

IDENTIFYING THE EXTENDED ROLE OF IT INFRASTRUCTURE IN OPTIMIZING OPERATIONAL PROCEDURES OF RESCUE 1122

[A report submitted in fulfillment of Observership at RESCUE 1122]

Prepared and submitted by

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FOREWORD

The concept of rescuing humans in man-made or natural disasters is marked with risk, and demands commitment, training, accuracy, timeliness and deliverance. The vision, scope and goals of RESCUE 1122 as life saving organization are all well-tethered into its organizational structure, training, resources and operational practices [R1]. However, the fast evolving dynamics of Pakistani society as in urbanization and its parallel rural co-exist have an interplay with ever increasing mandate of RESCUE 1122 to cover a wider ambit of activities. This confluence gives rise to a new spectrum of problems ranging from traffic congestion in cities to a inertial nonacceptance in rural settings. Such retarding factors to RESCUE 1122 services undermine the operational preparedness and efficiency of the organization. The observership was undertaken with an avid focus on the technological aspects of RESCUE 1122 to identify areas where the technology could be optimized as such or if need be, a new suite of IT-solutions could be suggested to address emerging issues. This consolidated report takes a stepwise approach to understand intra-RESCUE 1122 technology-based departmental activities, the interfacing with external agencies including patients, hospitals, traffic wardens, and service providers such as TPL, IDS, ISPs, PTCL, and other government bodies. It then identifies the obvious and non-obvious ineptness through the personal exposure of the observer in rescue missions and through the feedback received from the staff. As the most important and final step, concrete recommendations are made which serve in two ways; a) to address the shortcomings of the operational areas in order to meet desired goals in a better way, and b) to augment altogether new dimensions to the services which compliment the existing ones. Extraneous to the purview, but highly relevant problems of national significance including terrorism and sabotage and power crisis are also taken into broader consideration to make the report adept to incumbent and more strategic national needs.



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NOTE OF THANKS

The observer wishes to thank RESCUE 1122 as an organization that extended its warmth and hospitality to me for over two months of observership. From the learning point of view, it was a lifetime experience. I was exposed to in-situ operations, thematic basis of operations through candid debriefs by the staff, gratis trainings for vehicle tracking system and OASIS system, and enlightened conversations—all being very helpful in comprehending RESCUE 1122 in effective manner. The overall organizational support to me would not have been possible without the directives of the Director General (DG) Dr. Rizwan Naseer. Indeed, it was inspiring to witness the comradeship that he has imbued within his people. His adrenaline injecting slogan of “Hum hein.....Rescuers!” can be seen at work everywhere in spirit and in action.

On a more personal level, it would be nice to go back in time-line in order to mention the first ever received courtesy from RESCUE 1122, the procrastinating correspondence and much-needed encouragement by Emergency Officer (Research) Mr. Naveed Tahir, that eventually led to the observership. The Deputy Director (DD), Dr. Shehzad's operational clear-headedness, motivated disposition and consequent influence led to the administrative facilitation of my observership making it not only comfortable but a rewarding experience. The staff in PMC including Emergency Officer (EO) Mr. Naeem Murtaza and Mr. Muhammad Ikram gave an overarching operational purview of the technology and its relationship with District Control Room, on-site ambulances and hospitals. Engineer Rizwan Shoukat, EO Imran Awan and EO Ali Raza Baig deserve a note of appreciation to explain the core technical and legal aspects of these technologies and to provide me stress relieving “breaks”. In Lahore District RESCUE 1122 station, District Emergency Officer (DEO), Dr. Raza, EO Dr. Rizwan, Mr. Ghulam Shabbir (Control Room), Mr. Azam (Shift House Incharge), EMT Mr. Naeem and Driver Mr. Abid on vehicle (LA-1) are all acknowledged to have allowed me to experience the “real deal” of RESCUE 1122. In our visit to Kasur, the Emergency Officer Dr. Ahtesham and CRI Fariz Zaidi are gratefully acknowledged for their well laid-out and hospitable day-long itinerary for us. Certainly, the exposure to Kasur has given another dimension to this report in terms of unique and unwieldy issues of satellite districts of RESCUE 1122.

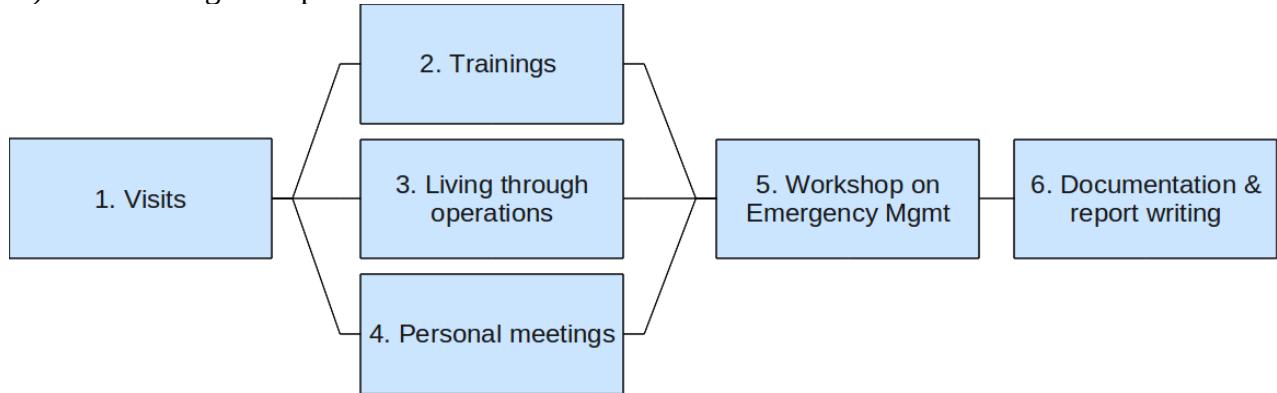
It would be amiss not to mention kind and helpful rescuers without whose help the report would be incomplete. To save pages, the acknowledgments are credited to people in the table below.

Department	Rescuer	Agenda of Interaction
DD's Office	Mr. Iftikhar Mr. Ayyaz	Compilation of daily consolidated reports & documentation
Workshop	Mr. Salman (Wireless Technician)	Understanding wireless communication equipment
Control Room	Mr. Imtiaz Bajwa	Understanding CMS
Ambulance (Kasur)	Mr. Imran Ibrahim (EMT)	RESCUE 1122 ambulance Ops in Kasur

Back at my university, I would like to acknowledge Dr. Muhammad Ali Maud (Chairman, CS& Engg.) and Dr. Waqar Mehmood (Director, KICS) to have confided in me to undertake this observership. Mr. Imran Sarwar and Jawad Khalid are also kindly acknowledged. I hope that this observership serves to pave inroads for UET into governmental and industrial collaborations.

METHODOLOGY

The report has been compiled after sequential execution of steps (1-6) and recursive execution of steps (2-4) in submitting the report.



0. Orientation on 16th June, 2011 through attendance in Resolution Day (Youm-e-Tasees)
1. Visits to various departments in HQ RESCUE 1122
 - First day visit to the office of DD Ops
 - Visit to control room of District Lahore
 - Biweekly visits to PMC
 - Day-long visit to District HQ Kasur
2. Training exposure provided by RESCUE 1122
 - C-Track Maxx day-long training at TPL Pakistan (Kot Lakhpat)
 - PDMA Meeting on Single Reporting Format and OASIS (Pearl Continental, Lahore)
3. Living through the operations
 - Attending RTC emergency in Ichra
 - Attending Fall from the Height emergency near ChenOne
 - Attending health emergency near Cavalry Ground
 - Attending RTC due to over-pillion riding in Kasur
4. Personal meetings
 - Interviews on-site and off-site
 - Group sessions with experts
5. Attending¹ conference and workshops in Turkey, Istanbul (1st-10th July, 2011)
 - a) Presenting a paper in International Wireless Communications and Mobile Computing Conference (IWCMC) [R12] in the area of Over-the-Air Programming (OTAP) of remote systems including ambulances and PDAs.
 - b) Attending workshop on Emergency Management Computer and Communications Protocols (EMCCP) [R4]-[R5] in conjunction with IWCMC.
6. Documentation and final report compilation

¹ Under financial support of MKE (The Ministry of Knowledge Economy), South Korea, under the Convergence ITRC (Information Technology Research Center) support program (NIPA-2011 C6150-1101-0004) supervised by NIPA(National IT Industry Promotion Agency), & Higher Education Commission, International Travel Grants, Pakistan

LAYOUT OF THE REPORT

The report starts with the macro-view of the key players that provide services to RESCUE 1122 through an IT support infrastructure. It is then shown how the services provided by these key players are interspersed across in the operational life cycle of RESCUE 1122. Each phase in the life cycle, henceforth referred as operational area is then broken down for an individual investigation.

The investigation comprises a brief on the need for an operational area, current use of respective IT tools and technologies to execute those operations, limitations of the technology as a specific finding of the observership undertaken, and the consequent need for the desired operation. The investigation concludes with a recommendation strategy to implement complimenting solutions to existing IT infrastructure or a totally new suite of IT solutions. The expected compliance of the solutions to the desired operation is also presented along with the additional fringe benefits.

RESCUE 1122 AND THE KEY TECHNOLOGY PLAYERS (MACRO-VIEW)

It is important to understand the technology players, as given in Figure 1, both national and international which are forming the baseline IT infrastructure of RESCUE 1122. Although these technology players are tethered into RESCUE 1122 fabric to meet the “necessary” requirements, this report further takes on to identify if these are really “sufficient” to address the impending and pending challenges. These technology players are providing their distinct set of services. However, after observing the system in detail, a functional overlap can be found amongst them which results in operational redundancy. Likewise, the observership has also resulted into identification of niche areas which are not covered by either of the key players. The report while presenting problems and their solutions throws a sporadic light on augmenting the 'per se' roles of these players as well.

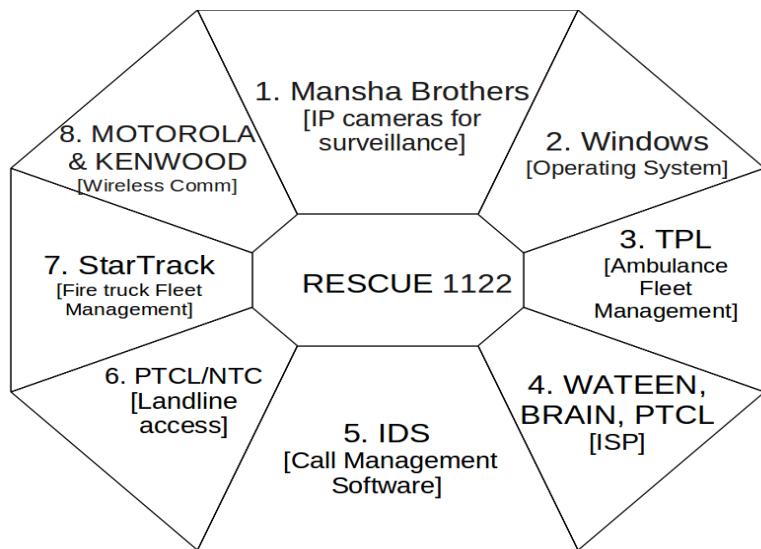


Figure 1. A constellation of key players providing services to RESCUE 1122.

OPERATIONAL DEPLOYMENT AND USAGE OF IT INFRASTRUCTURE AND SERVICES

The perceived and subsequently designated role of various departments within RESCUE 1122 has led to the distributed deployment of IT infrastructure through the key players. For visual convenience and clarity in comprehension, Fig 1 is replicated along with the operational deployment shown through a matrix in Figure 2. A detailed description of each of the operational area (aka department) follows in subsequent sections:

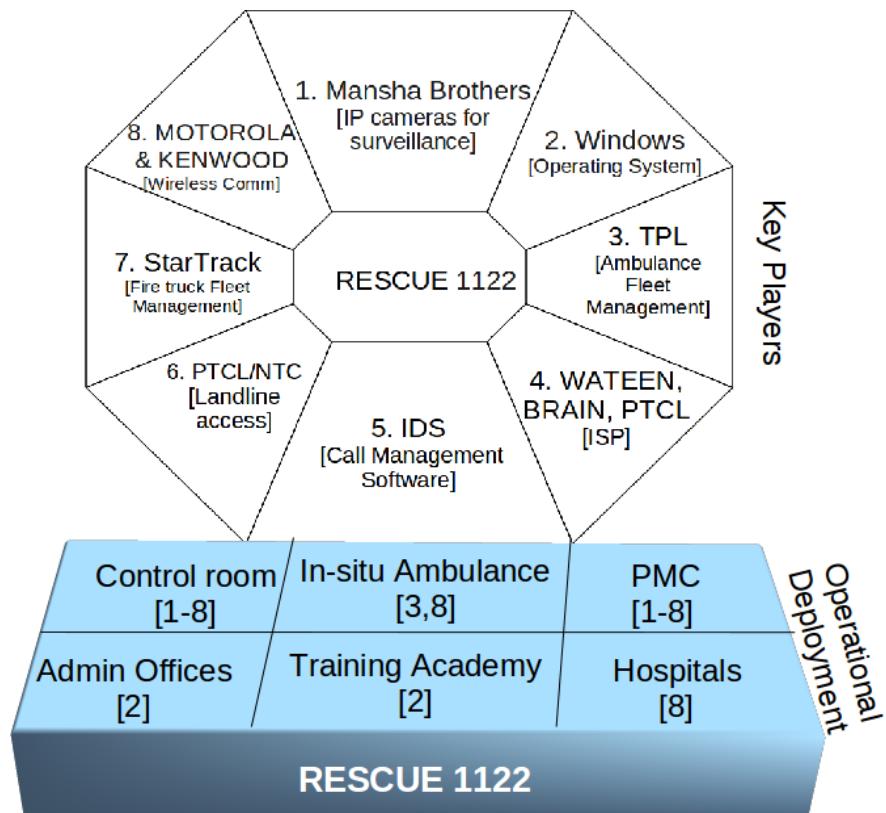


Figure 2. Functional deployment of IT infrastructure depends upon the designated role of an operational areas.

AN ANALYSIS OF END-TO-END RESPONSE TIME

In this report, we address the internationally recognized golden hour². The delays in ambulance response, patient evacuation, hospitalization and ambulance discharge are then shown to be attributable to various internal and external constraints. The findings and recommendations in this observership report are expected to reduce the end-to-end time that is of most interest to the patient and to their wards. For better readability of the report and in order to make effective use of the report, the problem areas are broadly categorized in terms of the golden hour (Figure below³)[R2].

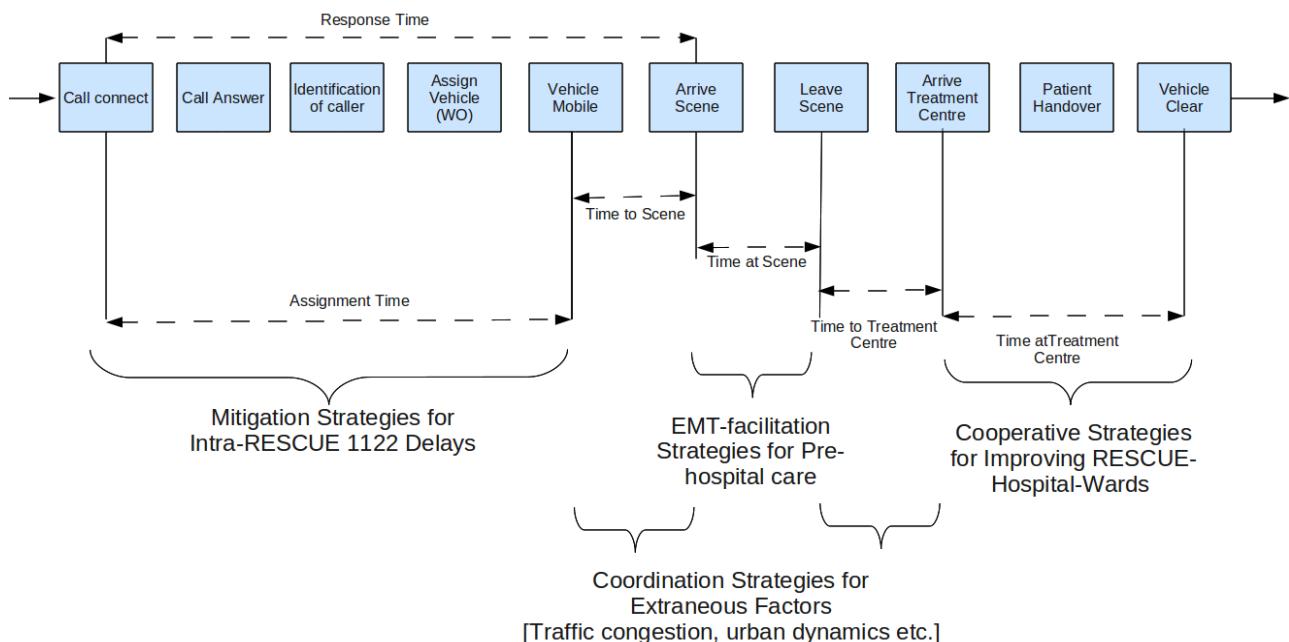


Figure 3. Detailed break-down of End-to-End time.

The solutions in the following sections and their respective implementation strategies are conceived and put forward vertically. Nevertheless, there would be a horizontal overlap between some or all of them at the more operational levels. This overlap can be best understood and utilized through developing a concerted perspective of the observer, RESCUE 1122 management and UET.

2 The first hour in which the treatment of patient is vital and critical with respect to first response, evacuation and hospitalization.

3 Extended from: Department of Health, “Improving ambulance response times: high impact changes and response times algorithms for NHS ambulance trusts,” Gateway reference 8048. April 2007, UK.

CONTROL ROOM

Disposition

Control Room is laid out in RESCUE 1122 District Emergency Head Quarters. It is adjacent to the shift house wherein EMTs and drivers are waiting for emergency dispatch. The infrastructural elements that Control Room houses are seen in Figure 2. It is manned by the following:

1. Control Room Incharge
2. Shift Incharge
3. CTWOs
4. WOs

Scope

1. District-wide management of emergency vehicles and staff.
2. Reporting of Daily Consolidated Reports to PMC, Lahore.

An important point that needs to be underpinned here is the high variability of resources as in limited alternate power sources amongst load-shedding, accessibility for different districts across Punjab in terms of the frequency and count of emergency at one end and the large spatial coverage at the other end. As specific examples, Lahore district covers the highest and most frequent emergencies on daily basis averaged over years. In fact, in terms of volume, it parallels with numerous small districts combined. The adjacent district of Kasur (visited by the observer) provides the contrary example of large geographical coverage involving radial distances upto 40 kms with sparse presence of district hospitals. Consequently, as shall be highlighted later in this section below that the use of technology besides its availability is constrained.

Brief on operations and use of respective IT tools/technologies

Control Room starts the response procedure to an emergency as soon as a call is initiated by the first responder citizen) through either a landline or a mobile phone onto a district-UAN number (1122). The call is received by Computer Wireless Operator (CTWO) through an interface of Call Management Software (CMS). CTWO logs necessary information onto Emergency Call Form (ECF). The information includes the nature of emergency, caller details and the location of the emergency. This logged information is then displayed onto the computer of Wireless Operator (WO) which communicates this information using base station (wireless communication). As soon as the vehicle is dispatched, CTWO fills in ECF details on paper as well. After the emergency is closed, the focal person, if available notifies CTWOS of the availability of the ambulance or in case the focal person is not available, the EMT in the ambulance notifies the WO. The CTWOS then wait for the EMTs to the Control Room, get the ECF from CTWO and fill in the remaining details. After an emergency is 'gracefully' concluded, ECFs and ERFs are completed and submitted with the CRI in Control Room.

EXISTING LIMITATIONS & PROJECTED MODIFICATIONS

This sub-section describes Control Room related problem areas, limitations of either the IT infrastructure or current operational practices limiting the effective use of the IT infrastructure or proposed value additions. These can broadly be categorized into two modes of assessment and identification, either as an internal feedback by the RESCUE 1122 staff or as an observation by the observer.

1. Problem Statement (Internal feedback)

There is no mechanism to ascertain caller details, especially its location is unknown. As a consequence, there is a likelihood that a false dispatch is performed in response to a bogus call or a dispatch is made for an already completed emergency. Likewise, for the rare but actually observed incidents⁴, a dispatch is considered dispatched whereas in reality it is not! These two scenarios are defined by the following matrix with highlighted Grey area.

	POSITIVE	NEGATIVE
FALSE	Wrong dispatch	Wrong <i>no</i> -dispatch
TRUE	Correct dispatch	Correct <i>no</i> -dispatch

Figure 4. Ambulance dispatch matrix.

1. Proposed Solution

Pakistan Telecomm Authority is approached to issue a “legal intercept” directive to various telcos to provide location information of a caller.

1. Recommended Implementation Strategy

Since the information is private both to the caller and to the telco, assurance mechanism must be implemented by RESCUE 1122 through a secure access server housed inside the Control Room. The assurance mechanism would assure PTA and to telcos that only need-based, short-lived and limited disclosure of location information to CTWO in the Control Room is allowed. The details of the assurance mechanism would be implemented through Terms of Reference (ToR) between telco and RESCUE 1122 overseen by PTA.

⁴ In Lodhran district, two simultaneous RTAs took place near famous Bhatti Hotel. In response to simultaneous calls from two near-by locations, however only one ambulance dispatch was falsely made.

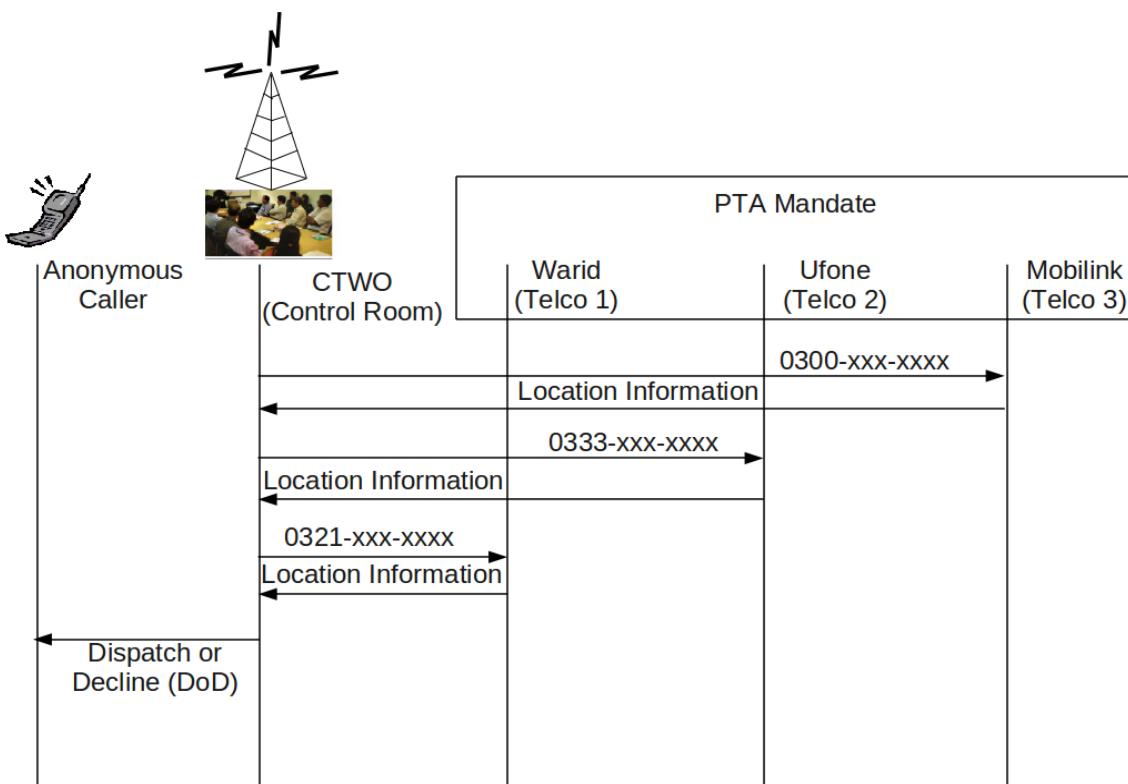


Figure 5. Message sequence diagram for localizing anonymous callers.

2. Problem Statement (Internal feedback, especially from Kasur staff)

In the wake of power outage (or scheduled loadshedding), the landlines become unavailable. When the UAN number is not accessible for dialing-in, the work of CTWOs is compromised. Furthermore, when the access to C-track software (provided by TPL Pakistan) for vehicle tracking is void, Control Room Incharge (CRI) cannot track and audit staff and ambulances effectively. Consequently, the operation of the entire control room comes to a standstill.

2. Proposed Solution

Automated switching to cellular lines⁵ in the wake of land-line unavailability/outage can yield uninterrupted and smooth access to callers.

CRIs could be equipped with the alternate means of accessing C-track software through a notebook and an Internet dongle. UPS is not proposed because it can provide backup for few hours, not days.

2. Recommended Implementation Strategy

Three mobile numbers are issued per District HQ, RESCUE 1122 each from a different telco. These are

⁵ A similar make-shift but manual arrangement is already available in Lahore RESCUE 1122 DHQ. However, the proposed solution is fully automatic and circumvents the human aspects of delay, forgetfulness and lethargy.

then mapped onto the landline numbers currently used for UAN. This pre-selected group of mobile phone numbers would be integrated into the Call Management System (CMS) such that when the landlines are dead, PTCL/NTC exchange detects the failure and automatically routes emergency calls to CMS for further processing.

Likewise, in order to provide continuous monitoring of ambulances through C-track software, each district HQ is equipped with a notebook and Internet accessing dongle that is only issued in the wake of a sustained power outage. The web-based version of C-track can then be accessed to monitor the movement of ambulances.

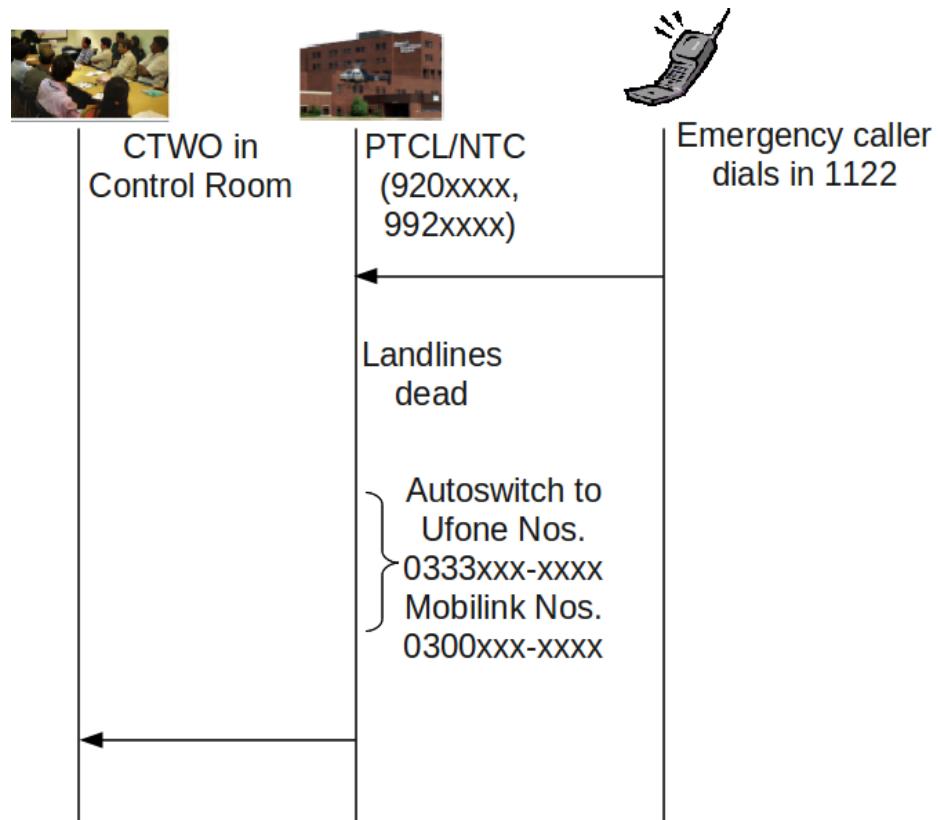


Figure 6. Message sequence diagram for automated switching from landline to mobile phones.

3. Problem Statement (Internal feedback from DD Ops office and CRI PMC)

Every day, an audio repository of emergency calls is logged into CMS. In order to ensure that proper Standing Operating Procedures (SOPs) are adhered to, CRI along with the Shift Incharge (SI) listens to the recorded calls. In case, there is an anomaly detected in, a follow-up as in an inquiry is initiated. Although, it is one of the responsibilities of CRI and SI, due to work overload and emergent activities, this activity tends to be quite cumbersome. In order to comply with the activity, however, CRI uses domain knowledge of emergency calls and sorts these calls in size. If there is a call with extraordinary duration, either too long or too short, CRI identifies it as a call to be monitored. Likewise, CRI is

interested in those telephone calls which did not lead to ambulance dispatch because such cases can give rise to litigation and followups. Listening to such audio files is a time consuming, non-realtime and offline activity that is constrained by the workload, office wisdom, time availability and interest of CRI.

3. Proposed Solution

Each call is initiated by the caller for a unique emergency. When the emergency is assigned Emergency Code (EC), the process of call taking through CMS, ambulance dispatch and finally emergency close activities are performed. Mapping them onto the recorded call can help CRI decide if it is the recording of a successful dispatch and emergency close, was it was a failed response on part of CTWO and WO, or the ambulance was never dispatched.

3. Recommended Implementation Strategy

We propose a wireless communication recording system that archives wireless communication according to the IDs which are assigned through a retrofit inside each device. Since the response is triggered in-line with the emergency call under unique EC. In this way, CRI can conveniently backtrack anomalous calls. Wireless communication which is broadcast in nature would need retrofitting of wireless equipment (including basestation, mobile sets and walkie-talkies). Each wireless must transmit its ID that is digital and can be assigned to transmission from a wireless device audio. The implementation of the recommendation helps CRI for auditing calls from the recorded archive and helps to implement non-repudiation for CTWOS, WO, drivers and EMTs in case of inquiry or a medico-legal case.

If an ID is assigned to Wireless device belonging to an ambulance, it would have a high correlation with EC at certain TIME_OF_EMERGENCY. This information can be used to relate device ID with the EC and group them together.

In case when the call is not an emergency (bogus, information, music etc) or the CTWO feels that ambulance dispatch is not required, BS does not broadcast ambulance request. The call is considered an anomaly. Since this call is not grouped with recordings of wireless transmissions, CRI can easily identify it and listen to it.

In case, the CRI is investigating an emergency call, the call is placed with grouped wireless transmissions which were recorded soon after the 'event' was stored. These wireless transmissions would, for sure, comprise transmissions relating to the current emergency and may be some other transmissions. However, since the correlation of the emergency call is high with consequent wireless transmission, the device ID of the ambulance mobile station would be recurring. The CRI can easily pinpoint the ambulance and EMT and driver on that ambulance. The information can be tallied with the Emergency Call Form (ECF) and Emergency Response Form (ERF).

The same information can be used in PMC and office of DD Ops.

NO.	CTWO AND WO RESPONDING TO EMERGENCY CALL	NEW OPERATIONS FOR CMS
1	Caller calls and is assigned a valid EC	CMS stores EC
2	BS broadcasts ambulance REQ (by WO)	CMS form stores this as 'event'
3	Available ambulance broadcasts ROGER	CMS receives ASK Modulated Device ID of Ambulances mobile unit (Note: Other device IDs may also be received) and stores wireless transmission
4	BS broadcasts ambulance dispatch emergency details (by WO)	
5	Ambulance broadcasts ROGER	CMS receives ASK Modulated Device ID of Ambulances (Note: Other device IDs may also be received) and stores wireless transmission
6	Ambulance broadcasts ON_LOCATION	CMS receives ASK Modulated Device ID of Ambulances (Note: Other device IDs may also be received) and stores wireless transmission
7	BS Broadcasts ROGER (by WO)	CSM stores wireless transmission

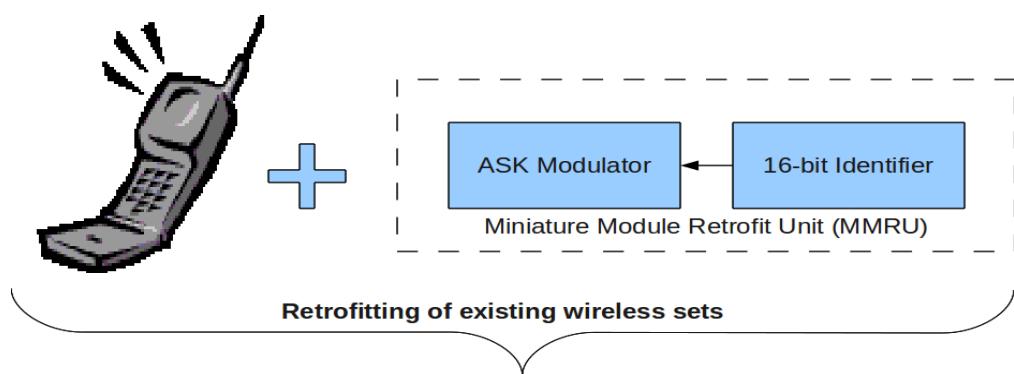


Figure 7a. Design of retrofitted wireless communication equipment.

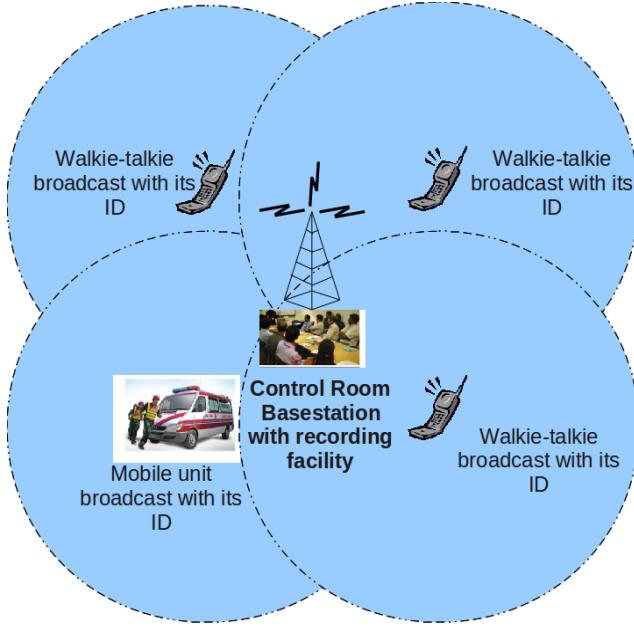


Figure 7b. Operation of retrofitted wireless communication equipment.

4. Problem Statement (Observer's suggestion)

In the wake of a major incident, the traffic already enroute towards the disaster site creates traffic congestion which in turn hinders the rescue and recovery operations. The problem is exacerbated when the last road segment leading towards the disaster site is long enough (of the order of a kilometer or more) to accumulate a lot of traffic. Ambulance dispatches destined towards disaster site are hampered and at times even make it impossible to let the ambulance reach the site.

4. Proposed Solution

We recommend that Cell Broadcast Service (CBS) may be used to notify the occurrence of a disaster in a particular area, warning the motorists and bikers to take detour well before approaching the area surrounding the disaster site. In this way, traffic can be thinned out and help evacuation and recovery by RESCUE 1122.

4. Recommended Implementation Strategy

CBS is a feature that telecommunication operators (telcos) use to disseminate cell-ID specified regions. In order to subscribe to this information, again PTA directive shall be required. An interface shall be developed that would let the CRI prepare a small text (160 characters) and submit it to the telcos using *web-to-sms* feature. The telco would be obliged to broadcast this SMS using CBS.

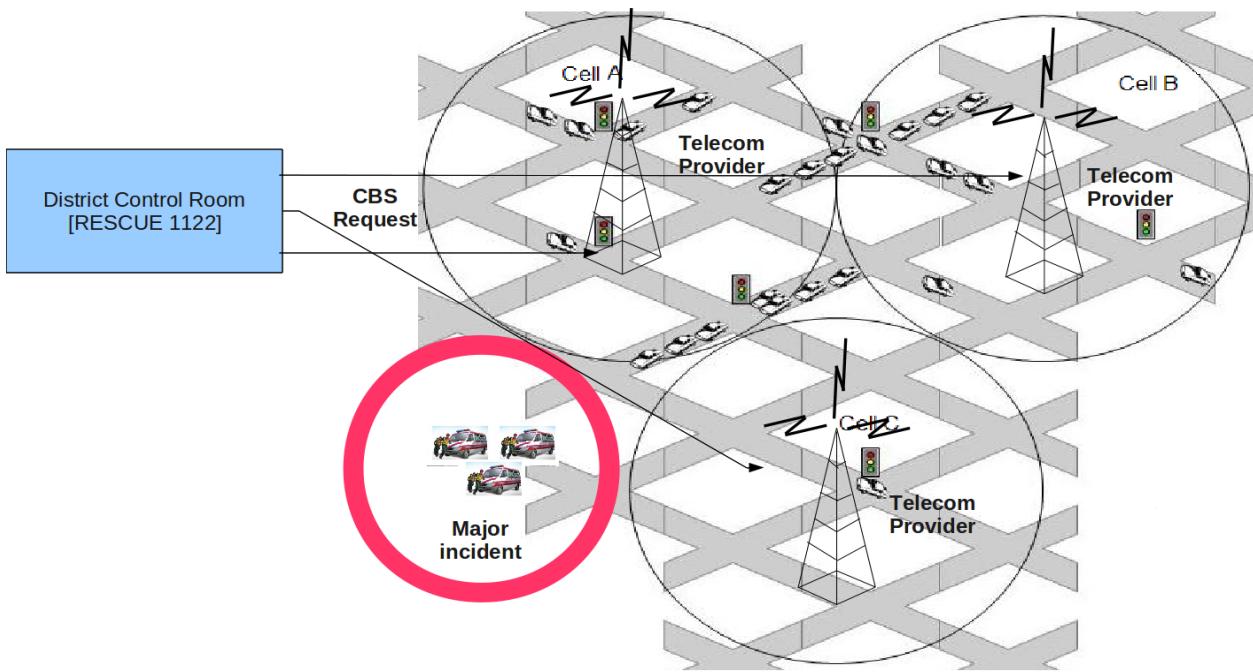


Figure 8. Cell Broadcast Service detouring traffic scenario.

5. Problem Statement (Observer's suggestion)

The recovery of living and dead from the debris of a collapsed building is a very challenging yet a top priority job. And it is well understood that the humans under the debris cannot be heard from a distance, nor can they make phone calls as they are too hard-pressed to move. Identifying the locations of such humans is central to evacuating them as it would save time to dig or remove rubble from a certain site as compared to clearing out the entire area.

5. Proposed solution

Cell Broadcast Service (CBS) can be used to detect humans under debris and rubble in building collapse by disseminating a series of messages within the disaster site using the cell ID. Rescuers present on-site can either detect the beeps from the mobiles of people under the debris by using sensory amplifiers.

5. Recommended Implementation Strategy

Subscription to CBS is recommended in the same manner as elaborated in 4.

Furthermore, the identification of an off-the-shelf acoustic sensor and the implementation of a server to

which such sensor is interfaced is recommended. The computational server is aimed at filtering out background voices, noise etc from the sensed auditory information so that beeps and maybe traces of human voices from deep down-under the rubble are extracted for site identification.

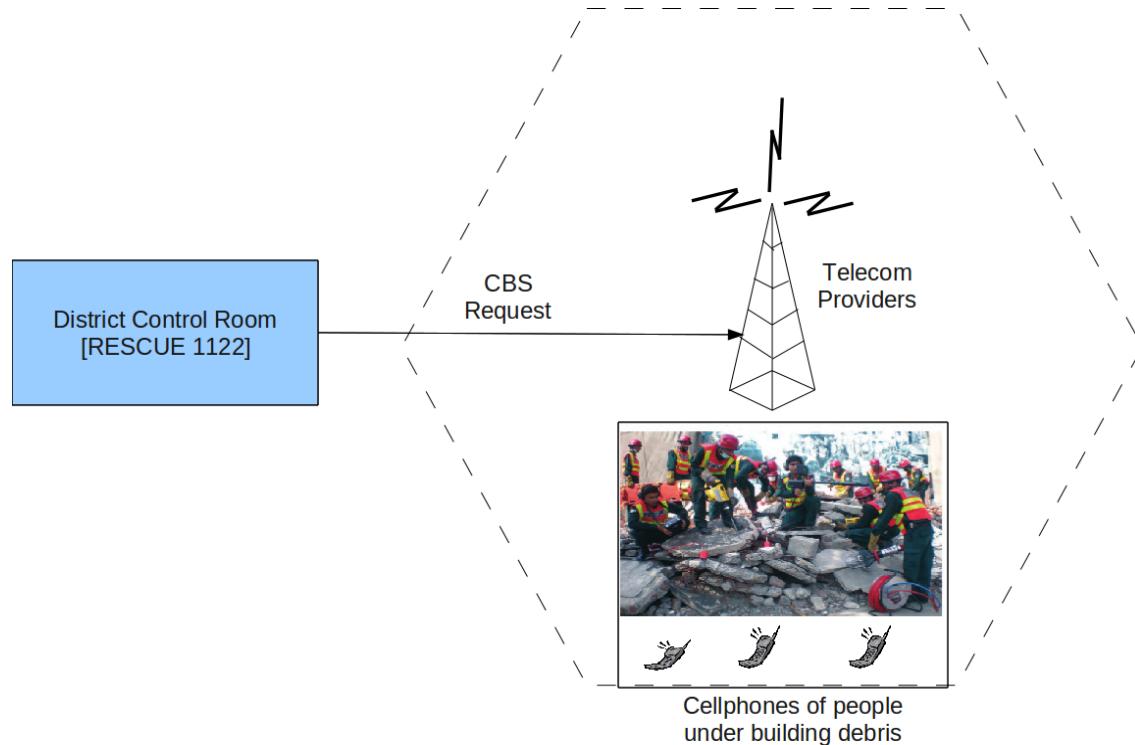


Figure 9. Cell Broadcast Service debris recovery scenario.

6. Problem Statement (Observers suggestion)

Lahore, as a baseline casestudy is a cosmopolitan city that is being extended by new suburbs while existing ones are being redesigned. Therefore, new inroads and tributaries form an ever-growing complex mesh for RESCUE 1122 to comprehend. The location of the reported emergency is determined by CTWO and WO using their best suburban sense and assistance from the caller. The driver and EMT together figure it out in real time when the ambulance approaches the site. At times, if the location is not precisely told by the caller to CTWO, it gets cumbersome to get to the exact location. It happens so that the ambulance keeps hovering around the exact location repeatedly before arriving on-site.

6. Proposed Solution

Landmarking through trip-sheets can be utilized to geo-locate new suburbs on Lahore map and perform real-time scene assessment.

6. Recommended Implementation Strategy

In the training days when the drivers and EMTs are given test drive sessions across Lahore for making road and street sense. It is proposed that the GPS coordinates are collected through a GPS device and subsequently stored for all the paths which are traversed during the training sessions and navigation sessions. Each of these paths are stored in the database using the names of these suburbs. Doing so would develop a database of paths that can be used to later help the EMT and driver navigate better. This information can be hosted either at the Control Room or onto a digital dashboard in the ambulance.

In this regard, an off-the-shelf GPS device would be required to be interfaced with a laptop that stores all the GPS points (longitude, latitude). A simple software shall be developed that would map this information onto coordinates and store these values into a database for use.

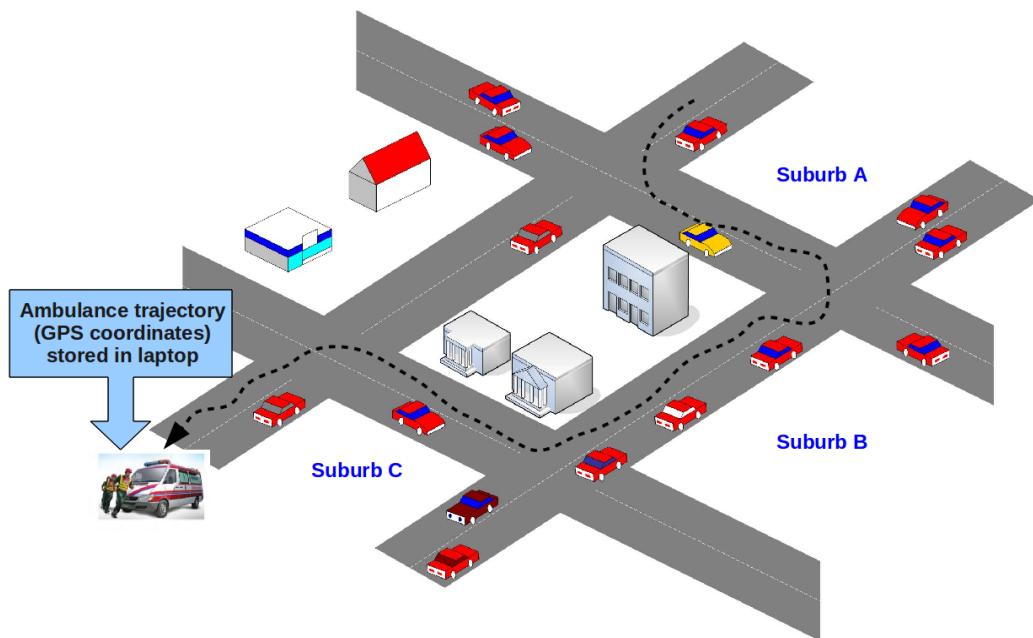


Figure 10. Improvement of road and street sense using proposed GPS landmarking.

7. Problem Statement (Observers suggestion)

In the wake of a major emergency that is declared as a disaster such as multi-storey building collapse or a terrorist attack such as bomb blast, mass casualty in terms of the number of dead and critically injured victims is large. These victims are relocated to various hospitals. The wards of the victims face great difficulty in the face of such incidents to know the location and current state of treatment of the victims [R9].

7. Proposed Solution

The information about the victims (Name, ID card No and/or Vehicle No, hospital dispatched to, and possibly a face picture) are made available on the website and is made accessible anywhere from the Internet. This information is also made accessible on mobile. The wards would be able to query either the name or vehicle number through SMS on pre-specified mobile numbers such as 030011221122 of RESCUE 1122 and obtain information regarding the location and state of the victim.

7. Recommended Implementation Strategy

The ambulance staff including EMTs and driver are advised to collect all the information of the patient enroute hospital. When the patient is handed over to the hospital staff, code specific to the hospital is noted down by EMTs. This code is “pre-specified” through coordination between RESCUE 1122 and public sector hospitals. It refers to hospital name and the location information. Patient details and hospital code are provided to the Control Room by the EMTs. This information is then uploaded to RESCUE 1122 website on local webserver. A separate link needs to be identified at the website so that the wards of the patient looking for the victim can access the site easily. The layout of the webpage may appear as:

Patient Name	Picture	Other Details	Hospital evacuated to	Nature of Emergency (sub-type)
XYZ		Vehicle ID, LEC 123	Services Hospital, Jail Road, Near Race Course	RTC (over-bleeding)

Figure 11. Proposed informational structure for citizen sharing portal.

As an alternate measure, the same information in textual form (limited to 160 characters) can be echoed back if someone sends partial details about their relatives in known formats.

Taking the service to the people

A full-scale citizen awareness program would need to be put in place both in electronic and print media to let people be aware of the facility (both through web and through SMS) for identifying and tracing the missing relatives in wake of a disaster.

Note: This facility may also be extended as an exception only to emergencies in which the patient is unconscious and is alone.

8. Problem Statement (Internal feedback from Kasur)

The evacuation of the patient to the hospital by RESCUE 1122 is incomplete and futile until proper handing over to the hospital staff. It has been shared with the observer by EMTs and has also been

perceived through personal experience through attending emergencies in the ambulance that the districts where the number of public sector hospitals are few and the trauma centres are overloaded, there is an observed unwillingness of hospital staff to accommodate the emergency cases brought by RESCUE 1122. This often mars the end-to-end goals of RESCUE 1122, i.e., provision of effective emergency care to the patient. This problem is often exacerbated for the cases which are medico-legal in nature. In order to ensure better post-hand over care to the patient at the end of RESCUE 1122, an awareness about the current load and available bedding at the trauma-centres of public sector hospitals is desired. This awareness in turn can help assess optimal delivery of the patient to the hospital with available resources and the 'will'.

8. Proposed Solution

A real-time many-to-one computer system-based update system is proposed that uploads state of affairs (doctor availability, infrastructural capacity) at the traumas centre through respective focal persons present in different public sector (government) hospitals and Control Room to let CTWO and WO make intelligent decision about vehicle dispatches.

8. Recommended Implementation Strategy

The presence of a focal person that is generally a 1122 RESCUER at public sector hospitals can be better utilized and the coordination between Control Room, ambulance and the focal person can be automated through a computerized information and status reporting system. The computer system shall keep Wireless Operators updated about the latest information without bogging them down with added communication burden. The information may include availability of bedding at the trauma centre, the availability of doctors and even the administrative capacities of the hospitals. It would help the EMTs and driver in the ambulance enroute hospital ensure that an expert doctor such as an orthopedic surgeon is coordinated by the focal person. Finally, after the successful closure of the emergency, the focal person may also upload turnaround times to the Control Room.

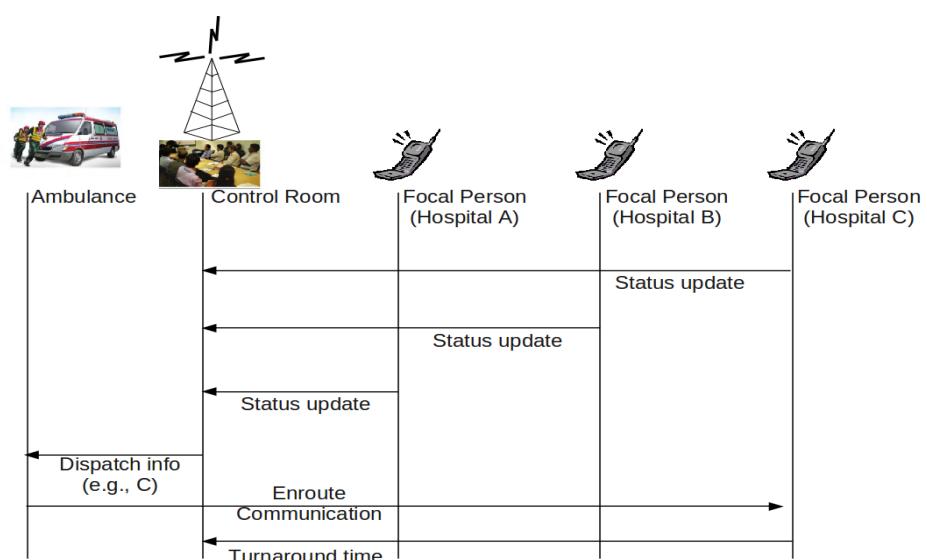


Figure 12. Message sequence diagram for focal person-assisted hospital arrival.

9. Problem Statement (Observer's suggestion for EMTs)

While attending to various emergencies in ambulance it was observed that EMTs must fill-out major part of Emergency Response Form (ERF) enroute hospital, taking important information from either the accompanying wards of the patient, or from on-site witnesses. It is also accompanied by the filling out procedure of trip sheet by the driver. At the hospital, if the focal person is present, EMT shares relevant information about patient vitals with him. ERF is usually shared partially with the focal person on arrival but not generally shared or communicated with staff at the emergency (trauma centre) of the hospital. When the ambulance is discharged and returns to the station, the EMT collects partially completed Emergency Call Form (ECF) from on-duty CTWO and fills out incomplete information about the incident on ECF from ERF. The trip sheet is also shared with the Shift House Incharge for book keeping. In cases, where the same ambulance attends back-to-back emergencies, the activities get piled up. Facilitation mechanisms must exist which provide relief to EMTs and to the driver and result into better coordination between ambulance staff, hospital and possibly the wards.

It was further observed in the ambulance enroute hospital that the treatments provided to the patients including vital signs measurements, giving shots, providing IntraVenous (IV), giving CPR are wide ranging and complex. Although the EMTs are fully trained to deliver, it is important to provide check-points for management serving as internal auditors to ensure best practices from the medico-legal perspective. This would ensure that EMTs and drivers comply well to the best practices that they have been prepared for.

9. Proposed Solution

The common denominator for all the above mentioned problems can be attributed to tiresome coordination requirements for the ambulance staff with focal person, hospital staff, CTWOs, Shift House Incharge and District Emergency Officers. Such coordination can be improved by augmenting in-vehicle [3] and [8] (see Macro-view) with the proposed infrastructure. We propose to install a rugged, milspec tablet PC with GPRS connectivity and a that is embedded alongwith a printer into a rostrum-like assembly in the ambulance compartment. When the EMTs evacuate the victim and enroute hospital, the Emergency Response Form is filled onto the tablet PC and a print out is taken as ambulance copy. Using GPRS connectivity, this information is pushed to a central webserver in district Control Room. Focal person uses this information to prepare in advance at the destined hospital such as for bedding, orthopedic doctor and blood pints (if known). This information is also uploaded for addressing problem # 7 stated above. If the EMTs have given a special treatment to the victim such as CPR, IntraVenous (IV) treatment, they would insert this information at the web-server. Emergency Officer or District Emergency Officer, if sitting online, could track the information almost in real time either for suggesting them an alternate therapy or for cautioning them in medico-legal cases. This would essentially encourage the compliance to the best practices by the ambulance staff as well.

9. Recommended Implementation Strategy

The system shall be implemented through GPRS interaction of ambulance with web-server in Control Room. The information in the Control Room is then available for hospitals and citizens through appropriate interfaces.

Since the information is multi-varied and significantly private, we propose secure filtering techniques and custom interfaces that would allow this information to be shared with concerned people on need-cum-basis. The *time to scene* and time to treatment centre are significantly reduced contributing to the end-to-end time from ambulance response to ambulance clearance.

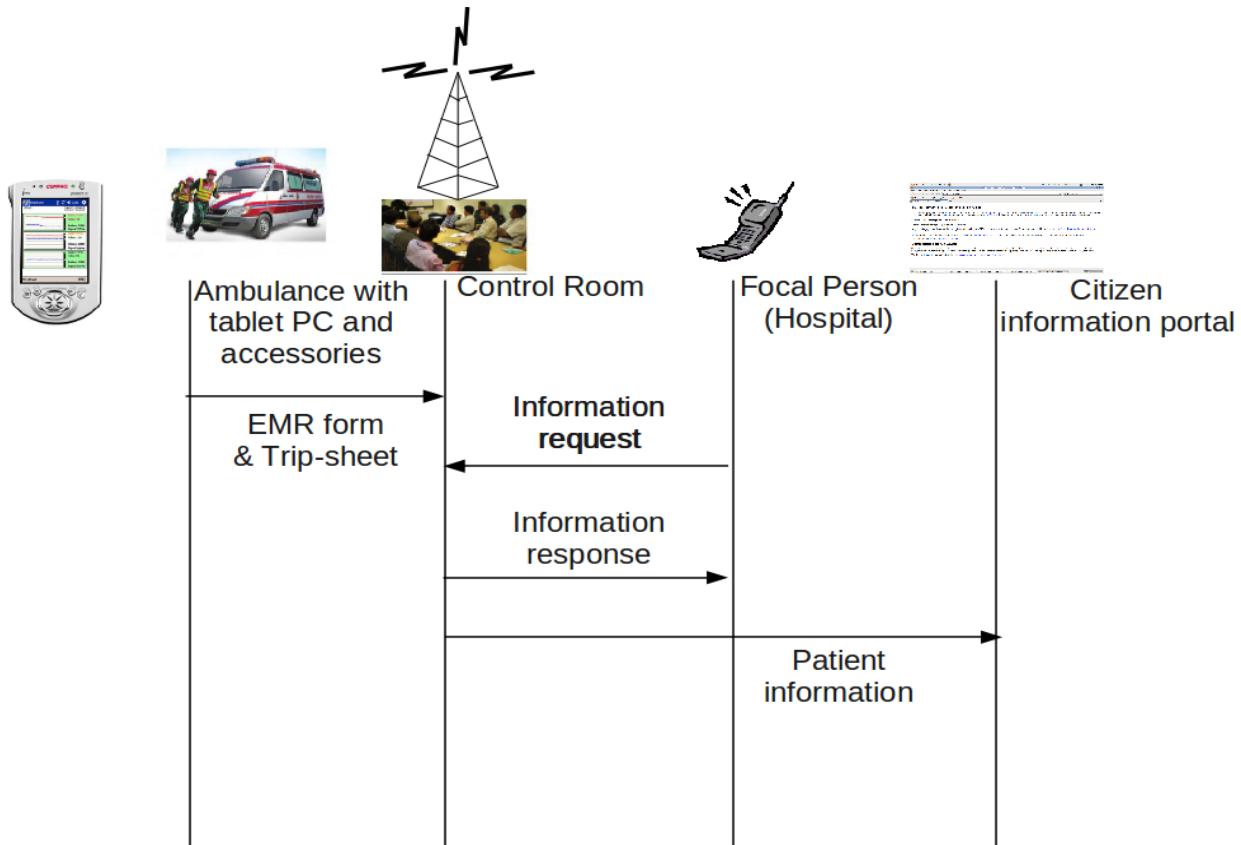


Figure 13. Message sequence diagram for technology-assisted hospital admission of patients.

10. Problem Statement (Observer's suggestion)

During interactions with the audit staff in RESCUE 1122 HQ, it was shared with the observer that the lapse in attending emergency calls due to dozing off of CTWOs and frequent absenteeism is tantamount to patients loosing lives. While District Emergency Officers use sporadic surprise visits in dull times of the day, the management of RESCUE 1122 HQ remains continuously apprehensive of 24/7 availability of CTWOs and other officials in the Control Room. The problem is exacerbated for remote districts geographically distant districts where ethnic, social and cultural affinity of the staff waters down the auditing and reporting mechanisms. An alertness assessing mechanism is needed that compliments the monitoring and reporting activities of Control Room Incharge and Shift Incharge.

10. Proposed Solution

We propose an interactive questionnaire that appears on the screen of the computer before CTWO. The questionnaire poses random questions from a pool of CTWO specific operations. The results are then stored and archived for follow-up at the computer of the Control Room Incharge or the Shift Incharge. The randomness in questions and the times at which these are posed to the CTWO ensures a) alertness on part of CTWO and b) an awareness on part of the Incharge about the alertness of CTWO. This information is displayed in terms of score on a display in front of the Incharge that performs *feedforward* for the CTWO and *feedback* for the management.

10. Recommended Implementation Strategy

The system is envisaged to be implemented as a client-server application comprising a web-server application that implements a questioner posing questions to CTWO in lull periods of a day. It logs the results and displays them onto a display unit. The display serves as dashboard displaying alarms that are triggered due to anomaly. It also displays call answering times, calls in waiting, calls lost per shift per CTWO etc. The information is also uploaded to PMC on scheduled times for macro-level monitoring at PMC, RESCUE HQs.

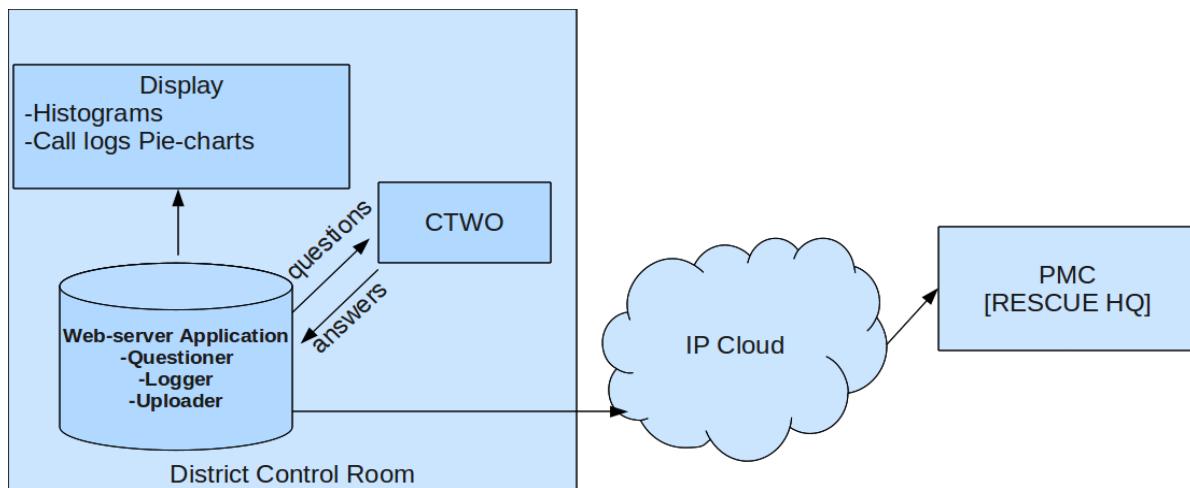


Figure 14. Slumber prevention system for CTWOS.

11. Problem Statement (Observer's suggestion)

In order to implement the archival, assessment, dissemination to the HQs, and consequently to improve the overall operations of RESCUE 1122, the digitization of Call forms including Emergency Call Forms (ECF) and Emergency Response Forms (ERFs) is performed by the Control Room. Taking the example of Lahore district, an average emergency calls frequency of 170 per day [R1] makes it difficult to synchronize the digitization activity with each emergency dispatch. The Control Room Incharge (CRI) alongwith the available human resource barely manages the digitization activity offline.

Unpredictable daily activities often result into a compromise of even this offline activity. It is important to facilitate this indirect but most effective mechanism to improve response times.

11. Proposed Solution

RESCUE 1122 deploys a reward-based scribing system for emergency-related Call and Response forms through student volunteers, under the umbrella of community partnership programme for universities. Student volunteers savvy in MS office would take call forms from the Control Room Incharge and transcribe them on the computers which are housed in an available room adjacent to Control Room.

11. Recommended Implementation Strategy

Following considerations must be made to plan and implement the system.

- a) Private sector universities may be encouraged to sign MoU with RESCUE 1122 under Corporate Social Responsibility (CSR). Whereas Public sector universities may sign MoU with RESCUE 1122 under Community Awareness Programme (CAP). The academic calendars of the universities must reflect this MoU as an important activity.
- b) The rewards for students could be defined in terms of Credit Hours (CRs) compensation in humanities and internship heads. The students from departments involving computers should be encouraged to apply through a competitive questionnaire.

The scribing activity is implemented as in master-slave coupling of clients (student PCs) and server (CRI master). The scribed call forms are approved by CRI for submission to server for local archival and dispatch to RESCUE 1122 HQs.

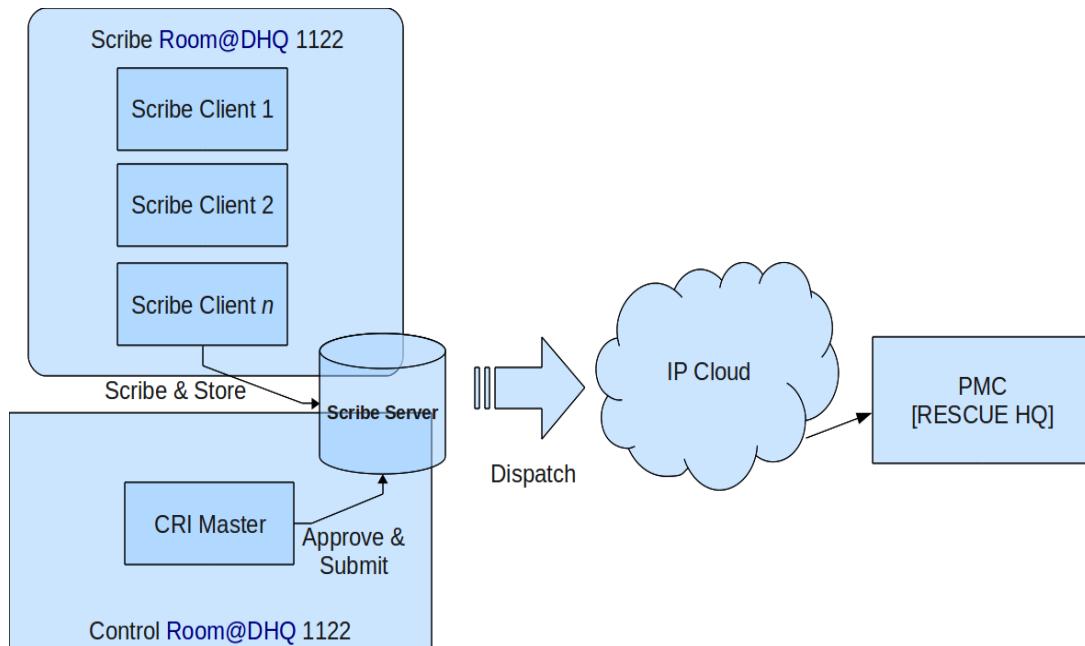


Figure 15. Scribing activity management through outsourcing architecture.

12. Problem Statement (Observer's suggestion)

The identification and continuous adjustment of blackspots (or hotspots [R1]) by the research analysts at RESCUE 1122 is key to optimal response time-based coverage of the cities. With a multitude of factors that define a hotspot, events-triggered or periodic readjustment of keypoints by RESCUE 1122-management is required. With the availability of limited ambulances, it is a daunting challenge to define few active keypoints out of a very large number of hotspots. Even after earmarking the keypoints, the occurrence of concomitant activities such as roadblocks, real-time traffic congestion, movement of religious and political processions and other factors all prevent the keypoints to be used effectively. It is needed that the management responsible for assessing the viability of keypoints is provided with a macro-level holistic perspective. The management may then employ existing approaches or devise new approaches to best adapt the usage of keypoints so as to improve the end-to-end response time.

12. Proposed Solution

An intelligent deployment-perspective builder is proposed that takes input from a broad range of phenomena and activities (socio, politico, weather-based, religious) and government websites and non-government agencies. Websites such as traffic-warden managed (www.raasta.pk) is publicly available information that is proposed to be linked and annotated on GoogleMaps and TPL C-Track maps [3]. The perspective builder maps these inputs on Christian and Islamic calendars in current form and from the recent past. The perspective builder then suggests to the management live key-points which have temporal lives, dormant keypoints which have seasonal activity and keypoints which must be front-loaded⁶ [R2]. This information would then be analyzed for keeping key points agile and useful. For real-time events that might skew the keypoints, the nature of emergencies can be assessed to let the ambulances stay in the keypoints in particular time of the day only and move to other keypoints in another time of the day [R7, R11].

Regulating Response-times through the deployment of front-loaded *RESCUErs-on-Bikes* (RoBs)

In addition, we propose the deployment of RESCUE 1122-owned fleet of motorbikes rode by RESCUErs (RoBs) which act as first responders. These RoBs can be used to provide scene assessment for viability of ambulance arrival at the scene and for providing immediate medical response for cases not warranting evacuation to the hospitals. RoBs arrival at the scene may always optimize the ambulance response times either by a) obviating the need of the ambulance to arrive at the scene and b) fastest in situ provisioning of pre-evacuation treatment such as triage and first aid, CPR, splinting and spinal immobilization patient preparation etc., [R1].

⁶ “Front-loaded model” means increasing Fast Response Vehicle (FRV) ratio to traditional ambulances.

12. Recommended Implementation Strategy

In order to implement it effectively, following considerations must be made:

1. The front-loading needs to be seen as a viability in overall route truncation of ambulances, improvement in response times and end-to-end times and better pre-evacuation treatment. Since front-loading is not carried out for every ambulance dispatch, the keypoints should only be assigned to areas with emphasis on emergency types, traffic-congested links and longer reported response times from the past archives as in tripsheets.
2. The dispatch of ambulance and that of RoBs should be concomitant. It is due to the fact that a legitimate call cannot be denied the rightful access to ambulance dispatch.
3. The Control Room must identify two deployment regimens that must compliment each other and are never used in a counter-productive way.
4. Induction of additional human resource shall be warranted that involves a hands on training on different set of first-aid methodologies.
5. ROBs may be provided with MMS-enabled mobile phones to do scene assessment and sharing with EMTs enroute the site. It would help preparation of ambulance facilities for pre-hospital care.

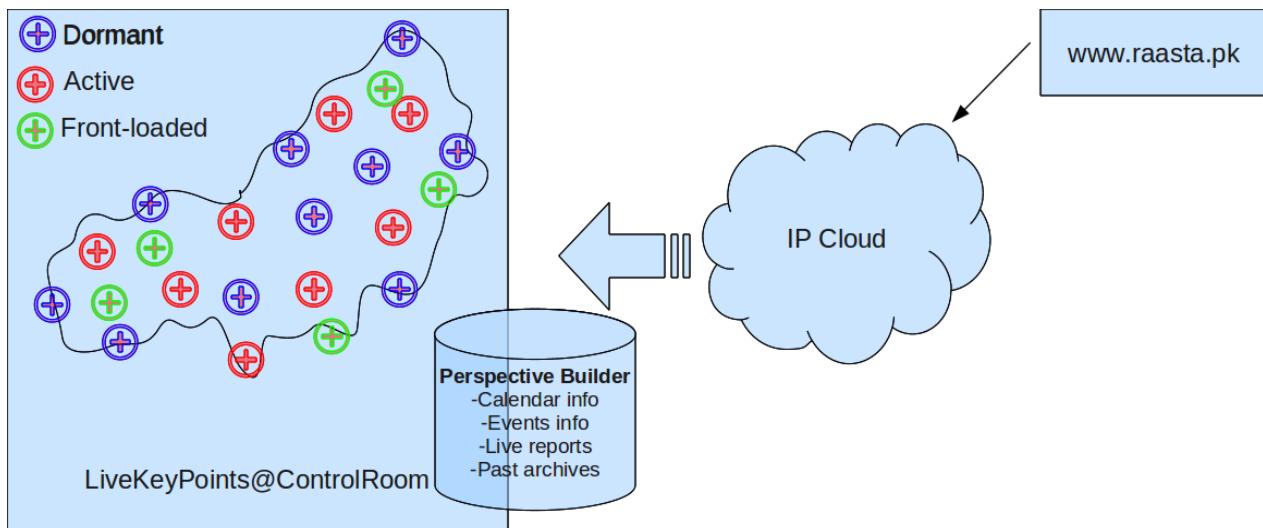


Figure 16. KeyPoints selection and de-selection using blackspot information.

13. Problem Statement (Observer's suggestion)

Traffic congestion due to urban sprawl is becoming a performance inhibiting factor for RESCUE 1122 operations. Frequent road maintenance and construction by government and other bodies further exacerbates the times to scene and to the hospitals for ambulances. The problem is compounded by the red traffic signals and the long traffic queues that make the traffic wardens working unbeknownst to the arriving ambulance. Apparently, this problem directly affects the response times for RESCUE 1122, however no direct implementation strategy exists that can provide priority treatment to ambulances on intersections. Internationally, coerced change of traffic signals to facilitate smooth flow of ambulance is reported in [R10]. However due to cultural issues and people's displeasure (if they are not overhearing ambulance siren) over sudden change of traffic signals, it is not possible to implement it per se. It is desired that a system is retrofitted in our local settings that facilitates ambulance movements while not disrupting usual traffic signals.

13. Proposed Solution

We propose an Intelligent Traffic System (ITS) based ambulance forewarning system for the traffic wardens. It would be based on a blue-light emitting post that displays the direction of ingress ambulance.

13. Recommended Implementation Strategy

The system is based upon the deployment of blue lights with directional display on polls which have embedded WiFi cards. These polls can receive communication from an incoming ambulance from distances varying between 500 meters to 100 meters. The traffic warden on seeing blue illuminating light and the direction of arrival assigns priority to that link. This helps the traffic to be cleared up in a faster way and at the same time encourages other vehicles to accommodate and facilitate arriving vehicle.

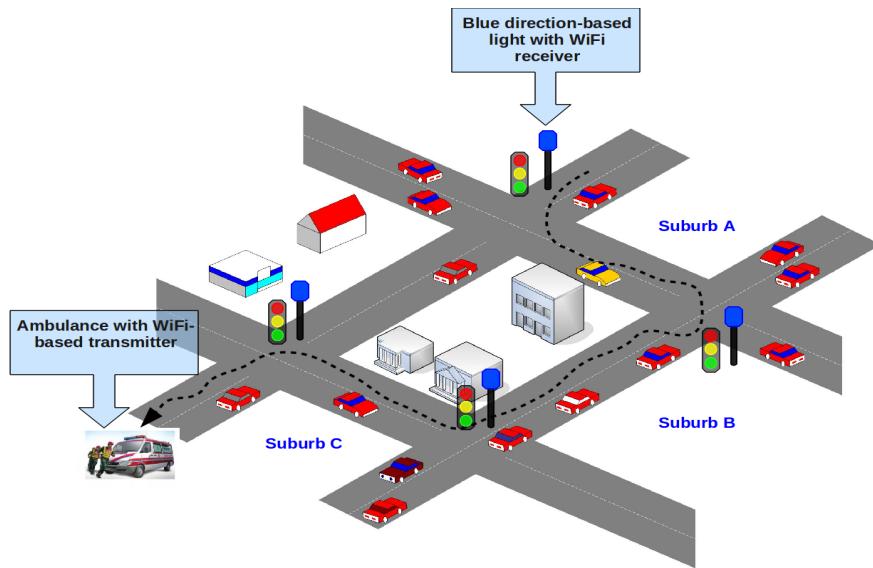


Figure 17. Deployment of warden assistance system to clear out traffic on ambulance ingress.

PROVINCIAL MONITORING CELL (PMC)

Disposition

The Provincial Monitoring Cell (PMC) lies at the heart of the RESCUE 1122 operations. Seeing its critical role, it is housed within the Head Quarters (HQ) of RESCUE 1122, Lahore. The infrastructural elements that PMC hosts and uses are seen in Figure 2. It is manned by the following:

1. Control Room Incharge
2. Shift Incharge
3. CTWOs
4. WOs
5. Staff on C-track software

Scope

1. Punjab-wide management of emergency vehicles and staff.
2. Punjab-wide analysis and follow-up of recorded emergency calls.
3. Punjab-wide compilation of Daily Consolidated Reports, their archival and necessary follow-up
4. Follow-up on complaints (0333-1122-1122)

Brief on operations and use of respective IT tools/technologies

The role and operations of PMC are holistic in terms of daily operations of RESCUE 1122. PMC activities also compliment the overarching role of the office of DD Ops through reporting and control. PMC extends the district-wide operations of Control Room to the provincial level, acting more like a 'Big Brother' watching over. In more specific terms, a) the movement of ambulances is monitored across 36 districts of Punjab, b) Wireless communication for dispatch-and-control is overheard for ensuring SOP adherence, need for likely intervention and broadcasting of district-specific administrative announcements and c) offline activities involving followup of both a) and b).

EXISTING LIMITATIONS & PROJECTED MODIFICATIONS

This sub-section describes PMC-related problem areas, limitations of either the IT infrastructure or current operational practices limiting the effective use of the IT infrastructure or proposed value additions. These can broadly be categorized into two modes of assessment, either as an internal feedback by the RESCUE 1122 staff or as an observation by the observer.

14. Problem Statement (Observers suggestion for DD Ops office)

The designated role of Audio Visual Controller (AVC) is conceived and preferred for providing media coverage for major emergencies as compared to a typical day-to-day emergency. Although the EMTs and driver are equipped with an in-vehicle camera, and are recommended to picture-shoot the emergency site, the follow-up by DD Ops is only triggered in response to a complain or an inquiry, e.g., as consequence to an emergency case becoming a medico-legal case.

According to the observer's interactions and movement in ambulances, the emergency site pictures are provided by the driver and EMT after attending an emergency to the Control Room, which in turn emails these to a designated personnel in PMC. The personnel receives these pictures and short-lists them in terms of priority and shares them with DD Ops to oversee the compliance of SOP in handling emergency. The information is also seen important from the legal investigative viewpoint involving police and forensics. The overall activity has an inherent latency in response, mitigating which is desired by the management.

14. Proposed Solution

The digital pictures are relayed to PMC by district HQ CRI and PMC displays the images of current emergencies on a large display. The images are timed such that those belonging to older emergencies are sent in the background, while the more recent emergencies are displayed in the foreground. The administration can have thus a real-time analysis of the performance of the in-situ staff.

14. Recommended Implementation Strategy

When the ambulance arrives at the district HQ, the pictures are provided to CRI. Instead of emailing them, CRI uploads them using a simple software interface provided at the computer. This interface links to the server connected to large screen display housed in PMC, HQ Lahore. The server receives these pictures and displays them onto the screen alongwith additional information (EC, Emergency type, District, Time etc.)

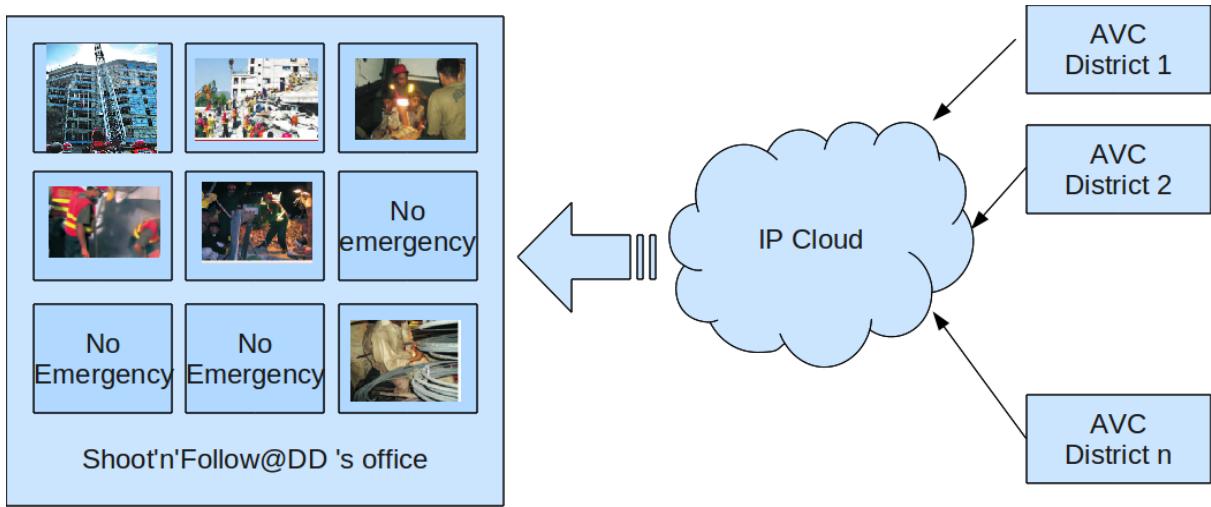


Figure 18. Post-event analysis framework for verifying SOP compliance.

15. Problem Statement (Internal feedback by DD Ops)

The overarching role of the RESCUE 1122 HQs in Lahore involving major operations of the PMC and the office of DD cannot be overemphasized. Routine interactions of HQ with 36 districts across Punjab involving staff parade state, compilation of Daily Consolidated Report (DCR) form a multiplicity of interactions including Gmail-based correspondence (Emailing), mobile calls and even personal meetings. Amidst such tightly-packed routine, if there is a major incidence across Punjab, getting details about it poses added burden. In the wake of multiple major incidents, the situation becomes uncontrollably cumbersome for PMC to oversee. A *pull* mechanism such as the automation of the reporting of major incidents across 36 districts of Punjab is desired that displays them all in unified and centralized way at PMC is earnestly desired that would facilitate the operations of RESCUE 1122 HQs, Lahore.

Likewise, RESCUE 1122 HQs disseminate periodic, intermittent and emergent communiques and office orders to district HQs. Especially for situations involving inter-district coordination and communication, the supervisory role of HQ is crucial. It is desired by the management that a *push* mechanism such as task break-down and responsibility devolution system must be put in place that allows the HQ management to assign, federate and monitor tasks to individual personnel and teams at district levels.

15a. Proposed Solution

An intelligent map of Punjab (IntelMap) is proposed as the *pull* mechanism that is housed in PMC. It displays multi-layer and interactive live map of Punjab. It shows the districts with current major incidents, the location and nature of incidence, and auxiliary information as provided by RESCUE 1122 district Control Room. It would also have the capability of displaying information about archived

major incidents in chronological order.

15a. Recommended Implementation Strategy

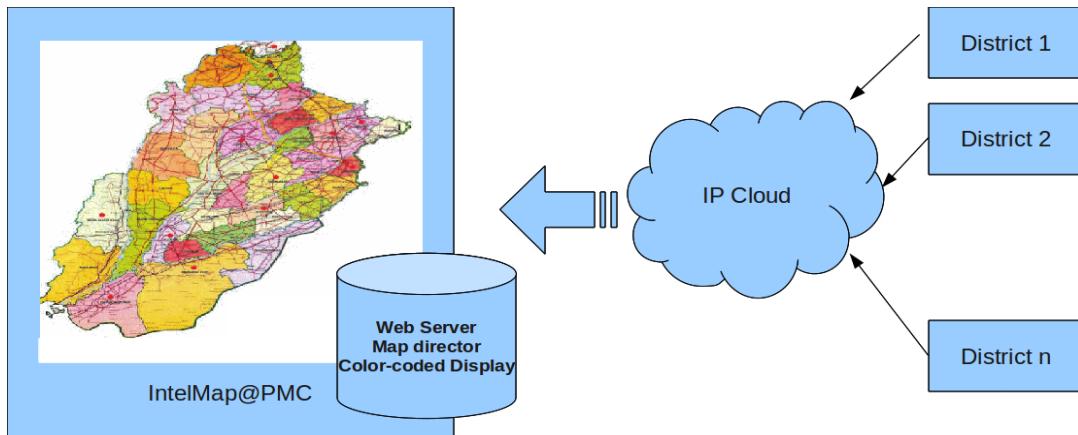


Figure 19. Province-wide macro-viewing system for managers.

IntelMap, a visual dashboard is implemented as a web-service hosted by a web server in PMC. Each district with Internet connectivity uploads information on the webserver. This information contains district-wise information on current major incidents, the location and nature of incidence, and auxiliary information as deemed necessary by RESCUE 1122 HQ. A map director partitions the geographical map of Punjab into districts each with its own sub-partitioning of RESCUE 1122 coverage zones and key reference points. The color coded display identifies the size of each district, its position and displays a color that is incidence-specific (e.g., red = RTC, Blue = Fire, Yellow = Terrorism etc.).

15b. Proposed Solution

Seeing the relentless work at RESCUE 1122, a *push* mechanism is proposed that implements scrum⁷ situation in the game of Rugby using a distributed software. Those who are familiar with the game would appreciate that scrum situations are best handled by sprints. Likewise, using the scrum methodology, every mission that is identified and defined by the HQ either for individual districts or for inter-district execution is declared as a scrum project. Since each project is time-barred with tangible deliverables or sub-tasks it is divided into sprints. These sprints are assigned to districts with specific deadlines. An embedded task scheduler is also provided to cater for the extraction rate⁸ that reduces emergency coverage of district staff. A long-term statistical analysis of extraction rate also helps RESCUE HQ management to provide optimally budgeted relief ratios⁹ [1] to individual districts on the basis of on-ground situation and mitigating the effects of various factors on performance during

7 Scrum or scrummage is a situation in Rugby wherein the forward players of each team put their heads down together and try to kick the ball thrown between the teams.

8 Extraction rate: In daily parade state (attendance roll), the number of staff that stand-down due to authorized leave.

9 Relief ratio: Permanent staff which is on shift-duties to compensate for the extraction rate. It is dependent upon various factors such as averaged total staff to stood-down staff, administrative staff vs on-site staff, and emergencies reported to lapsed responses.

peak-load season, trainings, seasonal and annual off-days.

15b. Recommended Implementation Strategy

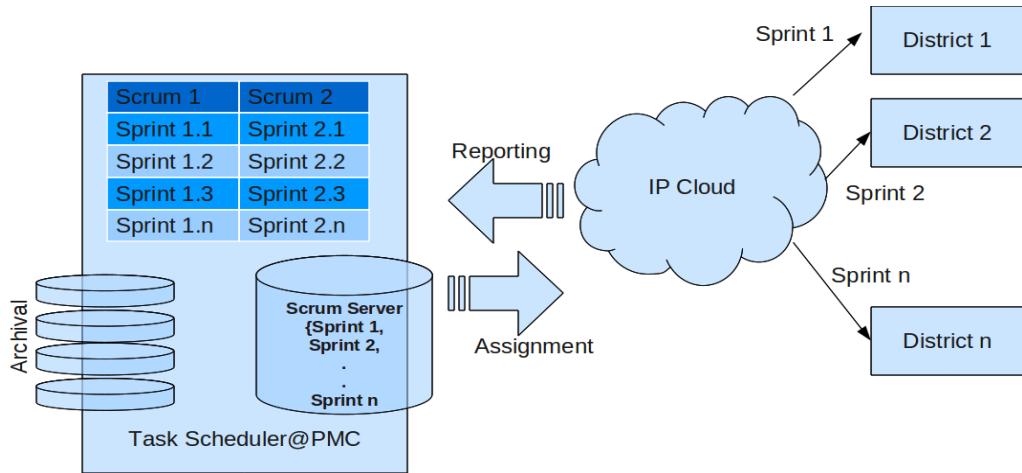


Figure 20. Project assignment and auditing system for HQ RESCUE 1122.

The task scheduler is used in RESCUE 1122 HQ to define scrum situations and their respective sprints. These are then assigned to districts which are responsible for their execution and reporting. These scrums are archived for statistical analysis and subsequent referral.

FINAL WORDS

In this report, as an observer, I have attempted to identify aspects of RESCUE 1122 operations in existing states and in expected forms. The undertaking initiative to realize these desired solutions and recommended implementation strategies, another milestone of venture capitalizing must be achieved. In this regard, UET through KICS and Dept of CS&E is already engaged in the process of funding requests for COMMONSENSE Project. The presence of a public-welfare based objective report as this is expected to complement and reinforce the funds management activities.

Other collateral but nontrivial aspects which are worth-mentioning from the completeness perspective are briefly presented in line.

Using key players services effectively

The existence of sufficiently working IT infrastructure bespeaks of the prevailing vision in RESCUE 1122. New technologies such as IP cameras provided by Mansha Brothers and vehicle tracking system (C-Track Maxx) by TPL, Pakistan can be better coordinated and channelized to address newer application areas such as camera-based attendance management system and usage of new alarms for mobile phones of operating chiefs in the fields, HQ (PMC) and Control Room in real time using the message forwarder utility, respectively.

Recent introduction to OASIS and Single Reporting Format (SRF: srfpakistan.pk) are some of the most valuable dimensions of technology that RESCUE can benefit from. The usage of NGO-related activities for post-disaster coordination and planning without having to interact with them are attractive applications. The Humanitarian Assistance Information System can then be used by RESCUE 1122 to add its information/activities/solicitation of donors/community services information even disseminated to interested stake holders through IMMAP.

Realizing it all through change management

Training Academy lies at the heart of all the operational and administrative exposure to the officers and RESCUERS. In order to ensure that the transition from the current system to the envisaged system is smooth, it would be pivotal to embed the technology solutions into training though Prospective Technological Integration Program (PTIP). This would imply tailoring of IT-based solutions on local parameters including power outage, working environment and psychological dynamics.

A SWOT Analysis

Having presented a plethora of technologically justifiable solutions, it would be amiss to not comment on the probability of success that is attributable to besides partly relevant but overly dominating issues including political, bureaucratic and financial, not to mention others. Regarding the Strengths and Opportunities, it is obvious through the discussion all along that the proposed solutions shall add value to the overall operations and citizens experiences with the organization. However, the Weaknesses and Threats must also be identified and duly addressed before undertaking the full-fledged project.

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