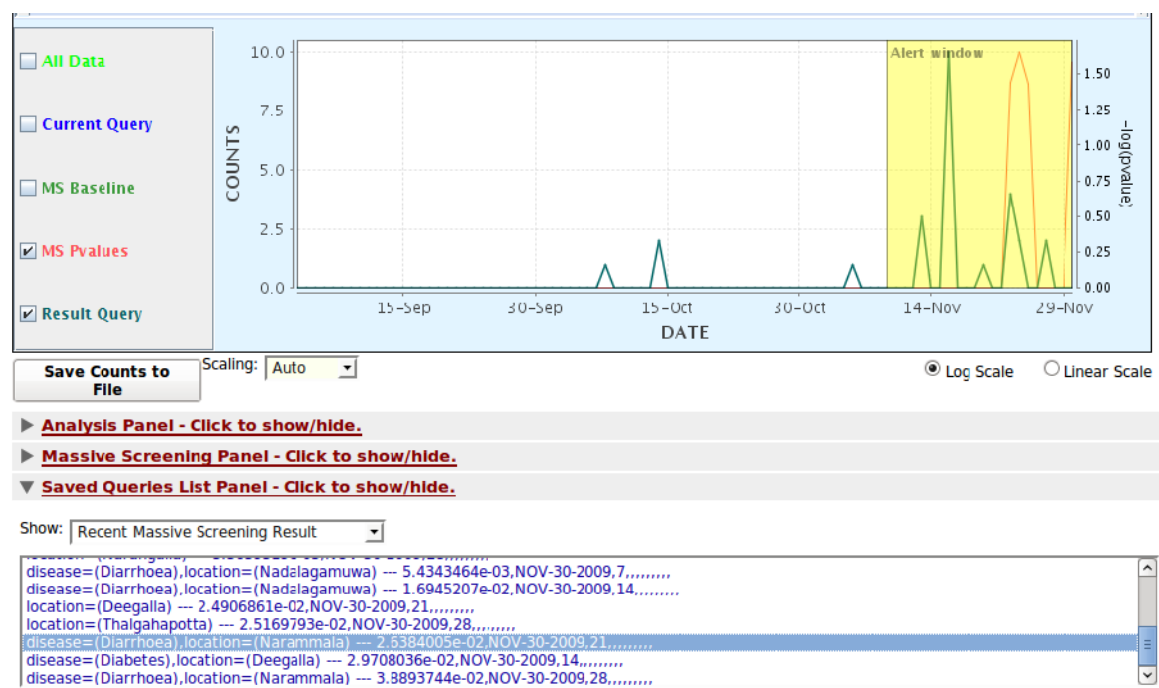


Figure 129: Pivot Table with disease in rows and locations in columns with counts in cells

Pivot Table

[Start Over](#) >> [disease -- location](#) >> disease=Acute\_Diarrheal\_Disease, age\_grp -- location

Attributes: [gender](#) [sign](#) [symptom](#)

Rows: [disease](#) [age\\_grp](#)

Columns: [location](#)

		Ammanamulla	Deegalla	Dunakadeniya	Horathapola	Horombawa	Kadapathwehera
Acute_Diarrheal_Disease	0-1	0	0	5	0	0	0
	1-5	1	0	24	2	1	2
	15-19	0	0	11	3	0	1
	20-24	0	0	10	0	0	1
	25-29	0	0	17	0	1	0
	30-34	1	0	11	2	1	3
	35-39	0	0	8	0	0	0
	40-45	0	0	7	0	0	3
	6-14	1	0	36	1	0	3
	Above_45	0	0	29	2	1	5
Total		3	0	158	10	4	18

Figure 130: Pivot Table for selected disease split by age group and locations

One can use the pivot table to view counts of the disease for all the locations. First, navigate to the **Pivot Table** by clicking the labeled tab. Drag and drop the dimension *Disease* in to the **Rows** and *Location* in to the **Columns**. After a few seconds, a table with total counts corresponding to the respective location and disease will be displayed in each of the cells (see Figure 130). Use the **Start Date** and **End Date** controls at the bottom of the table to adjust the dates to your liking.

If the user wants to investigate a single disease slitting it by dimension, click on the disease you wish to investigate (e.g. *Acute\_Diarrheal\_Disease*), which will show a drop down panel with the list of attributes, as shown in Figure 130. In our example, we have selected *age\_group* as the dimension, which results in the table shown in Figure 130. To return to the previous table, as in Figure 130, with all diseases and all location click on the link *disease—location* placed on the top of the page, next to link *Start-Over*.

## 12.10 *SABRO standard operating procedures*

### 12.10.1 ALERT AND SITUATIONAL-AWARENESS MESSAGING

Trained and certified health department personnel entrusted with the task of notifying health officials and health workers on health threats that require response actions or inactions should read this section. This section covers the procedures involving the RTBP Messaging/Alerting Module (MAM) and dissemination of alert and situational-awareness (situ-aware) messages via SMS, Email, and Web.

#### 12.10.1.1 Roles and Responsibilities

Purpose: define the roles and responsibilities of the actors involved with the alert and situ-aware messaging process.

- **Decision-Maker:** is the head or responsible person in each of the health jurisdictions assigned for making decisions on disease surveillance and response actions. The same person will be the authority to decide whether or not an alert or situ-aware message should be issued for a particular detected health event. Following are the decision-makers in Tamil Nadu, India.
  - (a) DDHS office → DE or DD or both
  - (b) PHC office → BMO or MO or both
- **Message-Issuer:** is a health official or a person with authority granted by the State Government of Tamil Nadu who will be responsible for the issuing of the message within that particular jurisdiction. The name of this responsible person will be identified in the **senderName** field of the CAP message. This person may be the same person as the Decision-Maker but should not be confused with the person creating the message in 2.1.3.
  - (a) DDHS office → DE or DD or both
  - (b) PHC office → BMO or MO or both
- **Message-Creator:** is a technically competent and trained IT person capable of manipulating the RTBP messaging/alerting module to generate a CAP message and disseminate the message to the intended recipients.
  - (a) DDHS office → DM or DEO or both
  - (b) PHC office → SHN or HI or both
- **Message-Recipient :** is a health official or health worker: DD, DE, BMO, MO, HI, SHN, VHN, the message is intended for and received through one or more of the delivery channels such as SMS, Email, or Web.

### 12.10.2 Training

Purpose: orient and mobilize health departments with issuing health category alerts and situational reports, conducting surveys, and other messaging requirements.

- Users must receive training through the RTBP to operate the MAM for the purpose of issuing health category situational awareness and alerting messages using the CAP standard.
- Only trained and certified health workers or health officials should be authorized to issue alert and situational awareness CAP messages. Alerting and situational awareness messaging is a quite sensitive and should be executed with caution because these alerts or situational awareness messages should not cause any panic or mislead those receiving the messages. Moreover, only designated health departments have the jurisdictional authority to issue alert and situational awareness messages.
- All personnel involving in the decision-making, message-creation, message-issuing, and message-receiving are encouraged to read the CAP Alerting for **Sahana Messaging Module - Real-Time Biosurveillance Program Software Requirements Specifications v1.1** (to download a copy - <http://irneasia.net/wp-content/uploads/2009/05/Sahana-CAP-Msg-Mod-v0.2.pdf>) or latest to get an in-depth understanding of the CAP elements and the selection of values.
- A copy of the user manual: “Sahana Alerting using the Common Alerting Protocol: User Guide version 1.0” describing the step by step process of initializing and issuing CAP messages can be obtained through –
  - (a) RTBP web interface at <http://www.scdmc.lk/> → Messaging/Alerting Module → Read Me → CAP Alerting User Manual
  - (b) Directly from the web link – [http://www.scdmc.lk/docs/rtbp\\_cap\\_user\\_guide\\_v1\\_3.pdf](http://www.scdmc.lk/docs/rtbp_cap_user_guide_v1_3.pdf)
  - (c) Requesting a copy from an RTBP support staff or other member listed in Table 2.
- At present RTBP is a pilot, users should be given training on providing feedback (or reporting) the acceptability of issues related to CAP, usability of the software, performance of the application and any bugs/fault encountered with the MAM applications. The feedback can be sent via email to the **General Complaints and Inquiries** or **Messaging/Alerting General Support** staff members listed in Table 2.

### 12.10.3 Prerequisites

Purpose: basic requirements for accessing MAM for health department personnel to use.

- The health departments intending to use the MAM should have a strong stable Internet connection to the personal computer they are accessing MAM through. To access the RTBP web interface use the URL –

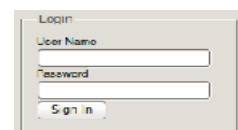


Figure 131: User login

<http://rs.rtbi-iitm.in/RTBPWeb/www/index.php>

- Health officials authorized to use the MAM, through the RTBP web interface, should be granted access with a user name and password. The username and password must be entered in text fields shown in Figure 131.
- To access the MAM the user must first log in to the RTBP web interface and then click on the menu item titled - Messaging/Alerting Module (Figure 132).

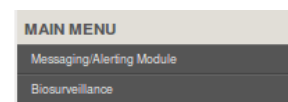


Figure 132: Menu screen

#### 12.10.4 Initializing messaging templates

Purpose: setup of message templates and recipient lists that need to be configured in the MAM prior to issuing health category alerts.

- To add or edit a template, the users can access the user interface by clicking on the add\_new template or edit template respectively (Figure 133).

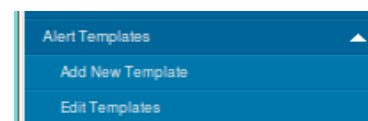


Figure 133: menu for templates

- RTBP team and Health departments in the respective project sites (Sivaganga District) will develop a set of CAP message templates in the MAM to issue both manual and automated alerts. The templates carry only a subset of the CAP message attributes with respect to the alert information, and resource segments that can be predefined. By clicking on each of the tabs, the user may view and edit the respective attributes of the three segments (Figure 134).

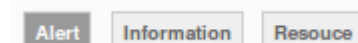


Figure 134: three segments

- For the purpose of the RTBP four main templates have been developed based on the policy and procedures assessment conducted during the months of April 2010 (Figure 135):
  - **Notifiable disease ACTION alerts** (action is required for the Form P & S list of diseases)
  - **Other-communicable disease ACTION alerts** (action is required for communicable disease not included in the Form P & S list of diseases)
  - **Notifiable disease awareness** (no action required, it is simply to make the health officials and health workers aware of the rise in Form P & S list of diseases)
  - **Other-communicable disease awareness** (no action required, it is simply to make the health officials and health workers aware of the rise in communicable disease not listed in the Form P & S list of diseases)
- In addition to the four main templates, the project has introduced one template (Figure 135):
  - **Top 5 WER** (Weekly Epidemiological Report) for IDSP to issue a situational awareness

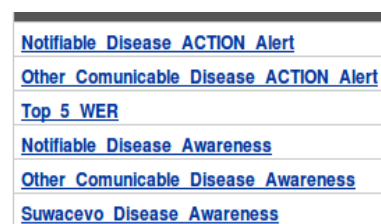


Figure 135: List of templates

message, once a week, to the health officials and health workers in their jurisdictions, to inform them of the diseases with the top five counts (i.e. first five diseases when sorted in descending order by disease count).

- Templates must be saved with the CAP alert **status** set to “Draft” (Figure 136). When issuing the alert the status should be set the appropriate value: *actual*, *exercise*, *test*, or *system* (see section 2.6.8)
- The **scope** of the message templates should be clearly distinguished between public, private, or restricted alerts. The RTBP will only issue restricted alerts in this phase of the project where the audience will comprise health workers and health officials. The set of designations of the recipients should be provided in the restriction field (Figure 136).

Figure 136: Attribute selection in the Alert segment

- In the information segment of the CAP template, the **category** = “Health” and **Language** = “English”. The **event** is a mandatory element must be pre-populated for the issuer's convenience (Figure 137).

Figure 137: set the language, category, and event

- The **headline** and **description** are partially defined with user having to complete these two elements in the Information segment of the CAP message at the time of issuing a message (see section 2.6.12). All words bounded by square brackets [ ] must be replaced with actual content pertaining to the particular incident (Figure 138). Any other values that should be populated at the time of issuing the message to complete the content in a meaningful manner should be demarcated with square brackets [ ]. Example the message issuer would replace the word disease with the dengue, if that were the relevant disease of concern.
- A URL to a website and a phone number should be predefined in the CAP template's information segment attributes: **web** and **contact**, respectively. The web URL and the contact number can be changed at the time of issuing a message (Figure 139).

Figure 138: partly defined headline and description

Figure 139: web and contact attributes

### 12.10.5 Establishing recipients and groups

Purpose: maintain recipient lists and groups of recipients to speed up the process of selecting recipients instead of looking up and entering them at the time of issuing a message.

- Health department should register the recipients and create recipient groups to efficiently selecting message recipients at the time of sending the messages. To add or edit the recipients email and phone numbers, click on the menu item **Contacts** (Figure 140).

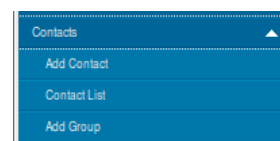


Figure 140: contact menu

- A designated staff member at each of the health departments should be responsible for the upkeep of the recipients list and groups. If a recipient changes his or her email or phone number, they should notify the staff member to update the system. Proposed staff members
- DDHS office → DM or DEO or both
- PHC office → HI or SHN or both
- For the purpose of the project the following individuals and groups have been identified: Deputy Director (DD), District Entomologist (DE), Data Manager (DM), Data Entry Operator (DEO), Block Medical Officer (BMO), Medical Officer (MO), Health Inspector (HI), Sector Health Nurse (SHN), Village Health Nurse (VHN)
- For the purpose of the project, groups have been created for each jurisdiction and designation (Figure 141). Examples: Seva\_HIs (Sevanipatti PHC area Health Inspectors), Thiru\_MOs (Thirukostiyur PHC area Medical Officers)

[Kuli PHIs](#)  
[Pann PHIs](#)  
[Wari PHIs](#)  
[Udub PHIs](#)  
[Pann MOs](#)  
[Kuli MOs](#)  
[RTBP Staff](#)  
[Kuru Dist MOH](#)  
[Suwacevo](#)  
[Udub MOs](#)  
[Wari MOs](#)  
[Wariyapola PHMM](#)

Figure 141: recipient groups

### 12.10.6 Creating a CAP Alert and situ-aware messages

Purpose: communicate diseases alert and situ-aware messages to the respective health officials and health workers for the purpose of choosing to respond to those communicated events.

- Only trained and authorized users should be granted permission to issue alert and situational awareness messages. Only alert and situ-aware messages that are authorized by the designated decision-maker should be issued.
- Health events detected manually through the T-Cube Web Interface (TCWI) or events detected through other processes must be, first, verified and authenticated by the disease-event-detection analysts and then receive authorization by the designated Decision-Makers of that health department before creating and issuing an alert or situ-aware message.
  - DDHS office: detection analysis done by Data Manager/Data Entry Operator and decision to issue the message is granted by District Entomologists and Deputy Director.
  - PHC office: detection analysis done by Health Inspector or Sector Health Nurse and decision to issue the message is granted by the BMO or MO.
- The Decision-Maker should instruct the Message-Creator of the alert type, as to whether it is a

Notifiable disease action alert, Other-communicable disease action alert, Notifiable disease situational-awareness, Other-communicable disease situational-awareness, Top 5 WER.

- Messages that are authorized for issuing should be relayed through the RTBP MAM; specifically the “Alert” sub module that uses the **CAP** standard (Figure 142). To access the CAP alerting module, Message-Creator should, first, login and navigate in to the RTBP Messaging/Alerting Menu; see *Figure 142: Issue disease alert menu* section 2.3 and procedures 2.2.2 and 2.2.3. Thereafter, click on the sub menu titled: **Issue DISEASE Alerts** followed by **Create New Alert** (Figure 142).



- Each alert issued must be given a name to identify that alert during an audit or when wanting to reuse that same alert to issue an update, acknowledgement, or cancellation of the message. The naming convention should be **jurisdiction-disease-date** (Figure 143). The jurisdiction can be the abbreviation or acronym of the jurisdiction name concatenated with the first 3 to 4 characters of the location (village, town, division, district, or province name). The disease name can be the full name or a short form like ADD for Acute Diarrhea or RTI for Respiratory Tract Infection. The date can be a single string concatenation of the four digit year, two digit month, and two digit day (leading zero if 1 - 9), Example – mohwari-rti-20100502.

Figure 143: selecting CAP, name, and existing template

- Although it is permissible to issue just-in-time fabricated CAP messages, it is highly recommended, in order to preserve the integrity, completeness, unambiguity of the message to use predefined templates to issue the CAP messages. Click on **Existing Alert Template** for this choice, which would present the templates as shown in Figure 143.

Figure 144: fill in the sender only

- **Sender** field is a mandatory element and without completing this the Message-Creator could not proceed further. It is recommended that the email address, of the message-issuer, decision-maker or responsible health official for that jurisdiction, is given (Figure 144). Message-Creator may allow other fields in the initial screen of the message creation (Figure 144) remain with the default values.

Figure 145: Alert segment elements

- The Message-Creator must remember to set the **messageType** and **status** (Figure 145) in the tab titled: **Alert**. The status must be changed from the value “Draft”, which is set at the time of creating the template (see section 2.4.5), to either “Actual”, “Exercise”, or

“Test” based on your intentions. Similarly, the messageType must be set to “Alert”, “Update”, “Cancel”, or “Ack” based on the intention (Figure 146).

- The **restriction** list, also in the Alert tab, should be edited to correctly reflect the list of actual recipients (Figure 145 is edited such that the message is restricted for PHIs only). Thus, in case the message is received by health official, health worker, or any other person not on the list, for that matter, they know that the message may have been sent to them by accident and that they may chose to disregard the message or choose to inquire from the sender as to whether the message was intend for him or her. All other attributes may remain as per the default values.
- Of the attributes in the **Information** tab – **language**, **category**, and **event** should not be changed and allowed to remain with the default values (Figure 146). These values are predefined at the time of creating the template as per the policy and procedures gathered from the interviews with the health department officials.

Figure 146: default Info elements

- It is essential that the **priority** of the message is set based on the severity, certainty, and urgency of the message (Figure 147). An **urgent** priority message requires immediate action, **high** priority message requires execution of response plans if the threat is eminent, and a **low** priority message is simply an awareness where recipients are recommended to be vigilant of the event escalating. The reader should refer to the RTBP CAP Guidelines mentioned section 2.2.3 to understand the scope of the message priority.

Figure 147: setting the priority

- The **sender name**, **headline**, and **description** must be changed to fit the particular incidence. Sender name is the actual name (example first name and last name) of the Message-Issuer. Headline requires that the [disease] name and the [area] affected be properly replaced. Description requires the [number] of cases, [disease] name, [age groups], [genders], and affective geographic [areas] are replaced with the appropriate words bounded by square brackets [ ]. Figure 148 illustrates an example:

Figure 148: sender, headline, and description

- 14 cases of Respiratory Tract Infection applicable to all genders and all age groups were reported by the Katupotha District Hospital.*
- Based on the priority level of the incidence a response action must be indicated. A set of fixed **response type** values are given in the drop down list; where **prepare**, **monitor**, **execute**, **assess**, or **none** are the most appropriate values to select one (Figure 149).

Figure 149: response type with effective, onset, and expire dates

- Alert and situ-aware messages are not intended to be internal. Therefore, the message must specify the **effective** and **expire** date of the message; meaning what is the date range, start and end, of the message validity (Figure 149). It is to the discretion of the health departments of Message-Issuer to decide the effective period of the alert (i.e. the number of days Expires = Effective + Num-days). A date time calendar will pop-up when the user clicks inside the text field of the effective or expire date boxes. The time zone is by default set to reflect the UTC shift for India and Sri Lanka; hence, the Message-Creator need not change the value and may leave it as default.
- The **onset** date is the date and time of when the incident began, which is intuitively on or before the effective date of the alert or situ-aware message. To set the onset date click inside the text box for the calendar to appear. Similar to the effective and expire date the UTC time shift is, by default, set to Indian and Sri Lankan time zones and need not be changes (Figure 149).
- The **instruction** text box can be used to provide additional information with respect to the description or response (Figure 150). A default set of instructions are indicated at the time of creating the template; however, can be changed based on the incidence such as mentioning the set of actions that should be applied specific to the particular disease.

Figure 150: instruction, web, and contact

- The recipient can be directed to a **web** page that carried a complete description of the alert or situ-aware message or web page carrying additional information. The **contact** is a telephone number (or hotline) for the message recipients to verify the message or receive further information. By default, the web URL points to the complete CAP message published on the web and the contact number is the DDHS office number. These two values may be changed; for example, if a PHC office is issuing the message, then the contact phone number can be the PHC office phone number opposed to the default DDHS phone number (Figure 150).

- The Area segment of the CAP message describes the geographic area for which the message is issued to. This **area description** is different from the area indicated in the description or headline, which indicates the locations the disease was reported from.

Figure 151: area description (locations message is for)

Whereas the area to which the alert or situ-aware message is issued is wider areas. For example, the disease incidence may be reported from two neighboring hospitals in a PHC division but the alert or situ-aware message may be issued to the entire district. The Message-Creator should first select the location category followed by the location type. Thereafter, type in the name of the geographic area for which the message is intended. When typing the name, the software application will recommend similar names that are in the database from which the Message-Creator may select one or more locations (Figure 151).

- After all values pertaining to the message have been completed, the Message-Creator should click in the **update** button, located at the bottom of the entry forms, to save the values to the

database prior to disseminating the message. Message-Creator may save the work during any time of the message-creation process.

### 12.10.7 Delivering the Alert and Situ-Aware messages

Purpose: select the appropriate recipients or groups of recipients and disseminate the message through the available SMS, Email, and Web publishing channels.

- Once the created message is successfully saved (or updated), a message will appear at the top of the form as in Figure 152. The Message-Creator or Message-Issuer can click on the blue hyper-link to begin sending the message.



Figure 152: warning message

- Overall, the Message-Issuer should check all values before sending a message because once the message is sent it cannot be revoked. In the event a user does want to correct or amend an issued message, then they should re-issue the same message but changing the Message Type to “Update” or “Cancel”.

- Alert and situ-aware messages should be issued only to those **recipients**: health workers and health officials the message is intend for. To deliver the message via SMS and email the mobile phone number and email address of the recipient is required. Recipient phone numbers and email addresses can be directly entered in to the recipients text box (Figure 153). Each phone number and email address must be separated by a comma. All phone numbers should preceded with 00 (for international dialing) followed by the country code (e.g. 0091).

```
0094777555222,
mohpan@health.gov.lk , {r7l2msg-
22:Pann_PHIs:team}
```

Figure 153: recipients list

- To add include groups of recipients, simply click on the group name (e.g. Seva\_PHC), shown in Figure 154. This would automatically include those recipients in to the delivery list, similar to the group id - `{r7l2msg-22:Pann_PHIs:team}` (Figure 153).

**Groups**

- Wayamba\_PDHS
- Kuli\_PHIs
- Pann\_PHIs

Figure 154: groups

- Once all recipients are included in the recipients list (Figure 153), click the button labeled “**Next → Alert Type**” to proceed to the next page for selecting the **delivery types**. Select each of the delivery types SMS, Email, and Web through which the message should be disseminated. There are three delivery types: long-text, short-text, and voice-text messages. The RTBP will use short-text and long-text delivery types only with **SMS**, **Email**, and **Web** as the three different delivery technologies (Figure 155). The difference between the short-text email and the long-text email is that the long-text email will attach the CAP XML file in the email.

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

Figure 155: delivery types

- Click “**Next** → **Transform Message**”, which will transform the CAP message to an SMS, Email, and Web as defined by the Implementers. The resembling transformed messages to be delivered via SMS, Email, and Web will be displayed in the next screen, as shown in Figure 156. The Message-Issuer has one last chance to edit the message, if necessary, before clicking the “**Send Message**” button, which would deliver the message.
- To change the appearance and the structure of the SMS or email alert or situ-aware messages, consult the Implementers or Support Staff mentioned in Table 2.

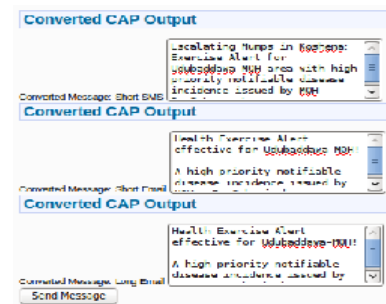


Figure 156: transformed messages

### 12.10.8 Reporting bugs and problems

Purpose: ensure uninterrupted use of application with less ambiguity, maximum functionality and minimal down time.

- Any bugs, problems, or observations, or enhancement requests with respect to the MAM should be reported to an RTBP member in Table 2.
- The Research Assistant will meet with the users each month to assess the workability, problems, and performance of the MAM.

### 12.10.9 Contact information

- Health officials should be provided with a list of important contact information

Table 83: Contacts list for health officials

Role	Name	Email	Mobile Phone	Fixed Phone
General Complaints	Janakiraman	<a href="mailto:janu@tenet.res.in">janu@tenet.res.in</a>	+919747010875	+919747010875
TCWI / MAM General support	Suma Prashant	<a href="mailto:suma@tenet.res.in">suma@tenet.res.in</a>	+919717763888	+914422570428

## 12.11 Quick Reference Guide – mHealthSurvey

The mHealthSurvey mobile application version 1.2 is intended for collecting outpatient and inward patient temporal and spatial information: case date/time, hospital/clinic location, gender, age-group, disease, symptom, and signs. This data is then used by MOH and Regional Epidemiology Unit in real-time analysis for detecting outbreaks.

**Note ::** Refer to your mobile phone user manual that you should have received to study the key pad functions, menus, and operating standard applications such as the Internet browser and setting the standard clock.

### 12.11.1 Mobile Phone SPECIFICATIONS


For the mHealthSurvey application to work on your phone, it must be Java enable and specifically contain the Java Specification Requirement (JSR) components: MIDP 2.0 (Mobile Independent Device Protocol) and CLDC 1.1 (Connection Language Device Control). The mHealthSurvey requires a minimum of 100 KB memory for the software and Record Management System (RMS).

### 12.11.2 Enable INTERNET Access

Contact your mobile service provider: Dialog Telekom, Mobitel, Etisalat, Hutch or other, and request that they enable GPRS services (Global Packet Radio Services). Make sure to ask that they enable both Internet WAP (Wireless Application Protocol) and Data Packet Services.

### 12.11.3 INSTALL Software


- **DOWNLOAD ::** Find the **Internet** icon (or default WAP browser) on your mobile phone main menu, the icon typically looks like the one in Figure 157, then press OK phone-key to access the World Wide Web (WWW). Choose the function “**Goto URL**” or “**Go to Address**” and type <http://www.scdmc.lk/mhslk/>. This will take you to a web page that displays the software -.

 [mHealthSurvey.jar](#) 10-May-2010 12:56 24K

Choose and click the hypertext link

**mHealthSurvey.jar**. The mobile phone will display a warning: “**Application is not from a trusted supplier. Continue anyways?**” Choose **YES**. Thereafter, the mobile phone will guide you through the installation process.

- **START SOFTWARE ::** click on the icon labeled **Applications**. By default the mHealthSurvey will install in which the “**Applications**” folder appearing as an icon; otherwise, navigate to the folder you chose to install the software.

 mHealthSurvey  
17/03/2010 56KB

Click on the icon: mHealthSurvey. if application executes, then you will see header displaying **Select one to launch**, press the mobile phone OK

 Select one to launch:  
m-Health Survey



Figure 157:  
Mobile phone menu

key to **launch** the **m-Health Survey**.

#### 12.11.4 **SETUP** your profile and locations

**Note ::** All fields and functions labeled with (\*) are mandatory and they must be completed before proceeding with the next steps.

##### 12.11.4.1 Download List(\*) - update lookup values

- Scroll to **Download List (\*)** press OK phone-key to retrieve all up-to-date look up values from the database. The mobile will ask “Access Network?”; Choose **YES**. Be patient for a few minutes, while “Status: downloading ...”; once completed will display “Successfully downloaded”; at which point you can choose ‘Dismiss’ or “OK”, which will return you to the mHealthSurvey menu (Figure 158).

**Note ::** You should execute step 1, at least, once a week to update your phone with the newest list of disease, symptoms, and signs.

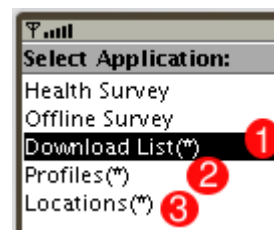


Figure 158: Menu

- Scroll to **Profile (\*)** press OK phone-key to setup your personal profile. Once you click, you will see a data entry form as in Figure 159.
- Scroll **Location (\*)** press OK phone-key to download the names of hospital and clinic, towns relevant to you. Once you click you will see a data entry form as in Figure 160.

##### 12.11.4.2 Profile (\*) - register single or multiple users

- enter your Health Ministry provided Health **ID:(\*)** in the first text box, then **Retype ID (\*)**, the same again in the second text box.
- Give your **First Name (\*)** and **Last Name (\*)**. The Last Name is also considered your “surname” or “family name”.
- Scroll to the health worker **Type (\*)**, which is also regarded as the professional title or designation. Click Type to expand the drop-down list, scroll down to the appropriate title and click to choose that one. If your title or designation is not in the list, immediately inform the Support Staff (Table 1).

Figure 159: Setup profile(s)

**Note ::** You may add any number of profiles, for example, if more than one person intends to use the same mobile phone for submitting records.

##### 12.11.4.3 Locations (\*) - define the working area(s)

- Click on **Location (\*)** in mHealthSurvey menu (Figure 158), you will be presented with the screen in Figure 160. Navigate to and click on health location **Type:(\*)**, which will display the list of health location types: . District, MOH, National, Province, Region, and village. Scroll down to the value then click OK key on your mobile phone to accept that value

- Type in the **Area Name:(\*)**; for example, if selected *PHI* as the health location type and are referring to the *Wariyapola PHI* area, then type “*wariyapola-phi*”. If you selected *District* as the health location type and are referring to the *Kurunegala District*, then type “*kurunegala-district*” to retrieve all towns and villages belonging to that district.
- Press the SELECT phone-key to pop-up the function menu to display the two options: **Send** – to send your request to the server to receive the locations or **Reset** – to clear all values you entered and to start again.

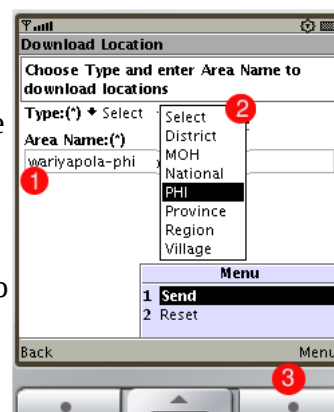


Figure 160: Setup locations

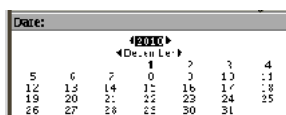
**Note ::** to change the list of locations follow steps 1 – 3 above in section heading: **Locations(\*)**, which will replace the old list with the new list of locations.

## 12.11.5 SUBMIT outpatient and inward records

### 12.11.5.1 Health Survey Screen 1: Patient demographics

Click on **Health Survey** in mHealthSurvey menu (Figure 158). You will be presented with the first screen of the Health Survey (Figure 161).

- The **Date** and **Time** will be automatically set to the current date and time as set on your mobile phone standard clock.



Click on **Date** to change it, then use the *Up*, *Down*, *Left*, and *Right* navigation keys on your phone keypad to change the date on the calendar.



Click on **Time** to change it, then use the *Up*, *Down*, *Left*, and *Right* navigation keys on your phone keypad to change the time on the clock.

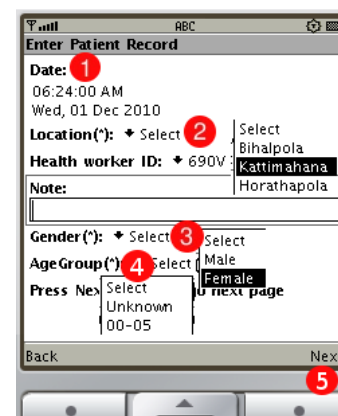


Figure 161: Health Survey screen 1

**Note ::** This date and time represents the patient visitation date and time. If you are not entering the data in real time then you should change the date and time to reflect the actual patient visited date and time, which otherwise, will affect the detection analysis.

- Scroll down to **Locations:(\*)**, then press the OK phone-key to expand the drop-down list. Scroll down to the desired value: *Bihalpola*, *Kattimahana*, *Horathapola*, ... and click OK phone-key to accept the value.
- Scroll down to **Gender:(\*)**, then press the OK phone-key to expand the drop-down list. Scroll down to desired value: *Male*, *Female*, *Unknown* and click OK phone-key to accept the value.
- Scroll down to **Age Group:(\*)**, then press the OK phone-key to expand the drop-down list.

Scroll down to desired value: 00-05, 06-15, 15-19, ... and click OK phone-key to accept the value.

- Press the SELECT phone-key to go to the next screen (Figure 162).

### 12.11.5.2 Health Survey Screen 2: Patient disease/syndrome



- **Disease** - There are three options for submitting the Disease information:

**Confirmed diagnosis:** If the patient was diagnosed with a disease, enter the first few characters of the disease name (e.g. disease is “chicken pox” then type ch). Scroll down to the **Disease**, press OK phone-key to expand the drop-down list, scroll down the list then press OK phone-key to choose the desired value.



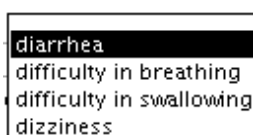
**Other confirmed diagnosis:** If the patient diagnosis is confirmed but the disease is not in the list, then type the complete disease name in the Search Disease:



**Unknown diagnosis:** If the patient was not diagnosed and only the symptoms and signs are known, then do not enter anything in the **Search Disease:** text box, simply scroll down to the **Disease:** and choose the value **Unknown**.

- **Search Symptoms (\*)** - the symptoms field is mandatory and must be filled. In the case of a “*confirmed diagnosis*”, when a disease is selected the symptoms field will automatically fill with values.

**Remove** those symptoms that do not apply to the specific case using the standard DELETE or BACK phone-keypad.



**Add** those symptoms that are not in the list by first, typing a *comma ( , )* to separate the word(s), then start typing the first few characters of the symptom name. Thereafter, all symptoms starting with those characters will appear in the drop-down list. Scroll down to the desired value and press OK phone-keypad to select

that value. It will then appear in the symptoms list box. To add another follow the same step by separating the words with a comma.

For “*unknown diagnosis*” or “*other confirmed diagnosis*” to **Add** the set of symptoms follow the same instructions above.

- **Search Signs** – signs are not mandatory but are recommended for accurate syndromic surveillance. The procedure for removing or adding symptoms are same as that for symptoms.
- **Update** – press the SELECT phone-keypad to submit the record to the database.

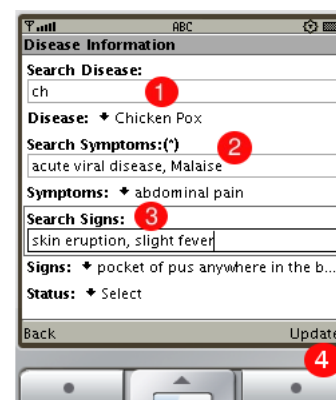


Figure 162: Health survey screen 2

### 12.11.6 OFFLINE Survey

If the Internet connectivity is poor, then the health survey record will be stored in the mobile phone's internal memory. After you regain connectivity, press the **Offline Survey** function (Figure 158) to submit all stored records to the database.

### 12.11.7 SUPPORT Services

If you have any trouble with setting up the phone, installing the software, submitting records, or understanding any of the operational instruction, please contact the personnel below.

**Name:** .....

**Phone:** .....

**Email:** .....

## 12.12 TCWI quick reference guide

### 12.12.1 How to load data sets



Figure 163: File upload panel

1. For preloaded dataset, click the **Upload File** button, select one item from drop down list (e.g. “TamilNadu-current.tcube”)
2. Once you have finished using TCWI or want to refresh the data - Click **Clear Data** button to unload the dataset and clean up time series and map display

### 12.12.2 How to query the data in T-cube

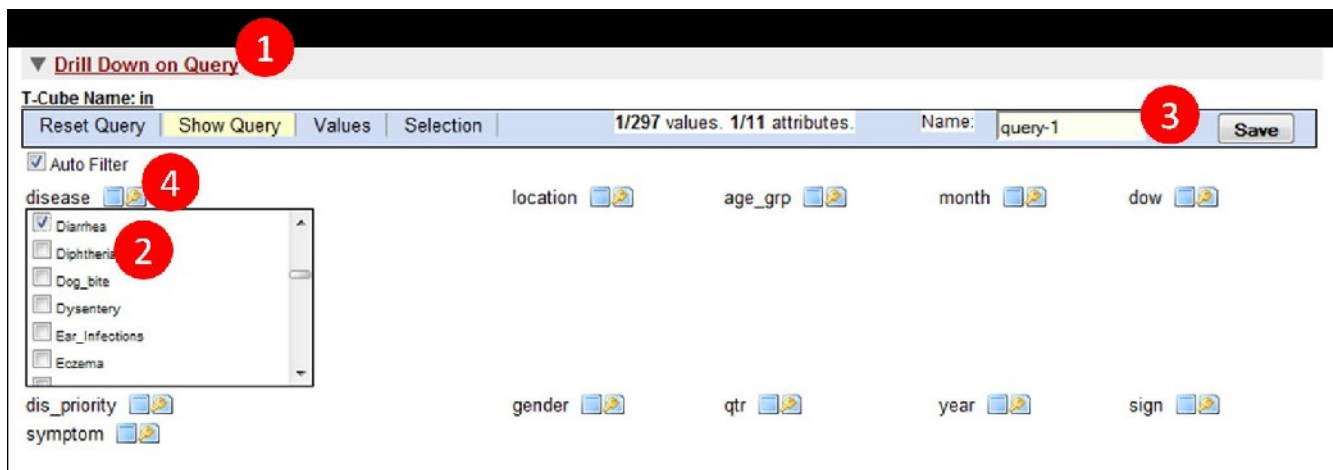


Figure 164: Query panel

1. Click to expand **Drill Down on Query** section
2. Click any attribute name and select attribute values (e.g., attribute =disease, value = diarrhea)
3. By default, this will update the “current query”. Optionally, you may supply a name of the query and save it, which will be appeared as a named time series in the time series panel.  
*Note: Named time series can be renamed to, rename a time series, expand **Analysis** section, in left panel select the time series to be renamed, supply a name at the bottom of the left panel, and click **rename** button*
4. For Advanced Query, click **key icon**, it will show panel as following, this example shows how to extract all fever like diseases – type “fever” , click **contains** radio button, click **select**, then **okay** button, Click **show Query** to confirm that the query is correct

Figure 165: Advance query

### 12.12.3 How to navigate the time series panel

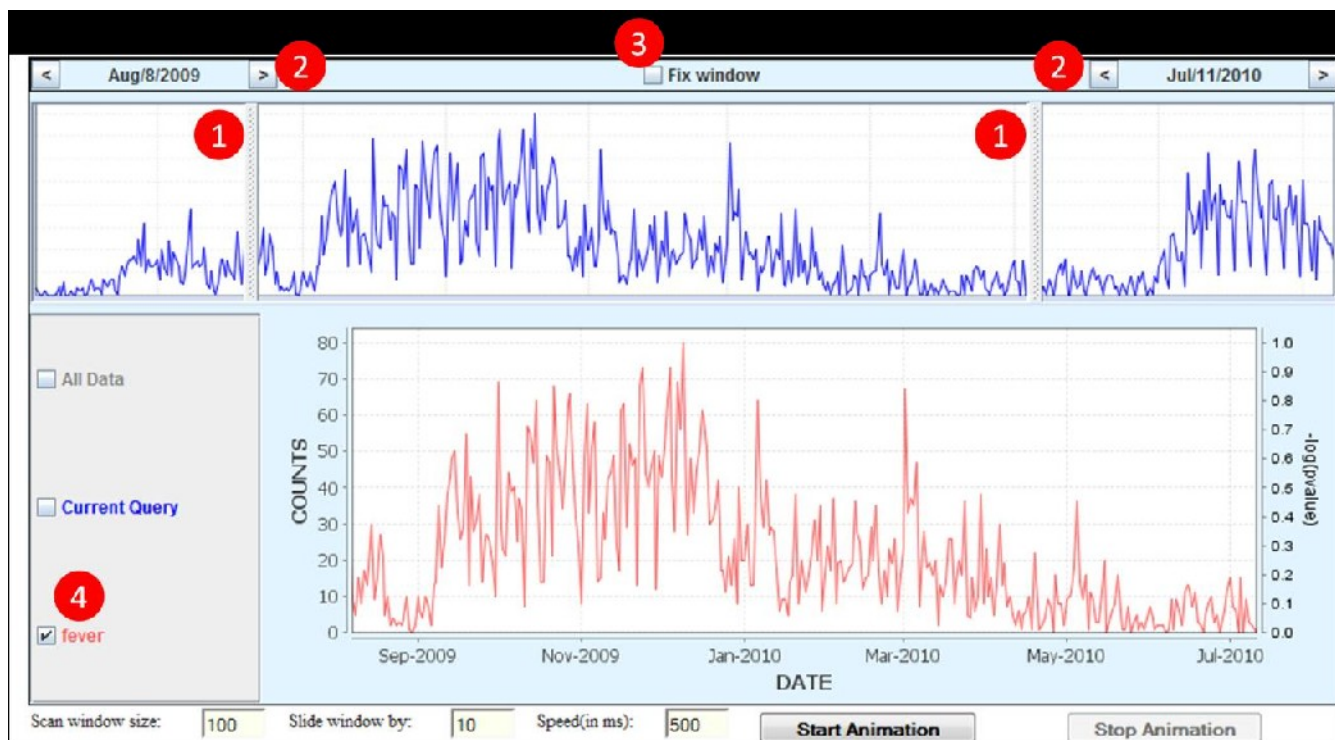


Figure 166: Time series panel

1. The upper panel of time series shows a complete view of “current query”, moving slider bars allows to sub select the time series, so that lower panel of the time series (i.e. look at the time series in a particular time window, e.g. Aug/08/2009 to July/11/2010) and then the map will be updated accordingly
2. For finer control of the sliding bar, use arrow button to move in one day increments or decrements
3. Check **Fix window** allows the two sliding bars to moving simultaneously
4. This area list all time series can be displayed, checking/un-checking any of them enable displaying/un-displaying time series. Right click the name of time series brings up control panel, which allows changing visual property of time series such as color, line type, thickness etc.

### 12.12.4 How to navigate map panel

1. Click to expand the **map** section
2. Optionally, you may switch among different type of map: map, satellite, hybrid, terrain
3. Optionally, zoom in or zoom out the map
4. This is the legend, circle size is proportional to accumulated patient case counts within certain range of time scoped by the sliding bars in time series panel

*Note: The circles are solid colored if there is only one time series in display; it changes to non-solid circle when multiple time series are displayed*

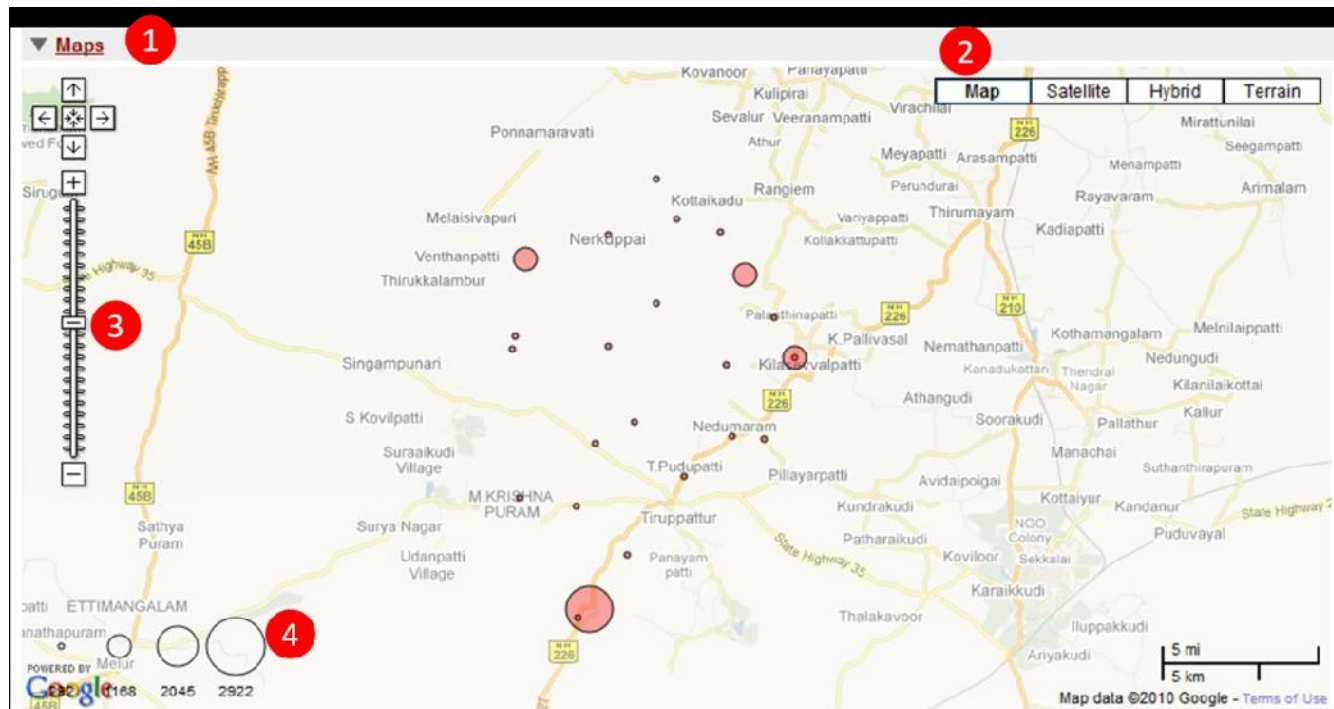


Figure 167: Map panel

### 12.12.5 How to do pre-defined screening

1. Click to expand the **Screening Results** section
2. Click on any of the button to run a particular type of screening (e.g. Escalating fever diseases)
3. This section describes the nature of the selected screening, for example, we are now screening for any significant upward trend of fever cases in last 7 days in a particular location and/or age group. This screen returns 15 result queries;
4. Click on any of the result queries in the list, the time series and map panel will be uploaded accordingly, a view of time series is shown below
5. This is a general description of the highlighted result query
6. You may navigate to other set of result queries by clicking this button

7. You may save the screening result to a comma separated (csv) file (**Save Result to File** button) or generate a well-formatted html file to be readily printed (**Print List** button)

*Below is a time series view of a particular screening result query*

8. This is the raw counts of result query (i.e. a target query in temporal scan, refer to temporal scan analysis)
9. This is temporal scan p-value series
10. Highlighted is the window with most the significant p-value (i.e. the window contains period with most significant trend of increasing fever diseases for a particular location and/or age group).

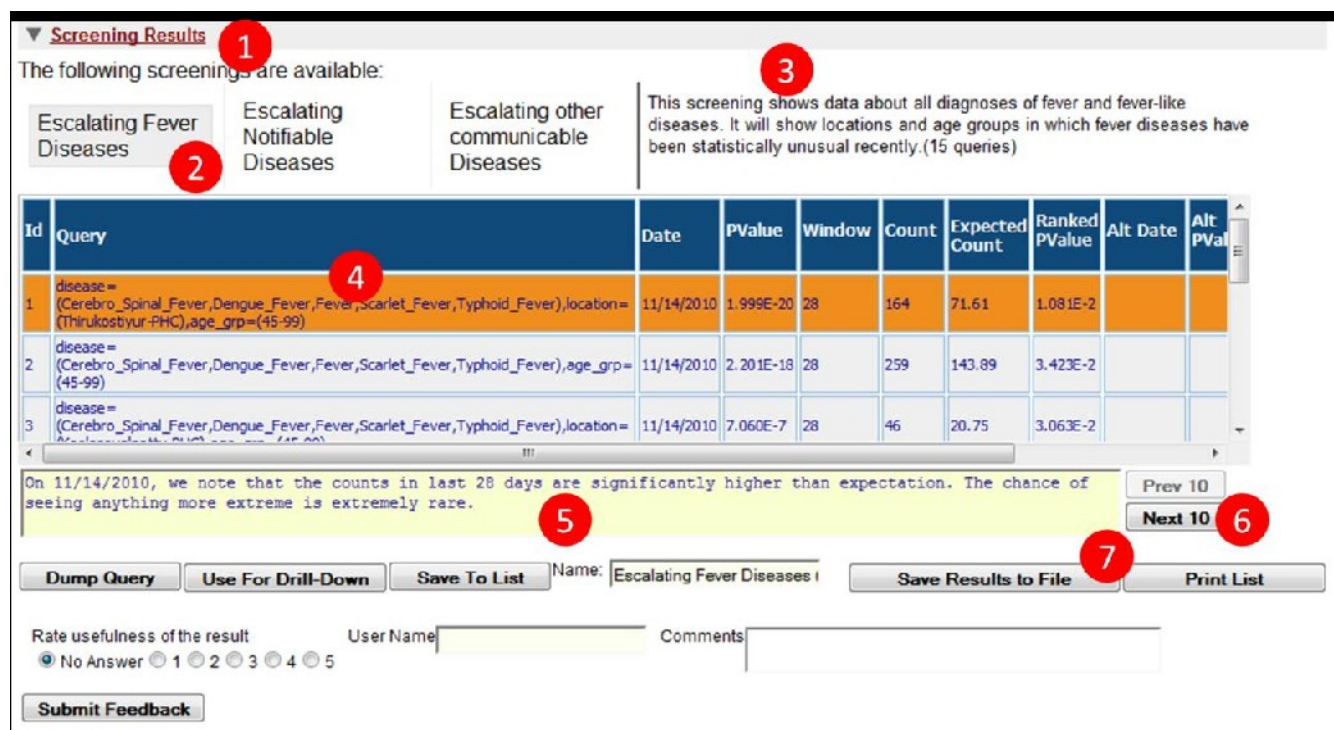


Figure 168: Predefined screening panel

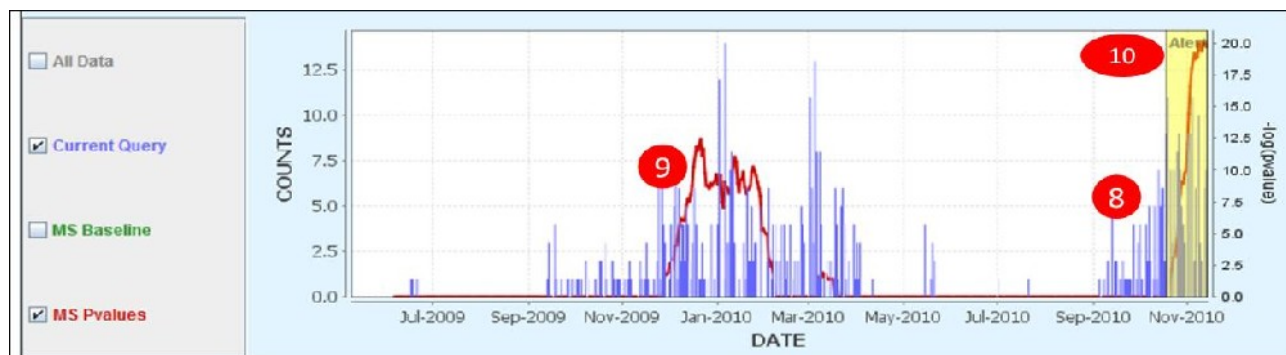


Figure 169: Time series highlighted with alert and most significant p-values

### 12.12.6 How to run pre-configured pivot table (report)

1. Click to expand **Pivot Table** section
2. Select data source of the pivot table (if multiple data cubes are loaded)  
(For IDSP weekly report)
3. Click on the title of report – IDSP weekly report, the pivot table is immediately populated with accumulated counts by disease by location from last seven days.
4. Colored cells indicate increase of counts from last period of same length (e.g. increase of counts from last week)
5. If set to “Numeric”, large numbers will be moved to upper left corner of the table, otherwise, the list of disease name and location names are ordered alphabetically
6. If set to “Yes”, the pivot table only shows diseases and/ locations with non-zero counts; otherwise, all locations and diseases in the database will show up in the table, rendering of large table can be slow.

	Acute_Diarrheal_Disease	Dog_bite	Dysentery	Fever	Polio	Total
Keelasevalpatty-PHC	0	3	3	37	0	43
Nerkuppai-PHC	0	0	0	15	0	15
Sevenipatti-PHC	5	2	0	11	0	18
Thirukostiyur-PHC	0	2	0	114	1	117
<b>Total</b>	5	7	3	177	1	193

Figure 170: Pivot table panel

(For monthly Morbidity Report)

7. Click on the title of report – Morbidity report, the pivot table is populated accordingly
8. click on any of the location to show the section of report related to that particular location
9. **Save to File** saves the current pivot table to a csv file; **Print Report** will display a well formatted html file for printing in following format

**Pivot Table Report**      **Report Run Time:**      **Wed Nov 17 11:16:08 GMT-600 2010**  
**Dataset ID:** in

This pivot table shows disease vs location for diseases in form P and S for the last 7 days. Pivot Table Date Range: 2010-11-08 - 2010-11-14

	Dysentery	Fever	Total
Kaiaasecalpaty-PHC	3	37	40
Nerikappa-PHC	0	11	11
Sevenipatti-PHC	0	11	11
Thindostyur-PHC	0	114	114
Total	3	177	180

End report.

Figure 171: Sample pivot table report

## 12.12.7 How to run analytical method

All analytical methods are made available from Analysis section. A generic procedure to perform analysis is as following:

1. Pick a time series as “target query” from left panel
2. Pick a method
3. Set parameters and where applicable, a second time series (e.g. as baseline)
4. Push **submit** button, the result query is added to the time series panel

### 12.12.7.1 Smoothing (moving average/moving sum)

Create New

Update

---

Choose Method: Moving Average

Series name: ma-fever      Target: fever      ☒ Auto update on target change

Smoothing: ☐ Trailing ☒ Centered ☐ Leading

Window Size: 28

Submit

Figure 172: Statistical estimations panel

*Note: when “Auto Update on target change” is checked, the analysis result queries will be updated with the target change. This is only applicable when use “current query” as a target query.*

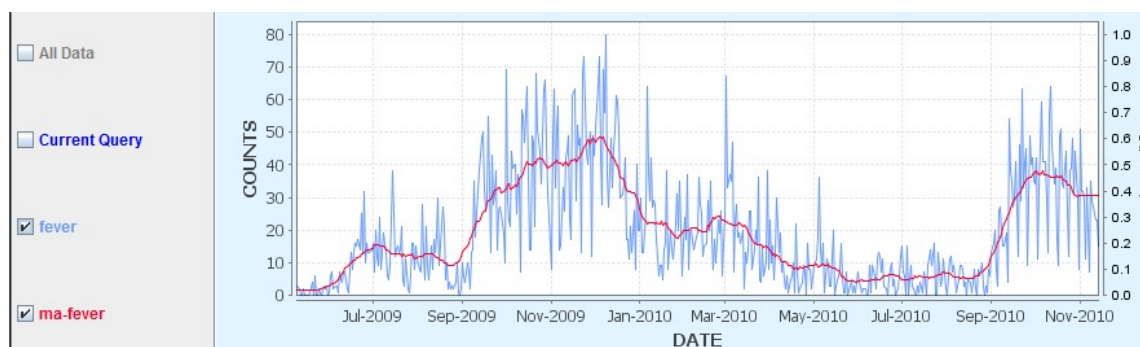


Figure 173: Sample output of moving average

### 12.12.7.2 Temporal Scan

The temporal scan result shows that there is increasing trend of fever cases as comparing with baseline (all disease cases) in September 2010.

Create New Update

Choose Method: Temporal Scan

Series name: tempscan-fever Target: fever ☐ Auto update on target change

Baseline: All Data ☐ Auto update on baseline change

Period of Analysis - Start Date: 05/10/2009 End Date: 11/14/2010

Period of Reference - Start Date: 05/10/2009 End Date: 11/14/2010

Window size: 7 ReferenceType: Reference Type Trailing

Reference Window: 28 Lag: 0

Scan option: Upper Tail Min Support: 0 Pvalue threshold: 0.05 ☒ Apply FDR

Submit

Figure 174: Temporal Scan parameters

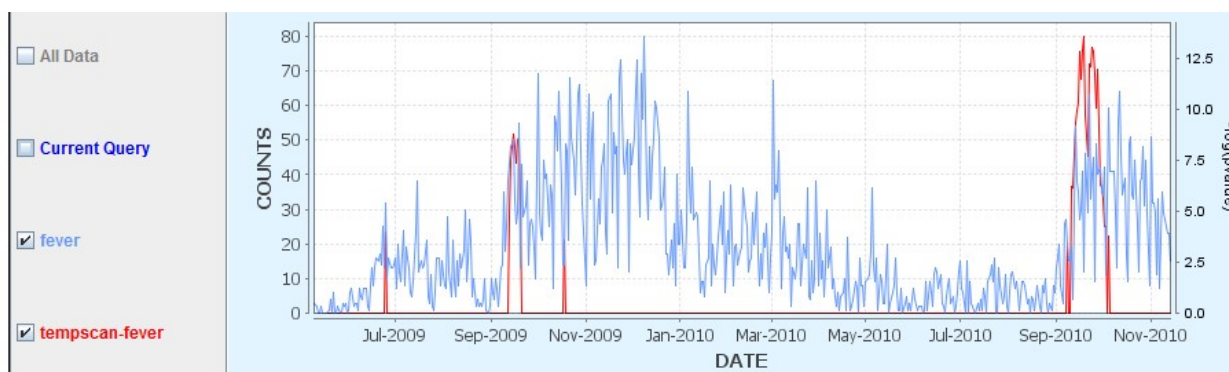


Figure 175: Sample temporal scan output

### 12.12.7.3 CuSum

Create New Update

Choose Method: CuSum

Series name: cusum-fever
Target: Current Query
☐ Auto update on target change

Cusum Tolerance (K): 0
Cusum Period (in days): 91
Cusum Threshold: 7

Submit

Figure 176: CuSum parameters

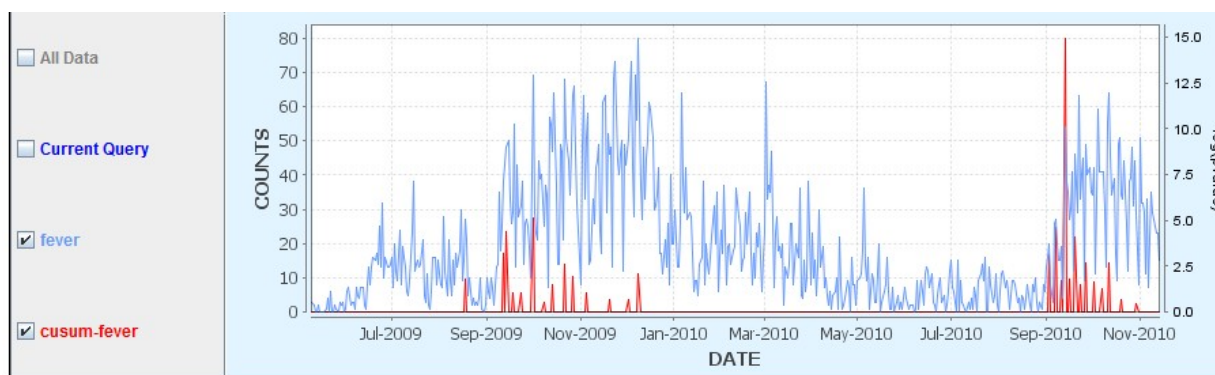


Figure 177: Sample CuSum output

Figure 177 shows The CuSum result indicates an increasing trend for fever cases in September 2010

### 12.12.7.4 Spatial Scan

Create New

Update

---

Choose Method: Spatial Scan

Series name: sscan-fever      Target: fever

Start Date(mm/dd/yyyy): 05/10/2009      End Date(mm/dd/yyyy): 11/14/2010

Window: 7      Group Size: 5      Amplitude: 1.5      Previous Days: 85

Submit

Figure 178: Spatial scan parameters

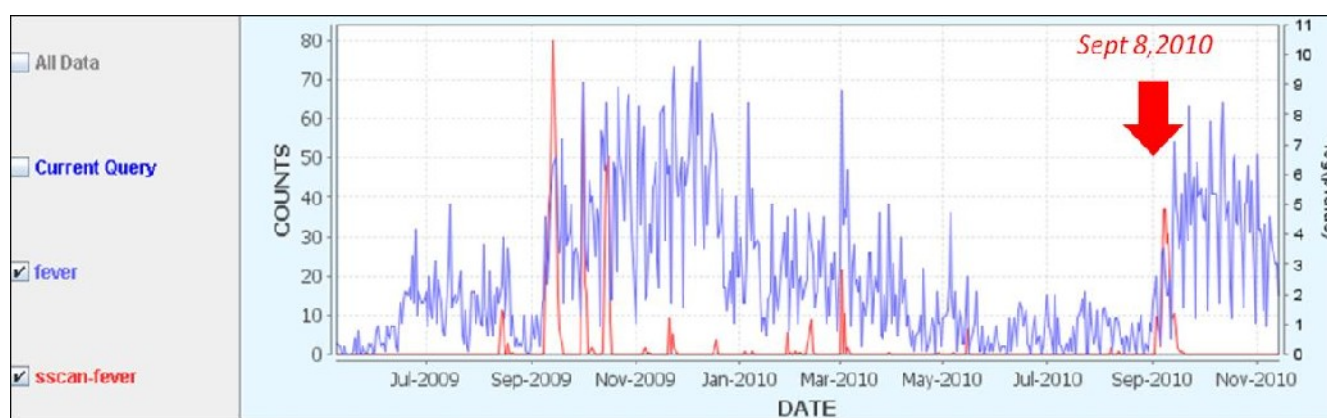


Figure 179: Sample spatial scan results

The spatial scan result shows global score of outbreak probability (i.e. the likelihood of having something going on among all the locations), when moving the sliding bar to the arrow location, the map view is as following, the red circle(s) highlights the location(s) where the spatial scan believe has high probability of outbreaks in last 7 days.

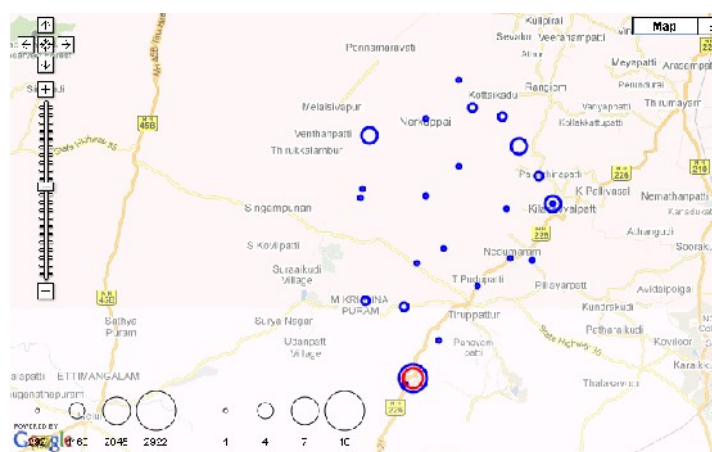


Figure 180: Sample plot of Temporal Scan on map

To confirm that there is actually something going on in this particular location, we plot time series of fever cases for this location (Thirukostiyur-PHC). It seems that there was sudden increase of fever case in this location around September 8, 2010.

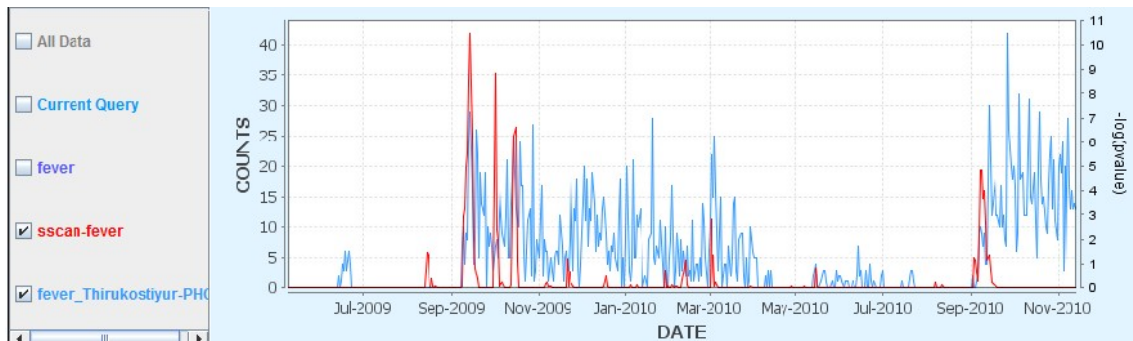


Figure 181: Temporal scan detects fever cases in a location

## 12.13 SABRO quick reference guide

This quick reference guide is intended for standard daily users and not super users. Therefore, it does not provide instructions on setting up templates or other implementation aspects. A user can create a new alert using an existing template or update an already created message, then issue the message to targeted groups via SMS, Email, and/or Web. This messaging application complies with the **Common Alerting Protocol** (CAP) global emergency messaging data standard. For more information on the CAP standard visit the URL: <http://tinyurl.com/njguqt> (CAP Cookbook).

### 12.13.1 Accessing the Messaging/Alerting Module

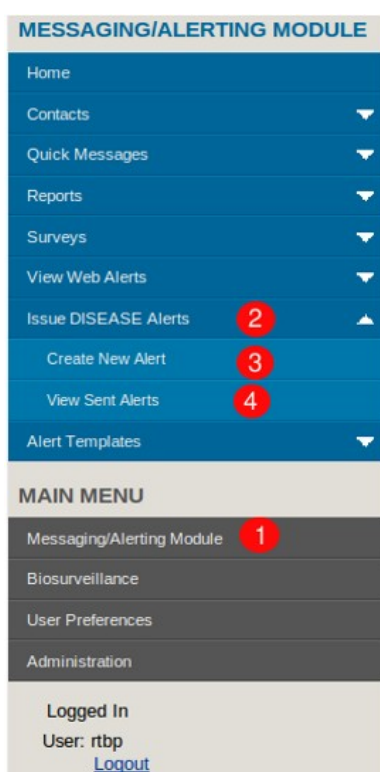


Figure 182: Menu

- After accessing the **Real-Time Biosurveillance Program** web application through the URL (<http://rs.rtbiiitm.in/RTBPWeb/www/index.php>) and completing the login process with the user name and password, you will be presented with the **MAIN MENU**. Click on the main menu item **Messaging/Alerting Module**. The menu will expand to show the full set of sub menus of the Messaging/Alerting Module.
- Click on **Issue DISEASE Alert** to expand the menu to see all available functions.
- Click **Create New Alert** to start generating a new alert
- Click **View Sent Alerts** to view the list of all previously created and possibly issued messages (see Figure 182)

**NOTE:** The applications is set to timeout if it is in idle for more than 5 minutes. This is to prevent any unauthorized user

from tampering with the application in case you forget to logout. Therefore, it is recommended that you have all information with you in relation to the alert you wish to issue before beginning the process.

Figure 183: Create new alert with template

### 12.13.2 Create New Alert

- Click the radio button **CAP** (Figure 183); then enter a unique name to label (identify) the alert message, which will show in alerts list (Figure 184); thereafter, click the radio button: **Existing Alert Template**.
- All values except the **Sender** text box will be populated with default values and you may leave them as is. In the **Sender** text box enter your email address.
- Click **Next** to proceed.

#### 12.13.2.1 Template List

- You will be presented with all the predefined templates (Figure 184)

Template List

Please select an alert template. 1

Template Name	Author
<a href="#">Notifiable disease action alert</a>	rtbp
<a href="#">Other communicable disease action alert</a>	rtbp
<a href="#">Non Communicable disease awareness alert</a>	rtbp
<a href="#">Escalating Fever</a>	rtbp
<a href="#">Top 5 WER</a>	rtbp
<a href="#">notification disease action alert01</a>	rtbp

Figure 184: Template list

[Notifiable disease action alert](#) :: click if the disease is a **notifiable disease** (PS List) and you want the recipients to engage in **response action** for, which you would provide instructions (Figure 184).

[Other communicable disease action alert](#) :: click if disease is not a notifiable disease but another communicable disease and requires recipients of alert to engage in response actions.

[Non Communicable disease awareness alert](#) :: click if the disease is a non-communicable disease and you wish to make the recipients aware of the increasing trend of chronic diseases but do not require response actions; however, the recipients can be vigilant of the escalating situation.

[Escalating Fever](#) :: Click if there is an unusually increasing number of patients complaining of fever. This alert does not require the recipients to take any action but should be vigilant of new fever cases and report those to the IDSP immediately.

[Top 5 WER](#) :: Weekly Epidemiological Report is a template used to issue a report of the five diseases with the highest number of counts for that

Alert	Information	Resource	Area
<span style="color: red; font-weight: bold;">1</span>	Message Identifier	Actual-1290240957	* ? HELP
	Sender	sivaddhs@health.tn.gov.in	* ? HELP
	Message Type	Alert	* ? HELP
<span style="color: red; font-weight: bold;">2</span>	Status	Actual	* ? HELP
	Source	rtbp-srv@health.gov.tn.in	* ? HELP
	Scope	Restricted	* ? HELP
<span style="color: red; font-weight: bold;">3</span>	Restriction [Restricted]	BMO, MO, HI, SHN, VHN	*

Figure 185: Alert elements

particular week. Recipients of this message are not required to take response actions but are informed of the health situation in their district or Block.

### 12.13.2.2 Alert tab

- By default, after selecting the template, you are presented with the **Alert** entry form (Figure 185). The elements automatically populated based on the values set in the template.
- The **Status** must be set to **Actual** – if you are issuing a real alert, **Exercise** – if you are conducting a drill or a training exercise. **Message Type** must be set to - (a) **Alert**, if the message is issued for the first time or reissued without making any changes, (b) **Update**, if message content was changed and is resent, and (c) **Cancel**, if the message was wrongly sent or the threat has subsided or is nonexistent.
- Given that these alerts are not intended for the public and is only for healthcare workers and health officials, the **Scope** is set to **Restricted** and the **Restriction** values are set as per the template. You may add to or delete items in this text box to fit.

### 12.13.2.3 Information tab

- Click on the **Information** tab (Figure 186); most values will be automatically filled based on the template predefined values.
- Select the **Priority** level that is most appropriate; **Urgent** priority is set if immediate response actions are to be executed, **High** priority is set if response actions may be required for those in the vulnerable areas, and **Low** priority is set if no response action is required but the recipients of message must stay vigilant. Based on your select the **Urgency**, **Severity**, and **Certainty** values are automatically filled.

The screenshot shows the 'Information' tab of an alert entry form. It contains several sections with various input fields. Red circles 1 through 7 are placed over specific fields to highlight them: 1 is over 'Language', 2 is over 'Priority', 3 is over 'Sender Name', 4 is over 'Headline', 5 is over 'Description', 6 is over 'Response Type', and 7 is over 'Onset'.

Figure 186: Information tab

- Sender name** is usually the supervisor or decision maker who authorizes to issuing of

the alert.

- **Headline** is a human readable subject or sentence. The message creator must replace the terms **[Disease]** and **[Area]** with actual values. Example – **[Disease]** = *Diarrhea* and **[Area]** = *Thirupathur Block* would read the headline as “*Escalating Diarrhea in Thirupathur Block*”.
- **Description** is a full account of the incident. The terms **[Number]**, **[Disease]**, **[Age Groups]**, **[Genders]**, and **[Area]** must be replaced with actual values. Example **[Number]**=52, **[Disease]**=Diarrhea, **[Age Groups]**=00-15, **[Genders]**=all, and **[Area]**=Thirupathur Block would read the Description as “52 cases of Diarrhea for age group 00-15 and all genders were reported in Thirupathur Block”.
- **Response Type** must be select to a value that is most appropriate: **Assess** if recipients must visit the locations to investigate the reported cases, **Monitor** if recipients are to be vigilant and observe the situations, **Execute** if recipients must immediately carrying out the instructions provided to them such as quarantine, **Prepare** if recipients should get ready to execute response actions but not execute until ordered to. This list none exhaustive and implementers may configure this list.
- **Effective** date and time establishes the start period of the alert message, **Expires** establishes the end period of the alert message; thereby, limiting the alert to a particular time period and not internal. **Onset** is the date and time the first case of the disease incidence was detected.

#### 12.13.2.4 Area tab

- Click **Area tab** to define the location(s) the message is applicable to (Figure 187). For example, the Diarrhea outbreak may be in Thirupathur Block only

Figure 187: Area tab

but you wish to notify all other Blocks neighboring Thirupathur to make them aware of the health status in the area in order for them to be vigilant of similar cases.

- Select the value '**Health**' in the **Location Category**, Select the desired **Location Type**, and Start typing the name of the location in **Area Description**; the text box will predict and suggest the name of the location, then click or press **<Enter>** key to accept that value. Separate the list of locations by a comma.

### 12.13.3 Issuing an Alert

Figure 188: Update and Clear buttons

Click the **Update** button to save the new alert (Figure 188). You may click the button anytime during the message creation process. If you

click the **update** half way through then you need to follow steps in section “**updating and resending alerts**” to recover the message to restart the editing.

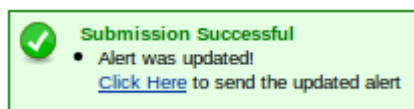


Figure 189: Submission successful

Once the **Update** button is clicked, if all message creation requirements are met without errors, then you will see a message at the top of the screen frame as shown in *Figure 189*. Click on the hypertext link that says “[Click Here](#) to send the updated alert”; that will take you to screen in *Figure 190*.

#### 12.13.4 Select Contact

- Click on **Group** to expand the list, then click on name (e.g. [VHN-Sevinipatti](#)), which will include that group in the **Recipients List**.
- The group identifier (e.g. {xik1msg-210:VHN-Sevinipatti:team}) will appear in the **Recipients List**. The software will determine the respective email and mobile phones of all recipients in that group as defined when creating it (to create groups see *Figure 182* sub menu: [Contacts](#)).
- Individual email addresses and mobile phones for SMS can be included as a comma separated list (e.g. **0091995551212, bmo\_siva@health.gov.tn.in**). If the phone number is an international number it must prefix with 00, then country code and number (e.g. **0091995551212**).

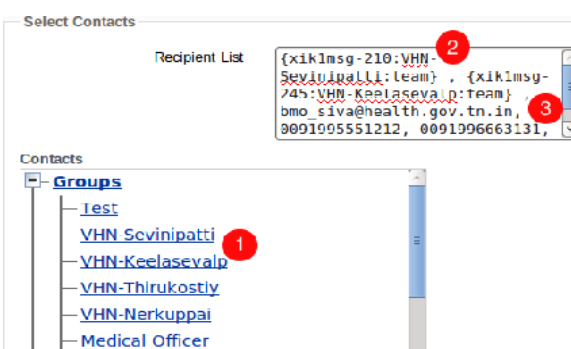


Figure 190: Select contacts

Fig

**Next -> Alert Type**

Click **Next -> Alert Type** button to proceed to next screen.

#### 12.13.5 Select delivery type

- SMS** :: check the **SMS** box, if you wish to send a **Short-Text-SMS** to the recipients.
- Email** :: check the **Email** boxes to send an email to the recipients. there are two options: (a) **Short-Text-Email** will send an email with short message with minimal information and (b) **Long-Text-Email** will send will send the short message as in (a) but include the full CAP XML file in the email as an attachment.
- Web** :: check the **Web** box to post a full CAP message on the website for recipients to view the full message, which would carry additional information such as the instructions.

**Next -> Transform Message**

Click **Next -> Transform Message** to proceed to the next screen.

Select Delivery Type		
Delivery Category	Delivery Type	Select
Short Text	<b>1</b> SMS	<input checked="" type="checkbox"/>
	HF	<input type="checkbox"/>
	RDF	<input type="checkbox"/>
Long Text	<b>2</b> Email	<input type="checkbox"/>
	Email	<input checked="" type="checkbox"/>
Voice Text	<b>3</b> Web	<input checked="" type="checkbox"/>
	VoiceXML	<input type="checkbox"/>
	IVR	<input type="checkbox"/>

Figure 191: Delivery type

### 12.13.6 Send Message

- If **Web** was selected as a delivery type (Figure 192), then this message will appear.
- Final text boxes will present the SMS and Email message content as they would appear in those respective messages. This screen allows the user to verify and edit this content, if needed, before disseminating the messages.
- Click **Send Message** button to disseminate the messages to the **Recipient List** (Figure 190) through the channels selected in the **Message Delivery Type**.

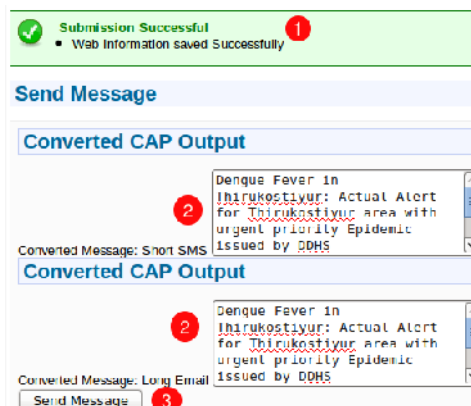


Figure 192: Send message

### 12.13.7 Updating and resending alert

This sections applies - (a) an alert message had been created but was not sent and you want to send it now (b) the alert message needs to be resent to a different set of recipients, (c) wish to make some changes to an already issued message, then resend the message with the changed values as an **update**, (d) to **cancel** a message that was issued as the threat no longer exists or message was wrongly created (refer section on **Alert tab** and paragraphs 2.)

MESSAGING/ALERTING MODULE		Alerts List		
Home		List		
Contacts				
Quick Messages				
Reports				
Surveys				
View Web Alerts				
Issue DISEASE Alerts				
Create New Alert				
View Sent Alerts	1			
Alert Templates				

Name	Type	Version	Author
<a href="#">Thiru exer 06 05 2010</a>	cap	1.1	DDHS@gmail.com
<a href="#">d-ex-thiru-phc-06042010</a>	cap	1.1	thiru-phc
<a href="#">d-hi--thiru-phc-06042010</a>	cap	1.1	M,O-PHC-THIRU
<a href="#">seveni phc 07042010</a>	cap	1.1	mosevni@gmail.com
<a href="#">Dengue Fever, Thirukostiyur, 08.04.2010</a>	cap	1.1	dphsvg@nic.in
<a href="#">thiru</a>	cap	1.1	ganesan@tenet.res.in
<a href="#">janakiraman</a>	cap	1.1	testing
<a href="#">janakiraman</a>	cap	1.1	Keelasevalpatti M.O

Figure 193: Alert list

Alert View	
Alert Information	
Message ID : Actual-1270719702	
Message Name : Dengue Fever, Thirukostiyur, 08.04.2010	
Mime Type : cap	
Alert Version : 1.1	
Author : dphsvg@nic.in	
Message Type : cap	
<a href="#">Send</a> <a href="#">Update</a> <a href="#">Delete</a>	

Figure 194: Alert view

- Click **View Sent Alerts** to view the list of created alerts
- Click on the name (e.g. [Dengue Fever, Thirukostiyur, 08.04.2010](#)) of the alert created to perform (a) – (d) described above, you will be presented with a screen like Figure 193.

**Send** :: click if you wish to resent the alert, without making any changes, to either the same set of recipients or a different set of recipients

**Update** :: click if you wish to make changes to the alert message before resending.

**Delete** :: click if you are absolutely certain that this message was a mistake and was not sent to anyone.

### 12.13.8 View Web Alerts

- In **Messaging/Alerting Module** menu click **View Web Alerts** to expand the sub menu, then click **View Recent Alerts** to view the most recently modified or issued alerts.
- The list of alerts will be displayed in chronological order. Click on the hypertext link (e.g., Dengue Fever in Thirukostiyur, Thirukostiyur) to view the full content of the alert message (see *Figure 195*).

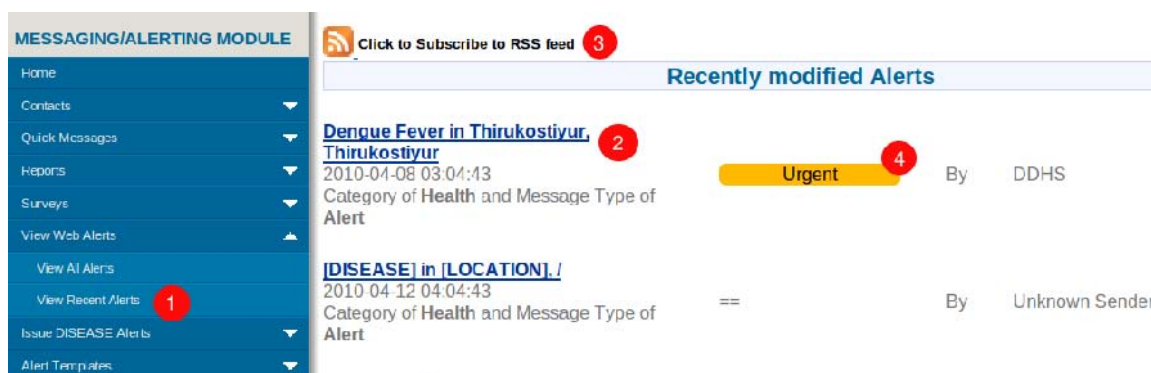


Figure 195: View recent alerts

- Alert subscribers (recipients) may receive these messages via RSS such as through the *Google RSS Reader* that can be installed on a computer or mobile phone. Click on the orange RSS icon to proceed with this task of obtaining the RSS feed URL. The following screens will guide you through this process. Before, you subscribe to RSS feeds you must have installed an RSS reader on your computer or mobile phone.

Priority	Urgent
Message type	Alert
Sender	DDHS
Sent	2010-04-08 03:04:43
Event	Epidemic
Status	Actual
Category	Health
Message Type	Alert
<a href="#">More</a>	

Figure 196: Summary of alert

- The priority of the alert is color coded as **Urgent**, **High**, **Low**. This priority is based on what was assigned in the **Create New Alert** sections (see **Information tab** paragraph 2, *Figure 195*)

First you are presented with a summary of the alert message, where the summary carries the mandatory information. Click on the **More** button to see the full CAP message.

# 13 Appendix D – Policy briefs for India and Sri Lanka

## 13.1 Indian brief




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**M-HEALTH: MOBILE PHONES IN PUBLIC HEALTH**

Policy Brief

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**KEY RECOMMENDATIONS**

<p><b>Digitization of health data through mobile phones</b></p> <p>Considerable cost savings can be made in the health sector by the digitization of health data at the point of care through simple applications designed for mobile phones. Significant efficiencies can also be introduced to the process through digitization, leading to earlier detection of disease outbreaks and providing a valuable baseline for public health monitoring and planning.</p>	<p><b>Data protection and handling</b></p> <p>Due to the confidential nature of the data being transmitted, additional encryption may be needed. The data should be managed and be in the hands of national or regional health departments; especially those that are labelled as "personal health records."</p>
<p><b>Adjustment of rules concerning paperwork procedures</b></p> <p>In order to incentivise health workers to use such mobile-based data entry applications, the existing rules concerning paperwork procedures need to be relaxed.</p>	<p><b>System-to-System Interoperability</b></p> <p>Disease outbreak information should be standardized in a manner that it can be shared with other national organizations such as border control health authorities as well as across borders with neighbouring countries or global organizations, if required.</p>

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**WHY M-HEALTH?**

The recording and communication of health statistics in developing markets is a labor and paper-intensive process. Public Health Center (PHC) Nurses, Health Inspectors (HIs), health staff, and Integrated Disease Surveillance Program (IDSP) staff spend an enormous amount of time and paper transferring data between various forms and registries. Consequently, it takes a considerable amount of time for these statistics to reach decision and policy makers, and urgently required actions to be taken to mitigate disease outbreaks.

The growing reach and use of wireless networks and handheld devices, especially in rural areas offers a convenient alternative to the 100% paper route. Simple mobile phone applications can be utilized in health data entry and dissemination, and can aid the detection of adverse events through statistical analysis software tools.

**CASE STUDY: REAL TIME BIOSURVEILLANCE PROGRAM (RTBP)**

RTBP is a pilot program implemented by IITM's Rural Technology and Business Incubator, National Center for Biological Sciences, and IIRNEAsia to investigate the conditions for effective deployment of wireless technologies in the collection of public health data, event detection, and the dissemination of event information (alerting) through the use of three software modules and web interfaces. The project was conducted in the Sivaganga district, Tamil Nadu, between June 2008 and July 2010 with the Sivaganga Deputy Director of Health Services and 4 Primary Health Centres in Thirupathur block.

Data Collection	Event Detection	Alerting
<p><b>mHealthSurvey</b> is a data entry software that works on any standard Java-enabled mobile phone. A typical record contains the patient visitation date, location, gender, age, disease, symptoms, and signs. Data is transmitted over GPRS cellular networks.</p>	<p><b>T-Cube Web Interface (TCWI)</b> is an Internet browser based tool to visualize and manipulate large spatio-temporal datasets. Epidemiologists can pin down a potential outbreak of for instance, a gastrointestinal disease among children in the Thirupathur block.</p>	<p><b>Sahana Alerting Module (SAM)</b> is a single input multiple output software capable of disseminating alerts to targeted recipients in the form of SMS, Email, and Web. SAM allows for the generic dissemination of localized and standardized interoperable messages.</p>

**How RTBP works:**

**FIGURE 1: DATA COLLECTION, EVENT DETECTION, AND ALERTING WORK FLOW**

1. Health records digitized by health workers in Thirupathur block using mobile phones.
2. Disease, symptoms, and demographic information transmitted across GSM mobile network to central database.
3. Data analysed by trained staff at the IDSP and PHC departments.

4. Automated event detection algorithms process a daily ranked set of possible disease outbreaks, which are presented to IDSP and PHC staff.
5. List of possible outbreaks examined by IDSP and PHC staff to determine likelihood of an adverse event.
6. Confirmed adverse events disseminated to Medical Officers, HIs, nurses, and other health officials, within affected geographic area.
7. Condensed version of the alert pushed through SMS to get immediate attention of the recipients.
8. More descriptive message emailed and published on the web (also accessible through mobile phone).

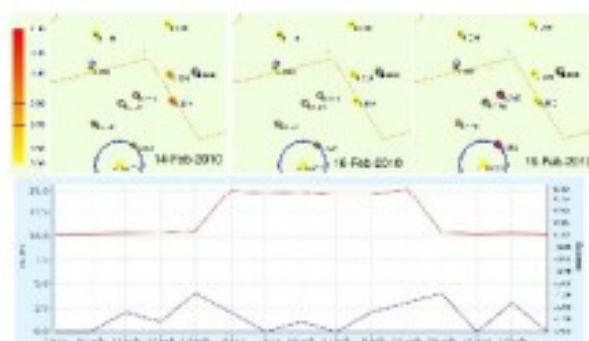
**BENEFITS OF M-HEALTH SEEN THROUGH THE RTBP**

Up until July 2010, a weekly average of 1,500 records have been collected from the 24 health sub centres and 4 primary health centers in the Thirupathur block through the mHealthSurvey.

**Outbreak detection:** The RTBP has proved effective with detected clusters of acute diarrheal disease, respiratory tract infection, dengue, and viral fever before the health departments came to know about those incidents through the normal process.

One such incidence is the 27 cases of a diarrhea detected through the automated communicable disease detection process in early February 2010. The disease propagation pattern (top of Figure 2) shows it initiating at two locations in the center (14-Feb-2010) and spreading south (16-Feb-2010), then escalating by 19-Feb-2010.

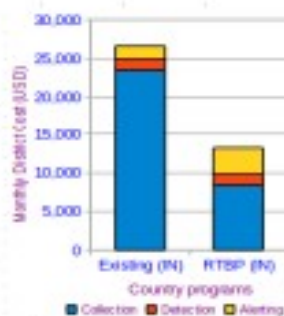
**Public health record building:** Reporting all disease and syndrome information from the point of



**2: DIARRHEA OUTBREAK, 14-19 FEBRUARY 2010**

care through m-health and analysing them in near-real-time is a prognostic active-surveillance approach for detecting and mitigating communicable and non-communicable diseases events. The resulting comprehensive database would be a valuable baseline for public health monitoring and planning.

**Cost effectiveness:** Data collection is the largest component of the cost of the existing system in India; the RTBP can reduce these expenses (Figure 3), while strengthening the system with rapid event detection of all diseases and alerting for better situational awareness.



**3: COST COMPARISON OF EXISTING SYSTEM VS RTBP**

**CONCLUSION**

m-Health is cost effective and operationally efficient. RTBP has proven its capabilities to detect outbreaks well in advance. Health workers in India are capable of adopting the RTBP technology as part of their routine work. A challenge lies in determining the difficulties in scaling the RTBP state-wide in Tamil Nadu.

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## 13.2 Sri Lanka brief



**Sarvodaya**



**M-HEALTH: MOBILE PHONES IN PUBLIC HEALTH**

Policy Brief

### KEY RECOMMENDATIONS

#### Digitization of health data through mobile phones

Considerable cost savings can be made in the health sector by the digitization of health data at the point of care through simple applications designed for mobile phones. Significant efficiencies can also be introduced to the process through digitization, leading to earlier detection of disease outbreaks and providing a valuable baseline for public health monitoring and planning.

#### Data protection and handling

Due to the confidential nature of the data being transmitted, additional encryption may be needed. The data should be managed and be in the hands of national or regional health departments; especially those that are labelled as "personal health records."

#### Adjustment of rules concerning paperwork procedures

In order to incentivise health workers to use such mobile-based data entry applications, the existing rules concerning paperwork procedures need to be relaxed.

#### System-to-system interoperability

Disease outbreak information should be standardized in a manner that it can be shared with other national organizations such as border control health authorities as well as across borders with neighbouring countries or global organizations, if required.

### WHY M-HEALTH?

The recording and communication of health statistics in developing markets is a labor and paper-intensive process. Infectious Disease Control Nurses, Public Health Inspectors (PHIs), Medical Officers of Health (MOH) staff, and Regional Epidemiology Unit (RE) staff spend an enormous amount of time and paper transferring data between various forms and registries. Consequently, it takes a considerable amount of time for these statistics to reach decision and policy makers, and urgently required actions to be taken to mitigate disease outbreaks.

The growing reach and use of wireless networks and handheld devices, especially in rural areas offers a convenient alternative to the 100% paper route. Simple mobile phone applications can be utilized in health data entry and dissemination, and can aid the detection of adverse events through statistical analysis software tools.

### CASE STUDY: REAL TIME BIOSURVEILLANCE PROGRAM (RTBP)

RTBP is a pilot program implemented by Sarvodaya and LIRNEasia to investigate the conditions for effective deployment of wireless technologies in the collection of public health data, event detection, and the dissemination of event information (alerting) through the use of three software modules and web interfaces. The project was conducted in the Kurunegala district between June 2008 and July 2010 with the Wayamba Provincial Director of Health Services.

#### Data collection

**mHealthSurvey** is a data entry software that works on any standard Java-enabled mobile phone. A typical record contains the patient visitation date, location, gender, age, disease, symptoms, and signs. Data is transmitted over GPRS cellular networks.

#### Event detection

**T-Cube Web Interface (TCWI)** is an Internet browser based tool to visualize and manipulate large spatio-temporal datasets. Epidemiologists can pin down a potential outbreak of for instance, a gastrointestinal disease among children in the Wariyapola MOH area.

#### Alerting

**Sahana Alerting Module (SAM)** is a single input multiple output software capable of disseminating alerts to targeted recipients in the form of SMS, Email, and Web. SAM allows for the generic dissemination of localized and standardized interoperable messages.

**How RTBP works:****FIGURE 1: DATA COLLECTION, EVENT DETECTION, AND ALERTING WORK FLOW**

1. Health records digitized by Sarvodaya assistants in Kurunegala district using mobile phones.
2. Disease, symptoms, and demographic information transmitted across GSM mobile network to central database.

3. Data analysed by trained staff at the RE Unit and MOH departments.
4. Automated event detection algorithms process a daily ranked set of possible disease outbreaks, which are presented to RE and MOH staff.
5. List of possible outbreaks examined by RE and MOH staff to determine likelihood of an adverse event.
6. Confirmed adverse events disseminated to Medical Officers, PHIs, nurses, and other health officials, within affected geographic area.
7. Condensed version of the alert pushed through SMS to get immediate attention of the recipients.
8. More descriptive message emailed and published on the web (also accessible through mobile phone).

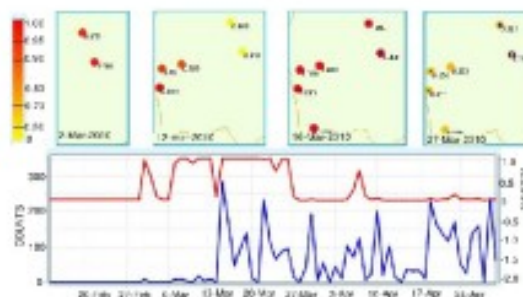
**BENEFITS OF M-HEALTH SEEN THROUGH THE RTBP**

Up until August 2010, a weekly average of 7,200 records have been collected from the 12 hospitals and clinics in the Kurunegala district through the mHealthSurvey.

Public Health Inspectors are fully utilizing the SAM for exchanging H544 information as well as disseminating alerts on any escalating diseases that are detected through the TCWI.

**Outbreak detection:** The RTBP has proved effective with detected clusters of Chickenpox, Acute Diarrheal Disease, Respiratory Tract Infection (RTI), Dengue, and Viral Fever before the health departments came to know about those incidents through the normal process.

One such incidence is the 1,408 cases of a RTI detected through the automated other-communicable disease detection process in early March 2010. The disease propagation pattern (top of Figure 2) shows it initiating at two locations (02-Mar-2010) and spreading over to all areas (16-Mar-2010), to then subside after 27-Mar-2010.

**2: RESPIRATORY TRACT INFECTION OUTBREAK, 6-27 MARCH 2010**

**Public health record building:** Reporting all disease and syndrome information from the point of care through m-health and analysing them in near-real-time is a prognostic active-surveillance approach for detecting and mitigating communicable and non-communicable diseases events. The resulting comprehensive database would be a valuable baseline for public health monitoring and planning.

**Cost effectiveness:** Data collection is the largest component of the cost of the existing system in Sri Lanka; the RTBP can reduce these expenses (Figure 3), while strengthening the system with rapid event detection of all diseases and alerting for better situational awareness.

**3: COST COMPARISON OF EXISTING SYSTEM VS RTBP****CONCLUSION**

m-Health is cost effective and operationally efficient. RTBP has proven its capabilities to detect outbreaks well in advance. Health workers in Sri Lanka are capable of adopting the RTBP technology as a part of their routine work. A challenge lies in determining the difficulties in scaling the RTBP nationwide.

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