Could ICT Be Harnessed for Prehospital Emergency Medical Services?
The Case of the Lebanese Red Cross

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Abstract: Of particular interest, this paper treats Information and Communication Technologies applied to the Emergency Medical Services Division of the Lebanese Red Cross. Information for the case study is gathered via semi-structured interviews with six informants and a database of Secondary data is collected from available management reports, assessments, feasibility studies, project reporting and documentation. The case of the ICT implementation investigated in this study offers insight into an implementation of a prehospital emergency medical services. Though ICT implementations in pre-hospital care systems, are now common practice, what makes this case particular is that it is starting from a volunteer-based.

1   INTRODUCTION

Dispatch Call 1: *"The 1-4-0 national hotline for ambulance services rings. The dispatcher picks up the phone, and opens a case in the system with the basic details of the phone number and the caller details prefilled with caller data".* The dispatcher asks the standard questions to the caller, and inputs the answers on the electronic form. The software then automatically assigns a priority to that call based on predefined criteria and links the call to the nearest available vehicle location. The dispatchers is able to see the geographical location of the ambulance on an electronic map on his screen as he sends the call data to the ambulance and monitors its progress on the screen. Trained in emergency medical dispatch the dispatcher begins patient care before the emergency team arrives to the site. While the call is in progress, the EMT volunteers in the ambulance complete their patient care report information on a handheld, the data is then sent to the dispatcher and forwarded to the receiving hospital."

Dispatch Call 2: *"As dispatcher "D1" takes caller details into the system, another phone rings and the only free dispatcher "D2" is an apprentice, who is limited to handle non-urgent transport calls. The supervisor checks his dashboard and realizes that the latest call that is ongoing is a non-urgent transport request, whereas all other dispatchers are receiving either a red code or a yellow code call (High priority). The supervisor informs dispatcher "D1" to transfer his call to dispatcher "D2". The ongoing case is transferred to D2 freeing D1 up to pick up the other pending call. The apprentice completes the call taking procedure, while the supervisor is listening to the call to make sure that the conversation is compliant to the local protocols. If necessary, the supervisor could take over the call from his own workstation and the case transfers to his screen for handling. Call recording is automatic and recorded information is saved in the case for future review. ... Reports on utilization rate, call duration linked to mission information, are at a press of a button"* (The Lebanese Red Cross Emergency Medical Services)

Such was the initial envisioning stage of the *Integrated IT solution* for the Emergency Medical Dispatch Services at the Lebanese Red Cross. The Lebanese Red Cross ICT strategy committee has recently completed a roadmap for an integrated solution for its prehospital Emergency Medical Services (EMS). The solution has expanded from its initial functional focus on Dispatch to include supporting functions such as: volunteer management, training, IT help desk ticketing, logistics (fleet and equipment management), and other functions such as blood donation management and financial donor management with real cost reporting and forecasting.

What were the core drivers to implement ICT at the Lebanese Red Cross EMS? How was the

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Lebanese Red Cross EMS able to implement ICT? What opportunities, challenges and rewards were observed from ICT? In order to answer these questions we set out on an in depth case study exploration of the LRC EMS' implementation of an integrated IT solution.

2 BACKGROUND

2.1 ICT Implementations in Non-profit Organizations

Information and Communications Technologies (ICT) in humanitarian services have been defined as the "*range of electronic technologies which when converged in new configurations are flexible, adaptable, enabling and capable of transforming organizations and redefining social relations*" (Michiels and Van Crowder, 2001:8). Indeed, ICT have been argued as essential components in humanitarian strategies; from poverty reduction for example (Grimshaw, 2015) to major incident management where information sharing and interoperability is cornerstone for realization of the objectives (Allen et al., 2014). Non-profit organizations typically operate in such complicated social environments, due partly to their reliance on external funds and partly due to different forms of compromise between multiple stakeholders with diverse interests. Political climates and drivers are major determinants in the approach for humanitarian action (MPC Research Report 2012/13). In general, ICT implementations in non-profit organizations must take into consideration such environment conditions (Thatcher et al., 2006). Though well documented in research contextual to the for-profit setting (Zhang et al., 2010), in-depth insight into ICT implementations in humanitarian and non-profit organizations is scarcely existent in the literature.

2.2 ICT Implementations in Red Cross Societies

In the context of the Red Cross societies, the British Red Cross have exploited ICT in volunteer management (Waikayi et al., 2012), especially targeted towards volunteer retention programs that would be based on data captured and analysed by systems that model volunteer management processes. Elsewhere, volunteer portals have been setup to support the volunteers for the Portuguese Red Cross

and monitor real time relief work management (Macedo et al., 2012).

The American Red Cross leveraged social media to build relationships (Briones et al., 2011), other applications were found beneficial in Disaster Response (Park and Johnston, 2015) leveraging the information technology platforms for collection and dissemination of field information in near real-time. These platforms would include tools for point-of-care diagnostics, case management, logistics management, community mobilization, payment and financial support distribution, and big data analytics solutions, etc… as in the case of the Ebola response in 2014 (According to a Technical Brief: Use of Technology in the Ebola Response in West Africa, *www.africanstrategies4health.org*).

The Finnish Red Cross reported the need for standard supply chain planning tools and logistics performance measurement systems to assist in their relief activities (Leppänen, 2012) reinforcing the role of ICT in humanitarian logistics (Christopher and Tatham, 2014). On the other hand, implementations of ICT in Disaster Risk Reduction (Kelvin and Innocent, 2012) and crisis management (Meier and Leaning, 2009) apply technology to crisis mapping and early warning (Meier, 2011) to help prevent disasters and manage their capacity to respond (Mung'ou, 2014).

2.3 ICT Implementations in Prehospital EMS

Prehospital EMS includes on-site first aid treatment of injured or ill patients and the transport of patients from the incident to a hospital in emergency or mass casualties. For major trauma patients as in the case of out of hospital cardiac arrest (OHCA) cases for instance, the speed of response of the prehospital EMS is critical to the survival of patients (NHTSA.org). Specific to prehospital care performance, ICT was shown to be vital (Blackwell and Kaufman, 2002).

Historically, computer-aided dispatch tools have provided means *of classification and prioritization of calls* (Curka et al., 1993) and measurements of effectiveness of EMS (Campbell et al, 1995). Emergency medical services may require a specialized and unique type of intelligent transportation system (Kuwata and Takada, 2004) that must place the ambulance the closest possible to the patient when the call is received. Geographic information systems (GIS) have been developed to minimize response time (Hall, 1999) and patient

survival rates have been linked to different response time thresholds (McLay and Mayorga, 2010).

Scholars have tackled the incorporation of *simulation-based training* for prehospital emergency care (Alenljung and Söderholm, 2015) to increase the skill levels of the participants and placed ICT as an efficiency constituent in EMS (Ahmed et al., 2014). However, technology offerings are yet to reach a ubiquitous level in real-time teleconsultation for pre-hospital emergency medical services (Thelen et al., 2014). Scholars have suggested that overall, ICT applied as telemedicine had a positive impact on emergency pre-hospital medical care (Amadi-Obi et al., 2014). The use of information tools such as tablets and medical device integration avail prehospital information to EMTs during Trauma Resuscitation (Zhang and Sarcevic, 2015).

In resources constrained countries such as Lebanon the implementation of an ICT system in support of pre-hospital emergency care is to be completed in a graduated fashion dependent upon resource availability (Sun and Wallis, 2012); resources could be human, financial and technological.

2.4 Prehospital EMS in Lebanon

Prehospital emergency medical services in Lebanon are based on volunteer systems with multiple agencies (El Sayed and Bayram, 2013). One of which is The Lebanese Red Cross (LRC), a humanitarian society established on July 9, 1945 as an independent national society, to "*provide relief to victims of natural and human made disasters, and help people prevent, prepare for and respond to emergencies, and to mitigate the suffering of the most vulnerable*" (*Mission of the LRC).*

Historically, in 1946, LRC was recognized by the State as a public non-profit organization and as an auxiliary team to the medical service of the Lebanese Army. In 1947, LRC joined the International Red Cross and Red Crescent Movement and became a member of the International Federation of the Red Cross and Red Crescent Societies (ICRC). It wasn't until 1964, when the LRC started provisions of providing Emergency Medical Services (EMS) established with 12 volunteers serving as the original first-aid teams.

Today (as of August, 2015), the LRC is staffed by about 8000 volunteers and members in 32 Chapters (or local branches); 36 Youth Clubs; 7 Mobile Primary Health Clinics; 12 Blood Transfusion Centers; 40 Medico-Social Centers; 6 Nursing Institutes; 12 local Disaster Management Units for relief in natural and man-made disasters and an Emergency Medical Services (EMS) department.

According to a poll issued by INFOPRO Marketing "*Perception towards Lebanese Red Cross,*" issued on August 24, 2012, the LRC Society (LRCS) derives most of its credibility and public image from its EMS; services chartered with the response to life threatening events including home, work and transportation accidents; medical and trauma cases; and acts of war casualties.

The LRC Emergency Medical Services (LRC EMS) runs a fleet of 260+ Ambulances, a team of 2700+ volunteer Emergency Medical Technicians, 46 EMS stations and 4 dispatch centers. The LRC EMS ensures the only nation-wide comprehensive medical transport available to all Lebanese. 28 full time staff provide the professional operational support to run this large-scale nation-wide multi- million dollar operation.

3 METHODOLOGY

Of particular interest, this paper treats Information and Communication Technologies applied to the EMS Division of the Lebanese Red Cross (LRCEMS). We will review the core drivers to implement the *Integrated IT Solution* as part of the ICT strategy at the LRCEMS and summarize the opportunities, challenges and rewards observed, presenting such study as "*lessons learned from practice*" for other humanitarian ICT implementations. This research into practice takes the form of a qualitative case study (Eisenhardt, 1989). Information for the case study is gathered through semi-structured interviews with six informants from LRCEMS chosen from the project team, management team, and stakeholders of the Integrated IT Solution implementation; namely, statements from the manager of the dispatch call centers; the director and assistant director for EMS development; the project manager; the EMS training manager; the EMS IT manager, with an added insight of the LRC undersecretary general, in order enrich the empirical evidence. Secondary data is collected from available strategy and management presentations, request for proposal (RFP) documentation for the Integrated IT Solution, Telephony and Telecom upgrade, ICRC reports and assessments (2005 - 2015), feasibility studies, project documentation for the Integrated IT Solution, and a review of information on the LRCEMS portal.

4 DISCUSSION

4.1 Strategic Drivers for ICT

In 2005/2007, assessments of the LRCEMS function, conducted by the ICRC, the dispatch centers were found to lack appropriate tools to effectively manage the coordination and communication activities with the other 4 regional dispatch.

Calls to 1-4-0 (The Dispatch Call Center Hotline) were going unanswered, in particular during daytime. This was identified as reputational risk.

The fleet is aging with unclear replacement plans, the infrastructure, materials and equipment were not standardized, often sub-standard and outdated with only a paper tracking mechanism in place to address this essential requirement.

The changing socio-economic patterns in the country make it more and more difficult to recruit and retain the sufficient volunteer base required to meet the EMS's ambitions.

Training of EMS volunteers was not standardized, and there was no recognized certification of their capacities as pre-hospital emergency care providers.

On the administrative side of the EMS action, attention needed to be given to reducing the risk of operating cost explosion. Financial requirements were indefinite. There was a recognizable need for effective systems to ensure proper financial management, actual understanding the cost basis and funding requirements and a clear transparency for cost control. The assessments also showed that the EMS had been chronically underfunded and the impetus for transparency and real cost budgeting was clear. *"Ambulance response is very expensive especially during the day when volunteers are not available, having reliable and precise data about ambulance response, will enable the LRC to respond more rapidly to the most urgent cases without increasing the associated cost"* said the undersecretary general.

Towards the end of 2007, the Lebanese Red Cross Society, with the support of Red Cross / Red Crescent Movement and other development partners, launched a 5 year strategy to upgrade the overall capacities and general performance of its Emergency Medical Services in the purpose of reducing incident response times and increasing the quality of prehospital EMS.

Key operational objectives of the strategy called for a solution that automates the EMS dispatch functions and supporting activities. *"One of the primary goals of the upgrade was to enable the dispatch function to manage calls centrally. [...],*

meaning one dispatch centre can talk to ambulances all over the country" (LRCEMS ass. dir. for development).

4.2 Integrated It Solution Overview

The *integrated IT Solution* was scoped around a computerized aided dispatch module designed to automate emergency missions, patient transport mission and mobile First Aid. The dispatch module incorporates Patient Care Reports into the dispatch functions with pre-set dispatch triage and decision criteria, call priority and call type. Complete with reporting capabilities and a mission dashboard, this module offers the ability to identify the available resources at each station at the beginning of each shift, log their scheduled missions into the dispatch timetable and respond to events that impede the call progress.

The automated dispatch function includes a telephony system facility for the automation of call routing and recording with correlation to cases for proper reporting. The ICT strategy comprises a rebuild for the telecom infrastructure aimed at improving security, and reducing interference is to be integrated with the data network for tracking, recording and statistics.

A set of supporting modules (Appendix- Figure 1) for logistics and volunteer management are conceived with specific functionality: (1) the logistics module covering fleet and equipment inventory is intended to monitor and report on consumables usage for stock level management and track nonperishable equipment location, usage and reporting; and (2) the volunteer management module incorporates a dashboard to report on the related activities with visibility into factors that could improve volunteer retention. Annexed to this module is a training component for training requests, approvals, activities, cancellations and reschedule. Finally, an EMS portal offers access to information from the public, volunteers, administrators and national societies.

4.3 Outcomes and Rewards

A phased approach was conceived to deploy the functionality in sequence in order to emphasize the proper adoption of the system. Dispatch centers have transitioned to computer assisted dispatch. The volunteer management and logistics modules are in the pilot stage. Databases for fleet management, finances and tracking of consumables are being developed and rolled out. Shortly after the implementation (6 months), the system is starting to

show rewards in terms of effectiveness & efficiency improvements and insight to vital information.

"*The success of the implementation in the dispatch centers has led to a decision to consolidate the dispatch function in two strategic dispatch centers significantly decreasing our operating costs*" adds the LRCEMS assistant director for development. "*This tool is starting to give us insight into the durations required for each part of the call management process*" states the Project Manager. Such information is vital for monitoring and improvement as necessary. As a source of operational data, this system is poised to serve as a basis for fundraising data related to donations and pledges, accounting and allocation of costs. It has also become clear that features such as "dispatch call recording" would add a level of real data capture to strengthen the legal basis of LRC activities.

Furthermore, the implemented solution has proven a visible utility for other LRC departments (e.g. Blood bank, logistics, Psycho-Social support, etc.) an opportunity for bolstering LRC services to the community through interfaces with smartphones and handheld applications that facilitate caller response, and through integration with social networks for communication diffusion in state of crisis.

4.4 Challenges

In system implementations of this magnitude, challenges are abound. Empirical observations from this case study bear witness to challenges before, during and after the implementation activities.

4.4.1 Challenges Before Implementation

In preparation for the implementation, the LRC-EMS issued a comprehensive Request for Proposals (RFP) for an "*Integrated IT Solution*" with the objective to secure funding by January 2011. Full buy-in by the rest of the LRC Society was slow to come. "*A proof of feasibility was an essential impetus for the donor support in the implementation process*" (LRCEMS ass. dir. for development). Furthermore, funding, as a package, was not forthcoming and the RFP was divided into components, which eventually did lead to funding for each component separately introducing complexity into the planning process.

In order to adequately support the project, "*an active IT Committee was engaged*" stated the Project Manager, mobilizing ICT staff resources augmented by outsourced consultant to plan the required updates for the infrastructure and prepare for the implementation of the new systems. "*The internet connection to the stations needed to be improved and this required the network to be upgraded*" (LRCEMS IT Mgr.). The *choice of vendor* was made based principally on their ability to execute on the technical portion of the implementation as there was no single source of expertise available for both, the operational and the technical aspects of the solution. *Succinct functional requirements* to build the solution's modules were difficult to muster. "*The user interface, field, forms and workflows were in a state of flux as the information was gathered*". (LRCEMS Training Mgr.). "*A specific focus on usability and speed scrutinized the structure and flow in a non-call-taking environment before being introduced into the dispatch centre.*" (Proj. Mgr.).

4.4.2 Challenges During Implementation

Above and beyond the classical guidelines of security, resiliency and ease of use, the context of the *Integrated IT Solution*, imposed *tight architectural imperatives*: (1) A bilingual user interface (English and Arabic) based on a web-based platform that can be modified centrally and reduces costs; (2) an "offline mode" functionality resilient to telecommunication connection outages with the ability to synchronize offline data automatically when reconnected without risk of data corruption or information loss; and (3) a scalability to an unlimited number of users with an open license for public access to portal functionality that would avoid the burden of long-term running costs. On the other hand, the dispatch software was believed to require extensive testing. The LRCEMS had to be prepared for delays. A specific software acceptance checklist was developed by the project team. Additional difficulties were attributed to maturity level of the dispatchers in IT was weak. "*We had to get them up to speed quickly on basic skills first, then train them on the operational aspects of the software*" (LRCEMS Training Mgr.). The implementation of the solution lagged behind schedule. Training simulation for dispatchers had begun too early and without the software, which required a retraining process nearer to implementation. Changing in operational processes necessitated a change in scope. The processes to be implemented had to be documented first and then adjusted before they are automated. "*As the implementation date nears, all heads of stations needed a set of guidelines outlining the expected changes and the impacts on current processes*" (LRCEMS ass. dir. for development). Finally, the variable levels of funding during the project presented a risk on the sustainability of the project as

institutional donors *"tend to prioritize beneficiary facing activities over infrastructure and organisational development"* (LRCEMS ass. dir. for development)

4.4.3 Post-implementation Challenges

The implementation is still in course, however some post implementation challenges are starting to be reported and addressed.

The LRCEMS assistant director for development indicated that *"most pre-implementation challenges are persistent in post-implementation [...] Supplemental funding could be required for added features, potential changes to scope, or simply to cover increased training costs"* (LRCEMS ass. dir. for development).

"Infrastructure such as connectivity and power requirements are necessary for the success of the system, especially such a 7x24 online system" Says the dispatch call centre manager. Work was being done on the internal infrastructure, however, the required utility based services (telecom, power, etc.) may not always be up to the required performance level. This presents a higher risk and higher cost for the ICT budget to bear as to emphasize opportunities for infrastructure resiliency; namely, options of hosting, multiple connectivity methods,

Even at the post implementation stages, buy-in is a persisting challenge primarily due to the scale of the national society and the number of stakeholders. *"The leadership team needs to better understand the "Integrated IT Solution" and its potential for optimization"* (LRCEMS Director).

The post implementation maintenance budget was strained: Though cost reductions are expected from the consolidation of the dispatch centre, the implementation, with the required infrastructure components (networks, systems and hosting services), brought additional costs in form of maintenance and support costs to the budget baseline.

5 CONCLUSIONS

The value of ICT in crisis response has been recognized (Sharoda et al., 2008). Cases have been made on the need for an integrated data flow from computer aided dispatch and patient care reports, into hospital information systems (Schooley and Horan, 2007) in providing quality prehospital care.

In the literature surveyed, ICT solutions tackle challenges of prehospital care in a form of specific objective based point solutions; either in dispatch

(McLay and Mayorga, 2010), training (Alenljung and Söderholm, 2015), mobility (Zhang and Sarcevic, 2015), or resource management (Waikayi et al., 2012), etc... In distinction, this study focuses on an integrated solution implementation in a non-profit EMS organization and reveals challenges before, during and after the initial implementation stages of this large scale ICT solution.

The participants in this in-depth study converged to three fundamental limitations in the planning and implementation of this solution. Namely, limitations of infrastructure, resources constraints and buy-in. The transformation to a performance based system requires change that is dependent upon support and action from both internal and external agencies and departments, including donors and funders.

Funding and buy-in dominate all the phases of the implementation with concerns of sustainability in the cost structure, resources, infrastructure capability. The complexity of the environment necessitated a thorough preparation exercise to properly identify the architectural imperatives, prepare the functional requirements, with a continued active management of time and scope of the project.

5.1 A Turning Point in Capability Transformation

Distinctively, the LRCEMS addressed their prehospital care services automation as an ecosystem through the automation of the dispatch functions and the related supporting services including volunteer, fleet, equipment, training, and financial management. This open solution quickly became the focal point of the LRC at large with integration functions into the remaining LRC divisions. The integrated IT solution is destined to build a database of information that would deliver a source of reliable measurable achievements. Furthermore, such reports would be indispensable as a basis for fundraising justification to motivate wider integration and full range of system adoption. The assistant director for development at the LRC, sees a greater value of the information collected from this system. For instance, the system would *"support the definition of needs for prevention campaigns (highest incidents of cardiac, etc...) furthering the role of the LRC in the service of the community"*. Thus, the Lebanese Red Cross is poised to maximize their impact on the community by using the data generated to refine their services, adjust their fundraising efforts, and train their volunteers and board members more effectively.

5.2 Research Limitations

The concepts outlined herein are collected from a single case study; some unavoidable limitations can be noted in contexts such as culture, organizational context and industry. Though limited in scope and generalizability, the research has reached its stated aim.

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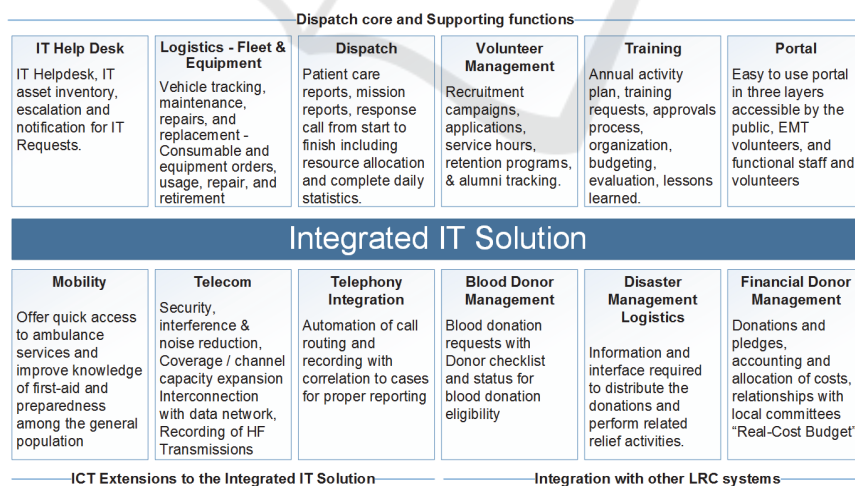Zhang, Z., & Sarcevic, A. (2015). Pre-hospital Information Use during Trauma Resuscitation. *iConference 2015 Proceedings.*

APPENDIX

Figure 1: LRC EMS Integrated IT Solution.