Service-Based Crisis Management: Local and Global Community Roles and Communication Options

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Abstract- **Health-related crises impact each community differently depending on the geographical dimensions of the crisis. Both local efforts and the efforts of global communities sharing the same relief goals are needed to prepare for and respond to emergencies. In this paper, local and global communities providing relief services for prevention and response are described. A specific attention is paid to service-based organizations in a local community that are essential for crisis management. These organizations respond locally to the individual needs of citizens faced with large scale disasters. To achieve an effective response, these organizations must play multiple roles. A high degree of collaboration among the responders of these organizations who serve on the front-line of a crisis is needed. This paper reviews the varying roles of these responders and how information and communication technology (ICT) device usage relevant to their respective roles can help. Increased ICT training and device usage is proposed for timely coordination when responding to a crisis. Focusing on examples from two organizational settings in communities - small grassroots organizations and philanthropic organizations - we discuss communication issues and options for the practitioners associated with these organizations. The contribution of this research is to identify methods and tools to increase device usage and collaboration effectiveness among service-based responders in local communities.**

Index Terms— **Public health, service-based organizations, crisis management, grassroots organizations, philanthropies, mobile technology, media richness, information and communication technologies (ICT), SMS text-messaging.**

1. INTRODUCTION

Planning and preparedness can reduce the impact of adverse events. To minimize the loss of life, it is increasingly important to leverage both local and global resources to prepare for a crisis. The individual "roles" associated with crisis mitigation vary based on the nature of the emergency and the availability of responders, thus adding another level of complexity to the crisis response effort. A "role" is defined as "the actions and activities assigned to or required or expected of a person or group [9]". Turoff [31] notes that "In a crisis it is never certain who will take on which role or which combination of roles. It is expected that people will be trained to be qualified in a number of different roles". Role-based applications show promise in assisting responders to leverage information and communication technologies during a crisis. When

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carefully deployed, information and communication technology (ICT) can fit multiple roles and support actions and activities between responders. Zhu discusses opportunities for role-based agents being applicable for many fields [40] and the privileges assigned for each role [39].

Zhu and Zhou [39] also define the importance of roles in a system's treatment of output and user input in electronic information exchange. Additionally mentioned are the use of SMS text-messaging that, for example, does not use an application system for information exchange, but rather a telecommunication architecture causing the information exchange dependency to fall directly on the user. Standard operating procedures/protocols are one method to achieve the needs of information exchange during collaboration for an assigned role. Dynamic roles could also be managed in a similar manner. For example, Zhu and Zhou [39] propose a five step procedure. In the example of text-messaging use for local community responders in service-based roles, emphasis should be placed on "Check incoming messages", and "Issue outgoing messages" as part of the training and practice protocol and the basis to improve productivity, performance [39] and to increase usage of the communication devices that are described in this manuscript. Protocols offer the potential to parallel information exchange functions of application systems for consistency while maintaining the mobile device flexibility needed in the field when responding to a crisis.

Organizations also play specific roles in crisis prevention. For example, service-based organizations - local and global organizations of volunteers, non-governmental organizations (NGOs), hospital and clinics, private and public coalitions, and philanthropies - focus on providing services to the people. Philanthropic organizations are one invaluable resource that aids crisis response. For example, Pfizer Inc offers training programs and partners with local organizations to act as a resource in aiding health needs of local communities through a dedicated foundation and philanthropy unit [25]. Philanthropic organizations often deploy supplies and services to communities during a crisis, but key to their success is the partnership and hand-off that occurs between them and the field organizations servicing the people in crisis. ICT can complement the hand-off process.

The focus of this research is to highlight the multiple roles associated with service-based organizations that focus on human well-being, and instances where ICT can improve communication. In this paper, we concentrate on two specific subsets of organizations within global and local communities: 1) small grassroots organizations; and 2)

philanthropic organizations. We discuss how local and global organizations preparing for, aiding and managing a crisis by playing specific roles (planners, influencers and responders) can be aided through access to the right communication tools and resources. This overview describes crisis needs and technology options based on grounded theories. The task-technology-fit is presented in the context of existing literature and the understanding of emergency roles and needs. Additional field research may be needed to validate the proposed frameworks. To this goal, future research will include empirically testing the fit of mobile and nomadic technology to each specific role. In this manuscript, we investigate global and local roles and the opportunities to better support these roles through proper ICT tools.

2. THE ROLE OF LOCAL AND GLOBAL SERVICE-BASED ORGANIZATIONS

2.1 Public Health Goals to Aide Communities

The mission of Public Health is to fulfill society's desire to create conditions so that people can be healthy [21]. Public health in the United States (U.S.) is defined differently than in other western countries with social health care systems. The United States has a private health care system, yet the goal of protecting the citizens (i.e. disease outbreak, bioterrorism) through surveillance, control, and prevention is common with other nations. The means of protection, the approach, and the available services to reach citizens are what vary. "Healthy people 2010" is a national "public health" initiative and goal that focuses on the health and well-being of future generations. Started in June 2003, this initiative places emphasis on both emerging issues and the vision for safer, healthier people **in every community**. It moves away from a disease control focus toward a more holistic aim of health protection [3] whose goals include: 1) health promotion and disease prevention; and 2) preparedness. Preparedness in all communities requires initiatives for the protection from infectious, environmental, and terrorist threats. These initiatives will assure readiness to confront traditional and emerging public health threats [4].

2.1.1 Local Communities
Local service-based organizations who serve the people in a community extend from public health and support many common initiatives. These organizations work with the community frequently in a hands-on capacity. An understanding of the local community landscape and protocols for emergency response escalation can enable effective solutions to public health issues. The collaboration during a crisis initiates the formation of a crisis response team, defined as "a real and virtual community of specialists and experts that must have unrestricted access to one another and is able to act as a collective" [11] [31] [16] [38]. Training and regular use of

ICT can increase preparedness of these responders who may need to initiate a call for assistance from either inside or outside of the local community. Service-based responders who serve as front-line responders for health-related emergencies (i.e. epidemic outbreak, bioterrorism) may form part of the crisis response team, yet are not accustomed to the use of communication devices like two-way radios.

Two examples warranting local community response were the Lebanon 2006 evacuations and the China 2006 typhoon warnings. In Lebanon, Swedish citizens who were registered with the Swedish mobile network were contacted with five distinct text-messages over four days beginning with a message that evacuations were taking place, followed by additional text-messages with instructions for meeting locations leading to the actual evacuation [30]. Pre-registration with the Swedish mobile network enabled evacuation preparedness.

Alike, the 2006 typhoon season in China, predicted to be stronger than previous years [1] leveraged short-messaging services (SMS), also called text-messaging, for early warning notifications. Over 18 million messages were sent for the five 2006 typhoon warnings in the Fujian province and coastal city. The content of the text was "Typhoon forecast to make land this evening near Jinjiang," and "Please attend to preparations." contained essential information that was a match for the task-technology fit, yet served as a vehicle for preparedness. With China as the world's biggest population of mobile phone users (the 426 million mobile phone users have surpassed the country's 365 million fixed-line phones) and increased mobile phone use spanning beyond the urban consumer to the blue collar workers and farmers. In the countryside, many poor villagers have no fixed telephone lines but dozens of mobile phones [1]. In these communities, early warning notifications provide essential information as a one-way communication medium. However, it is not clear what happens to those citizens who may receive the message, yet have limited ability to prepare on such short notice. For example, citizens with limited mobility or with special needs may need some assistance to better prepare in a timely manner. Local service-based organizations can step-in and assist citizens with preparedness needs at the onset of an early warning with a proactive approach [34] rather than taking a reactive approach once a crisis has taken place. ICT use can aide this process through two-way communication exchange.

2.1.2 Global Communities
Global organizations also play a role in ensuring public health goals. Collaboration across governmental public health authorities have taken place with private sector health care providers, insurers, managed care companies, and nonprofit religious organizations to provide various public health services, , directly or indirectly [14]. These organizations provide large contributions that are more global or recurring in nature and are not as hands-on with the community on a daily basis.

Gerencser, Napolitano and Van Lee illustrated the concept of global organizations for public health and emergency preparedness by introducing the term "megacommunity." A megacommunity is "a larger ongoing sphere of interest, where governments, corporations, NGOs, and others intersect over time. The participants remain interdependent because their common interest compels them to work together, even so they might not see or describe their mutual problem or situation in the same way [10]". Examples of such megacommunities are found in the coalitions for the prevention of several emergencies. These include communities focused on fighting the spread of HIV/AIDS in India (initiated by the Global Business Coalition on HIV/AIDS, Booz Allen Hamilton and the Confederation of Indian Industry); the small business vitality program in Harlem (William J. Clinton Foundation); the rain forest conservation project (World Wide Fund and Goldman Sachs); and the energy availability and environmental quality program (Enel SpA) [10]. Table 1 illustrates some of the activities, clusters and players around selected disaster prevention, wealth and well-being initiatives.

As discussed later in the paper, both levels of community (global and local) intervention and coordination are needed to solve some of the complex emergencies the world faces today.

Table 1. Examples of Megacommunities

Driving Issues (Health, Crisis Prevention, Well-being)	Megacommunity	Initiators	Communication and intervention methods
Prevention of the spread of HIV/AIDS in India (health and crisis prevention focus)	Public-, private-, and civil-sector organizations involved in the prevention and treatment of HIV/AIDS, both in India and worldwide	Global Business Coalition on HIV/AIDS (GBC), Booz Allen Hamilton, Confederation of Indian Industry	Cross-sector dialogue, war-gaming and simulation exercises
Rain Forest Conservation (flooding and environmental crises prevention focus)	Providers, distributors, resellers, and consumers of lumber; local communities and NGOs concerned about environmental decay	World Wildlife Fund, Goldman Sachs	Cross-sector dialogue, market methods (certification of approved lumber sources), skilled use of publicity
Small Business Vitality in Harlem (well-being and development focus)	Harlem's small business, community members, local companies, and interested observers	William J. Clinton Foundation, Booz Allen Hamilton, and community leaders	Cross-sector dialogue, community conversations and volunteer consulting
Energy availability and environmental quality in Italy (environmental focus, crisis prevention)	Local companies, residents, fishing industry, government bodies, NGOs, universities in the Veneto region and Po River Valley	Enel SpA (National Energy Provider)	Cross-sector dialogue, diagnostic matrix

Source: Adapted from Gerencser M., Napolitano F.,Van Lee R. [10].

3. CRISIS MANAGEMENT IN LOCAL AND GLOBAL SERVICE-BASED NETWORKS

Crisis management is here defined as a way to prepare and control an emergency. A problem-to-solve becomes a crisis when a time factor impacts the lives of citizens and influences the responders who are called upon. Emergency events, such as hurricane Katrina, place emphasis on the importance of preparation, timing, communication, and coordination. Hurricane Katrina also placed emphasis on the importance of the local public health community. Hooke and Rogers [18] discuss health risks associated with disasters and remind us how important the role of public health is within a community. Timely and accurate health risk information must be communicated to the public to ensure human well-being.

Crisis management implies that communication patterns must be clearly mapped, enabled and coordinated across the multiple boundaries, such as the local and global boundaries listed in Figure 1. Turoff et al. [31] refer to organizational emergencies where implications can have a macro-social effect causing harm to people outside of the organizational jurisdiction or boundary, initiating a concern from local, state and federal agencies.

Figure 1 displays selected ties and threads within the global and local public health networks and one possible level of coordination and interaction that will take place in the event of a crisis or disaster. This level of interaction requires training and coordination of a large number of players. The uncertainty of the crisis and of the response plan (i.e. who is available to respond and the skills of the responder) requires that multiple organizations servicing the community initiate collaboration and coordination in

several ways. For example, a coordinator serving in a "command and control" capacity could direct collaboration to increase response effectiveness where ICT is beneficial.

Strong Angel III, an international demonstration conducted in August 2006, brought together local and global partners to test 50 real-world challenges [27]. Included were mobile telecommunication components such as Smart Personal Objects Technology (SPOT) wristwatch technology's use of an SMS gateway to allow SMS text-message exchange between cell-phones and SPOT wristwatch users. Among users exchanging messages were medical, NGO, private and public sector participants. Alternately, Codespear notification gateway developed by Bell Canada allows for multi-cast group messaging across laptops, cell phones, SPOT watches and multiple radio frequency bands. Figure 1 below displays those service-based organizations that collaborate during a large-scale crisis and extend from the organizations represented by Strong Angel III [30].
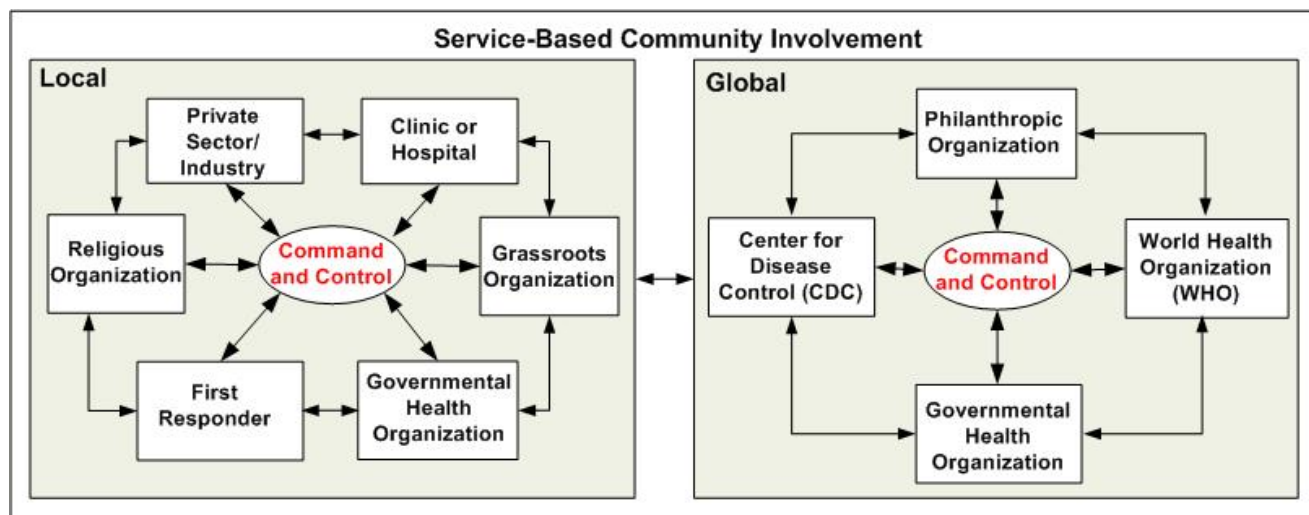

Fig. 1. Global and Local Communities and Public Health Networks.

Current governmental initiatives are focusing more on data management rather than communication management. For example, the Center for Disease Control has developed a data model posted on its website [3]. Many state and local public health offices have websites that can push information to individuals, yet the process of how the information is used across the local public health community remains undocumented. The complexities are vast, particularly in managing communication across communities.

4. SERVICE-BASED ROLES

Roles have always been a key driver for improved communication in any structured group communication process [32] [33]. Ownership of data in a system, as Turoff [31] mentions, is typically identified by who was responsible for supplying and updating it. Zhu [40] notes that roles are commonly applied concepts in many fields and can be used in different aspects, such as natural organizations, task distribution, and application systems.

Crisis response complicates roles because of the uncertainty associated with the incident and response. Moreover, when responders move to the field, they reduce access to management information systems (MIS) and rely more on devices with limited functionalities. Responders in the field also rely on command and control coordinators to retrieve information and pass only the result set to the field. Role identification and access to pertinent information as responders move to the field is essential. Our focus is on the role of responders in service-based organizations (service-based role) who aid – before the crisis - in preparing for the crisis itself, and – after the crisis - once the level of severity has exceeded that of first responders (i.e. fire, police, emergency medical services - EMS/medical). Service-based organizations and their associated practitioners collaborate together in more of a partnership (horizontal) than managerial hierarchy (vertical). Focusing on saving and extending lives is the common denominator. ICT access for responders working in the field is essential to execute their roles and address the inter-dependencies between them. For example, a triage is set-up in the field of an earthquake. Those in need of minor medical assistance and food and water would be supported by grassroots organizations while those critically injured would be triaged to the medical responders. The philanthropic organization would play a role in this scenario by providing food, water, or medical supplies or all three needs. This partnership requires coordination, communication and understanding across roles when preparing for a crisis.

Figure 2 shows the roles (clustered here in the functions of **community planner, influencer and responders**) that each service-based organization conducts at different phases of initiatives [11]. For example, the daily planning within a service-based organization could be conducted at

a stationary location either at the organizations location (primary occupation) or from home (secondary occupation). Daily activities allow access to MIS systems. Once the responder moves towards the field to offer daily assistance to the communities, the need for mobility increases. Daily assistance in the field often calls upon a need to collaborate with other local resources. Moreover, the number of responders increases while timeliness to respond also increases causing a dependency on devices of low-richness (such as pagers and basic cell phones).
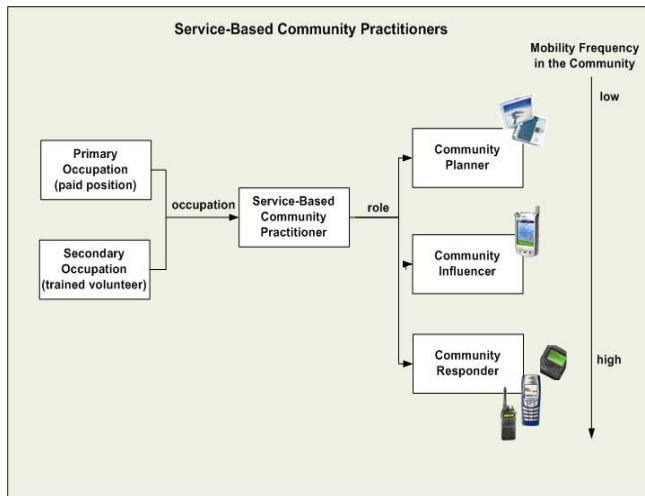

Fig 2. Service-Based Practitioners and Organizations Classifications (adapted from [11]).

4.1 Grassroots Organizations in Emergency Management

Grassroots organizations are comprised of local people working together to find solutions in their communities [12] [19]. These practitioners are trained for their organizational position, but often lack information communication technology training due to limited financial resources as mentioned by the Institute of Medicine [20]. Additionally, these organizations often have a smaller infrastructure limiting organizational roles and reporting hierarchy. As a result, they may rely on larger external organizational structures for guidance (i.e. Center for Disease Control - CDC, state and federal public health offices). These local organizations who step forward in a crisis are invaluable in reaching the citizens and attending to their needs. These responders, who form part of a community crisis response team, do not always report to an office regularly or work with the other practitioners in their organization. However, they are accustomed to changing roles, responsibilities and filling-in for others as-needed, yielding the "on-call" status a crisis warrants.

Self-help groups which are volunteer-based, bring similar qualities to their respective organizations. Self-help groups generate a casual information exchange or assist with resources and provide a source of mutual aid. They are driven by people's need to find others who have experienced similar problems. These volunteers are motivated by passion and the cause towards the need and the organization. Their informal structure and flexible

nature encourage changing roles and peer-to-peer relationships along a horizontal continuum [12] [38].

4.2 Philanthropic Organizations in Emergency Management

Philanthropies - groups and organizations that collect and allocate financial and human resources to humanitarian causes – also play a fundamental role in emergency management. This role is different to the service-roles that entail frequent "hands-on" assistance with the citizens in need. The volunteers in a philanthropic organization reach out and partner with the organizations closest to the people. They bridge the gap to resources and supplies. For example, philanthropic agencies have volunteers and employed staff working on the needs initiated by a crisis. They prepare for their role by identifying ways to assist by thorough planning. One of such planning activities is the rotation of their employees as field workers. This sense of "knowing" the landscape and observing first hand the needs in a crisis is invaluable to the evolution and advancement towards subsequent relief efforts.

Several foundations, public and private donors, and large corporations are increasingly involved in supporting social causes in transnational environments Corporations are progressively focusing on promoting social growth through donations [5]. In addition to monetary resources, private involvement also brings intellectual capital (in terms of knowledge and core competencies), in-kind donations (medicines), and can leverage specific business competencies such as logistics, distribution, and technology use. Private involvement in philanthropic initiatives is being driven by a raising awareness that the world is facing complexities that cannot be resolved by independent means.

Examples of such business-led philanthropic efforts are found across industries. For example, Pfizer Inc was granted the 2003 Excellence in Corporate Philanthropy Award by the Committee to Encourage Philanthropy (CECP). Pfizer Inc leads philanthropic initiatives through a specific unit (Pfizer Philanthropy) tasked with managing multiple international and local programs. Such programs include partnerships for the fight against HIV/AIDS worldwide; the International Trachoma Initiative; the Global Health Fellows program that donates Pfizer employees' time and knowledge for the promotion of training and learning in developing economies; and another large number of community programs for improving health, education, and access to medicines [24].

Pfizer has supported large infrastructure projects such as the building of a hospital in Uganda (the Infectious Disease Institute –IDI- in Kampala). In the IDI project, Pfizers' employees leveraged their specialists knowledge and business management experiences to take leading roles in the project management (playing **project managers** and **content experts**, as well as **medical educators** roles), and provided resources to help with the strategic, tactical and operational aspects of the center construction. In addition, they provided consultation and other support, including

free access to treatment medicines such as Diflucan ® (fluconazole) for antifungal therapy.

In other projects, such as the Global Health Fellow program, personnel rotate in numerous assignments, from responders to emergencies, to teachers and infrastructure building support. In Uganda, Pfizer I/T employees supported the development of new health information systems applications with new easier to use interfaces for the local health providers' communities. The installation of satellite receivers also enabled moving the IDI into a distance learning center promoting affordable access of ICT, ensuring equal access for women and girls, and overcoming infrastructure limitations in rural or disadvantaged areas [35]. Among the success factors of the IDI were the deployment of efficient communication tools and their interoperability that provided both synchronous and asynchronous opportunities for extended and frequent planning in addition to interactions across the different roles listed in Figure 2 (**community planners** in the project management tasks; **community influencer** in the education roles; and, **community responders** in their treatment and prevention initiatives).

5. EFFECTIVE COMMUNICATION THROUGH ICT TOOLS: RICHNESS, FIT THEORIES AND COMMUNICATION OPTIONS

Communication management and collaboration, often identified as key problem areas in emergency management, can be improved with the use of ICT tools. We discuss opportunities and limitations of ICT usage based on their support of communication, synchronicity, richness and reach. We first review key principles and grounding theories that support the claim for an effective role of ICT in emergency management and then focus on characteristics and technological options.

5.1 Media-Richness

Daft and Lengel's [6] media richness theory dates back to 1984 and is based on two forces: uncertainty and equivocality. Using rich media for rich information is predicted to resolve ambiguity and equivocality. Face-to-face (FtF) is considered a rich media. However, media of low richness is predicted to be most effective in resolving uncertainty. SMS text-messaging is considered a low-richness medium, yet one that could play an important role in large scale crisis communication management. Two examples of text-messaging for emergency preparedness and alert notification successfully used in the District of Columbia (DC) and the City of San Francisco are briefly described next [17].

The 2005 hurricanes throughout Louisiana and Florida prompted the District of Columbia to dedicate two websites to the community and how they should respond in the event of a man-made or natural disaster. Viewing these catastrophes as lessons learned for the rest of the country, DC has initiated steps to increase residents' preparedness in the event of an emergency evacuation [2]. Under the direction of Mayor Williams the DC Office of Emergency

Management and the Emergency Information Center has been established which lists services and information, area maps with evacuation routes and agency news affecting the community [2]. On the emergency information center site community member can participate in "Alert DC" which is a three part notification system that has: text alerts (citizens enroll online, identify their text capable device and access number), voice alerts (citizens are automatically enrolled, information is transmitted about impeding or actual incident which gives proactive instructions to front-line responders for dissemination into the community) and the emergency alert system (local media outlets and radio stations where emergency messages are broadcast). The varying roles of the service-based practitioners show where the mobile devices could vary in relation to what is currently being utilized in DC for their emergency preparedness efforts.

In January 2002, The City of San Francisco began initiatives through wireless communications towards improved public safety [15], such as becoming the first 9-1-1 center in California to receive wireless 9-1-1 calls placed from cell phones [17]. Google has proposed to the City of San Francisco free city-wide Internet Wi-Fi to test local Internet services [26] However, studies also show the need of underserved communities to access affordable computers, appropriate training, and technical support [22]. Community services, such as free Internet access, could then be supplemented by outreach and training initiatives.

5.2 Cognitive Model and Media Synchronicity

Te'eni [29] improves upon existing theories of communication by providing a new model. Effective means of communication are essential when dealing with the vast amounts of information available today. Over the past two decades, there has been an enormous shift in the role of task-oriented functions. Today's technologies allow us to measure and increase performance by linking tasks and communication media. The communication means should be chosen according to goals and situations. Rather than building on either cognitive or affective aspects of communication, the model should capture both aspects to build a more accurate representation of actual behavior.

Media synchronicity theory (MST) details the extent to which a communication environment encourages individuals to work together on the same activity, with the same information, at the same time [7]. MST differs from media richness theory by placing emphasis on an outcome-centered approach to media selection. Whereas media richness theory has taken a task-centered perspective on task-media fit, MST proposes that every group communication process is composed of two primary processes, conveyance and convergence that are both necessary to reach a group outcome. Communication effectiveness will be enhanced when processes are aligned with media that support the communication process [7].

In the case of health emergencies, the task consists on trying to resolve crisis situations with limited information. This introduces a need for a task-technology fit, viewed as

an important factor in determining whether the use of technology would result in performance improvements [23] [13] [28] [36] [37]. Having the right technology for a task is essential. The communication medium must be suitable for that objective. Mobile communication tools and smart-devices are well positioned to support the communication processes and needs of emergency situations because they support flexibility and fast outreach (provided that back up options are available and part of a continuity strategy). For example, text-messaging is a low-network load option that enables quick outreach without overloading the communication backbone.

5.3 Richness, Reach and Roles Supported

Mobile devices can play a pivotal role in emergency situations as they can serve multiple purposes: to be reachable anywhere and at anytime, to obtain information while in an outreach situation; and, to be 'visible' and traceable through a device enabled with global positioning systems (GPS) capabilities.   A mobile device maximizes flexibility, increases timeliness to reach community partners, and increases readiness for a crisis related health alert. Recognizing the limitations of obtaining extensive information across a mobile device, protocols and standards for communicating with an individual who has access to limited display size with a limited connection speed can be created to ease interactions during emergencies. Although data transfer capabilities are increasing through wireless-wide area cellular network third generation channels, the need to shrink data and content of 'what' is communicated is vital for mobile devices in emergency scenarios. In addition to connectivity options on the mobile device, it is important to identify codes and alter messages that may quickly trigger responses, for example through a specific set of pre-loaded icons or tools (such as the already famous 'emoticons' used in chat rooms).

Overall, the importance of low-richness, low-cost technology and communication practices should not be compromised to the numerous preferred options noted in Table 2, but rather complement the potential of these tools and capabilities. As witnessed in the Indonesian earthquake of 2004, SMS text-messages were exchanged when cell-phone circuits were overloaded with phone calls. Basic messages, such as "I am not injured but lost some climbing gear, my camera and [my Thai] mobile phone. Please tell family am safe." [8] provide essential information exchange when preferred modes of communication are unavailable.

There are a number of mobile devices, connectivity options, and communication needs that may be suitable to manage response in an emergency situation. Each communication medium enables different levels of message richness (through multiple media such as voice, text, graphic and videos) that may in turn offer higher or lower rich capabilities (as presented in Table 2). Some of these communication tools may not be easily managed in an emergency context due to electrical and connectivity requirements (the same being true for most communication tools). Therefore, while we can plan for their deployment, we always need to consider back up options, such as the possibility to roam on satellite links should the cellular towers become unavailable. For example, Iridium low-orbit satellites (LEO) that offer world-wide coverage when no other landline or wireless service is available, can provide a back up solution for computer, cellular and pager communications through a variety of satellite-compatible devices [35].

Table 2. Mobile Media Communication Options (adapted from [11])

Mobile Tool	Connection Details	Communication Options	Richness /Reach	Roles Supported
Pager (text and voice pagers)	*Throughput: 512/1200/2400 bps* *Coverage: varies by area*	Text – one-way Voice pagers (already used in EMS, police, fire departments, hospitals)	**Low→ Medium** *High - Push-to-all software*	Community Responder
Walkie-Talkie (and walkie-watch)	*Throughput: up to 1Mbps* *Coverage: up to 1,000 feet*	Voice – one way (half duplex)	**Medium** (cannot display images)	Community Responder
Cell Phone (basic)	GSM (2G). Global System for Mobile telecommunications *Throughput: Voice 13Kbps (full voice) and up to 115 Kbps for data rate Coverage: 1-5 miles*	Text-messaging (SMS)– Voice – Localization (one-way)	**High** *Pull and push options – high reach through SMS*	Community Responder, Community Influencer
Smart Phones (multimedia)	GPRS (2.5G) and 3G (Ev-DO and W-CDMA cellular broadband) *Throughput: 384Kbps- 2.4 Mbps Coverage: 1-5 miles*	Text-messaging (SMS)– Voice – Localization (two-way?); email and instant messaging; Internet browsing	**High** *Pull and push options – high reach through SMS; MMS*	Community Responder, Influencer, Planner
PDA Phones (also connected through Wi-Fi cards)	See Smart-Phones and Tablet PCs	Text-messaging – Voice – Localization (two-way?), Map Tools; email and instant messaging; Internet browsing; picture taking; video recording	**High** *Pull and push options – high reach through SMS; MMS*	Community Responder, Community Influencer

Tablet PC (connected through Wi-Fi cards)	Connected to WI-FI *Throughput: 11-54Mbps* *Coverage: Up to 300 feet*	Text-messaging – Voice – Localization (two-way?), Map Tools, Hand-Writing, Yahoo-Groups, email; instant messaging; Internet browsing.	**High** *Push-Pull limited to email / Internet connectivity*	Community Influencer, Planner

Specific communication tools are associated with the roles supported by responders in case of crises. Figure 2 showed that community planners will have lower mobility needs than responders who are the first on the field after the emergency. The need for flexibility and immediate communication are highest among responders. They will be more effective at executing their tasks using a low-weight, easily rechargeable communication device (such as pagers, walkie-talkies and basic cell phones with AAA batteries or solar chargers now incrementally available). Community planners and influencers will also require access to more sophisticated communication tools, such as tablet-PCs and smart phones, to leverage mapping and localization tools, quick access to databases to push alerts and large scale text messaging for regular use. While these emergency players will also benefit from higher mobility, their need to visualize maps, boundaries and plan for recovery will be better solved with access to fast and reliable wired and connected infrastructure, access to printing or other hardware to organize instructions, distribute directions, and coordinate the response.

6. CONTRIBUTIONS

Numerous initiatives are currently addressing the needs of our nation with respect to public health, yet many remain in-progress. Recognizing where technology can improve communication, community initiatives are being introduced to better deploy technologies and train users [17], as in the earlier examples of the District of Columbia and the City of San Francisco. Many communities are turning to wireless communication for both public safety agencies and communities. Clear lines of communication [15] are but one gap between partnering agencies, practitioners and local communities. Some of the communication gaps can be overcome with adequate use (and user training) of ICT technology supporting planning and response.

This paper provided an overview of the links among different players that play a critical role in supporting emergencies response (for example grass-root communities, local and global players). We associated the communities and organizations with specific roles that they play in addressing several public health and emergencies issues now affecting society. We argued that their roles can be enhanced by the use of appropriate ICT devices that can fit specific support tasks, based on the associated need for mobility, communication reach and richness. Our preliminary map contributes a framework that leverages communication theories and tools. This framework may clarify agency needs and planning, and also drive investments and training decisions. It highlights the importance of mapping technology use to communication options and roles.

The generalization of this framework to multiple geographic locations is highly dependent on the underlying infrastructure available at these locations. While some of the high-mobility, low-richness technologies can be easily deployed also in developing countries, the unavailability of a wired infrastructure to back up communication and the lack of technology training represents a clear barrier for replication. However, since these tools leverage the recent growth in wireless communication across continents (with Africa being the highest mobile penetration growth country in the last six years), the opportunities increase. Effective response systems using basic communication tools and easy-to-use phone interfaces may be a step forward for response planning also in other less developed contexts. Pfizer's involvement in the Infectious Diseases Institute briefly introduced earlier is an example of the incremental possibilities now available.

7. CONCLUSIONS AND FUTURE RESEARCH

The mitigation between local and global organizations discussed in this research highlights the functions of each organization and the current (or suggested) technology needs. We posit that leveraging everyday needs can maximize field support and collaboration during a crisis. Extending roles and practice prior to a crisis alert should increase coordination and enable each organization to familiarize themselves with the role of the organizations they interface with during a crisis.

The goal of future research begins with a bottom-up assessment of a two-way SMS text-message communication exchange achieved through an Internet-based simulation. The simulation developed by the researchers will assess effective communication dialogue between a responder and a community-based command and control volunteer coordinator. The ability to communicate with SMS text-messaging and reduce ambiguity in the message exchange will be measured.

The objective is to identify communication patterns of service-based responders and obtain a baseline measure to further recommend alternative low-cost mobile computer-mediated solutions and to better associate specific levels of effectiveness and dependencies among tools and roles in case of emergencies, with a particular

focus stemming from the use of text-messaging in emergency situations. Moreover, the proposed research aims to enhance the efforts currently taking place in the governmental sector of public health and emergency management. Finding the right media that support multiple roles is essential because of the varied roles of the local public health community practitioners. These tools will complement those currently available or being developed, and will include suggestions on suitable media interfaces that may support and improve emergency response.

The major contributions of this research will be to extend the use of information systems and mobile technology to the local United States public health communities to increase effective communication between organizations while providing a state of readiness for homeland security related events. Using technology to assist those community organizations with limited resources should empower them to increase effective communication across organizations and when interacting with our citizens.

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