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Workshop Summary: Collaboration and Crisis Informatics (CCI)

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Abstract. Events like 9/11, the hurricane Katrina or the Sendai Earthquake have drawn more and more attention on ways how individuals, organizations or society as a whole can improve their crisis preparedness as well as their coping and recovery strategies in crisis situations. In all scenarios, the collaboration of professional responders, public administrations and citizens and organizations affected offers a great potential that needs to be further understood and explored. In this workshop we will bring together academics from various disciplines as well as reflective practitioners to discuss challenges and approaches for improving intra- and interorganizational collaboration in crisis situations.

Introduction

This workshop addresses the topic of understanding and supporting intra- and interorganizational collaboration in crisis situations. It aims at drawing together experts from academia and practice to collect and discuss empirical studies, theoretical considerations and technological concepts to improve crisis preparedness as well as coping and recovery work in crisis scenarios.

Crisis Informatics does not only target the development of technologies and information systems that help professional actors in their coping and recovery

work, but particularly addresses socio-technical concerns in medium- to large-scale emergency response. Additionally it expands consideration to include not only official responders (who tend to be the focus in policy and technology-focused matters), but also members of the public. It therefore views emergency response as a social system where information is disseminated within and between official and public channels and entities. Crisis informatics wrestles with methodological concerns as it strives to develop new theory and support informed development of ICT and policy (Palen et al. 2010).

As the diversity of the challenges of emergency management and response increases with the number and complexity of threats organizations and the society face, the opportunities to collaborate on the basis of an exploding number of communication and collaboration technologies (mobile devices, locating devices, social networking sites, crowdsourcing approaches) urge us to find new ways of understanding, conceptualizing and evaluating possible usages for these collaboration technologies in emergency management and response (Landgren 2007; Reuter et al. 2009; Wiedenhoefer et al. 2011). Interesting research topics we invite position papers for include (but are not restricted to):

- studies in the use of social software for collaboration in emergency response
- studies in the collaborative use of mobile and locating devices in emergency response
- theoretical considerations on emergency response as a social system,
- technological concepts and prototypes to support collaboration in crisis situations,
- methodological and ethical considerations of doing research in and for crisis situations.

Goals of the Workshop

The workshop aims at identifying and structuring key factors and challenges for preparation, coping and recovery work in crisis situations. It particularly aims at fostering a research agenda that looks at emergency response as a continuous social process of a network of interdependent actors and organizations. We will discuss and develop

1. theoretical approaches to capture collaboration dynamics in crisis situations,
2. appropriate research methods and strategies to make practitioners experiences accessible for academic work
3. appropriate design, development and evaluation methodologies to conceptualize and test innovative approaches using collaborative technologies in a way that secures their relevance for emergency response practice. The results will be published in a number of ways (see below). An

overall goal of the workshop will be to identify and articulate issues for future research.

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Why Expressiveness Matters in Command & Control Visualizations

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Abstract. Crisis command centres often gather data from disparate locations and collect it for visualization on a large, shared screen. However, the resulting visualization often lacks expressiveness: it fails to express nuanced mediating characteristics about the information, such as specificity, urgency, awareness, or reliability. We suggest that our previous work on creating expressive realtime embodiments can inform the design of crisis management embodiments on large displays, improving communication and decision-making. We make several recommendations for future research directions.

Introduction

Crisis command-centres are increasingly using shared, surface-based displays for large-scale overviews of information (as described [1] and exemplified in [2]) and mobile devices are beginning to be used as the sources for information visualized on such displays. However, this important information often lacks expressiveness in its presentation: subtleties and nuances are not well expressed in state-of-the-art visualizations.

Consider, for example, a fire crew fighting a wild grass fire, such as the 2009 Oklahoma fires described in Vieweg et al. [3]. A crew chief has a mobile tablet

updated with information from the Command and Control (C2) centre. As the crew chief communicates with the C2 centre, either explicitly or implicitly through updates from the tablet, the information generated through this communication is displayed on a large, shared display in the C2 centre. To be effective and useful, this information should be mediated by its importance, urgency, reliability, accuracy, specificity, and the situational awareness of the chief. Such nuances will change how the information is visualized in the C2 centre.

Embodiments -- representations of remote collaborators, often designed to represent their physical movements in a workspace -- could encode much of the complexity that crisis management systems need to represent, including different kinds of uncertainty, emphasis, specificity, and temporality. As yet, embodiment designs do not support such subtleties of information visualization. Indeed, little is currently understood about how to present these information characteristics, despite their importance in communication, particularly where understanding is constrained by time pressure, such as in crisis management scenarios.

Previously, we have explored the idea of expressiveness in collaborative embodiments -- a way of describing the amount of information contained in distributed representations of users. We extend this idea to representing information in crisis-management collaborations, where the amount of information and the way it is presented can have a critical impact on the success of management. We believe that a more nuanced understanding of how embodiments are interpreted can resolve much of the more challenging aspects of information representation in geocollaboration and distributed crisis management.

For example, our recent work has shown that representing the height of deictic gestures helps distributed collaborators convey variations of confidence, specificity, and emphasis [4], concepts that are usually difficult to associate with geospatial data. We have also shown that adding temporal traces to data representations helps with awareness, increases the emphasis associated with the data, and provides additional tools for users in real- time communication [4-6]. Finally, because work in crisis management must move between local and distributed collaborations, we are interested in leveraging the work on social traces to support an awareness of the actions of distributed collaborators while a user's attention is elsewhere [7-8].

Our studies have raised questions related to how people, and their nuanced communications, might be better represented during distributed collaboration. We have begun to explore the design space of embodiments in the context of *fidelity* and *enhancement*. *Fidelity* is the faithfulness with which remote reproductions of

people and their actions are represented in a shared workspace. *Enhancement* is the augmentation of visual representations using data not available through the highest-possible fidelity. For example, enhancements may include: information about collaborators; their actions, status, and roles in the domain; the reliability of their information; and their situation awareness (so we can see what they can see). Both fidelity and enhancement are mediated by the level of augmentation (how much subtle information is emphasized), type of aesthetic (the artistic component of embodiment design which can influence perception and tap encultured responses), and the applied interpretation (information about the intuited intent of collaborators, such as the intensity of interest gathered from tracking eye gaze and other engagement metrics), all of which can have a profound impact on how visualizations are interpreted.

A key aspect of our investigation is the amount of information that can reasonably be used in these contexts. Crisis management is a time-constrained task, thus all information competes with other information. Therefore, any embodiment information added to an already complex C2 display will compete for users' attention, and may create information overload. Thus, methods of minimizing distraction and overload must be a priority when designing new information visualizations. We are beginning to explore the limits of what can be expressed and understood in this context, informed by earlier work on embodiments that shows that this limit is remarkably high [9].

Expressiveness in Distributed Communication

When groups of people work perform command and control activities on remote locations using large displays, a wide variety of information about the remote location needs to be displayed for effective collaboration [1]. This information includes practical information about who is where and doing what in the remote location, but also includes expressive information about the remote location and agents, such as workload, predicted performance, and awareness. As earlier, this additional information is not without cost, both in terms of production (the sender of the message) and in terms of consumption (the receiver of the message). A core challenge is to find mechanisms that allow people to be expressive through their embodiments to emphasize "important" aspects while de-emphasizing less important aspects (to reduce superfluous information for the receiver).

We have explored some of these ideas in a preliminary form for video-based embodiments of people's arms over distributed tabletops. In prior work [5], we applied simple non-photorealistic rendering techniques for video captures of people's arms as they gestured over a shared workspace. These filtration techniques were used to emphasize edges/boundaries of the gesture, or helped to

accentuate motion of a contact point on a tabletop surface. Importantly, they are not simply video reproductions of gestures - instead, specific *aspects* of the gestures are emphasized in a non-realistic way.

We see new opportunities for creating expressive visualizations through variations in the fidelity with which information is reproduced on shared displays and the enhancements that are applied to that information. Next we discuss how our ideas about expressiveness can apply to crisis management scenarios.

How Embodiments can be Expressive in Crisis Management

Embodiments already exist in most crisis management software packages as status visualizations. For example, a fire-fighting visualization might include a representation (either textual or iconic) of a crew of five people with two trucks and their fire suppression capabilities. This is valuable information, but fails to provide any nuance. For instance, embodiments should provide information about urgency, accuracy, probability, and awareness associated with the team's information. Perhaps the crew has been in the field for 14 hours and are in urgent need of replacement; is experiencing limited accuracy in their GPS reporting due to a mountainous landscape; are not yet aware of an updated weather forecast; and there is a possibility that the number of volunteers associated with the crew is wrong in the C2's records. We believe that embodiments in the C2 visualizations should provide clues about this information at a glance. In the following sections we introduce two ideas about how this can be done and one possible barrier to expressive embodiments.

Real-time Representations

There are many ways in which expressive embodiments can represent information in realtime for crisis management visualizations. Based on the previous example, we explore the representation of urgency, accuracy, and probability.

Representing urgency and emphasis
In our research on embodiments for distributed collaboration, we found that the height of gestures above a surface is key for indicating emphasis. Using features of enhancement, such as adding shapes, varying sizes, or changing colours can provide non-specific cues to the urgency or emphasis of embodiment information. In particular, repeatedly varying size, such as an expanding and contracting circle, is a clear indication of emphasis or urgency.

Representing specificity and accuracy
We have had success in visually representing specificity, and accuracy through the use of diffusion and shadows. The more sharp (less blurry or diffuse) an embodiment the more the information is interpreted as specific; the more diffuse, the less the information is interpreted as specific or accurate.

Representing probability and uncertainty
Uncertainty and probability are difficult to represent visually without undermining the readability of the primary information, although there has been extensive research on this topic. We have had some success in using a variety of temporal traces, visualized as fading or faded versions of the original embodiment to represent the possible historical or future movement of embodiments in two dimensions. More challenging, however, is indicating non-geographic uncertainty. In this context, we have begun exploring changing the fidelity of the underlying visualization, where possible mediating this change through the use of alternative aesthetics. This can be achieved through the use of alternative fonts, where data is in a written format, or different artwork where data is represented through images.

Each of these techniques for increasing expressiveness require further research, particularly in the context of crisis management, where the nuances in information representations can have a more significant impact than in many other domains.

Awareness of Past Events

In many situations collaborators may need to shift their focus or attend to details away from the collaborative system. In these situations waiting for an answer or entering into direct communication require more time than is required. Because timely access to nuanced information should be a central requirement, support should be built into systems to allow questions about past information to be answered. These can and should be supported without the need for direct communication with individual collaborators.

Gutwin and Greenberg described support for awareness as providing an up-to-the moment knowledge about others actions [7]. Tam and Greenberg focused on aspects of awareness that encompass asynchronous changes. They define *change awareness* as the ability of people to track asynchronous changes made by collaborators at different times [8]. In particular, Tam and Greenburg highlight that providing visuals of all history may be overly complex, because changes can occur in many different places, can be overlapping, and can be involve many different individuals or groups. To alleviate this potential complexity a viewer may want to query an interface interactively, to receive history only related to an object of interest. They defined three views of change in which a viewer might be interested:

1. an artifact-based view - relating to the physical objects required to support the work
2. a person-based view - relating to the people or groups who are in the collaboration
3. a workspace based view - relating to the geographical region where the work is taking place

This allows questions about who, when, what, where, and how relating to the object of the view to be addressed. For example, C2 might be interested in knowing details about a team, and engage a person-based (or team-based) view. In this view they may be able to answer questions related to *where* the team has been, *when* they arrived at their current location, *what* is their current location, and *what* was the urgency of their last request. Being able to answer such questions in a timely fashion may allow C2 to most efficiently make sense of a particular situation.

How Much is Too Much?

Common sense suggests that there is a limit to the amount of expressive information we can, and should, show in a single embodiment. Stach et al. found that people can track over 20 pieces of information encoded in telepointer- style embodiments, although they suspected that people were paying attention to only a subset of these when actually using their software [9]. This area remains largely unexplored, but it may be that the limit is on what expressiveness can be designed into embodiments without overly distorting the core information. Perhaps methods of de-emphasizing information will become particularly important in this context. We suggest that this is a key area for future research into expressiveness in embodiments.

Workshop Goals

Our expertise resides in understanding communication and designing systems that are responsive to a wide variety of expressiveness in communication. We have limited experience in the particular domain of crisis informatics but feel that our work can be applied well within this field and are seeking collaborative opportunities to this end. This workshop provides an excellent starting point for us in both extending our understanding of crisis informatics beyond the corpus of literature and in making connections for future research. We also believe that our approach to information visualization, an approach that seeks to embed subtle information in more standard representations, has much to offer in the context of crisis management.

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Integrating Process Modeling and Linked Open Data to Improve Decision Making in Disaster Management

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Abstract. In disaster management, personnel of the involved organizations need to make quick, but informed decisions. Many activities need to be coordinated within and across organizational borders. The information basis available to decision makers is typically sparse, and still relies mainly on radio reports from the field. We propose an approach to extend this information base: First, techniques from business process management should be used to formally describe the activities in disaster management; second, the elements of the resulting process models should be annotated with tags derived from the concepts characterized by an emergency management domain ontology. These annotated process models serve as basis for retrieving relevant contextual information, e.g. from linked data pools provided by governmental agencies. Our approach will allow disaster management personnel to take a contextualized perspective on planned and ongoing actions, and facilitate quicker and more informed decisions.

Introduction

In crisis situations, emergency management organizations typically establish a command staff, which is responsible for planning and coordinating the actions and measures that are taken to resolve the situation. Today, this command staff mainly relies on paper-based mission blueprints and lists of actions. However, especially for large and catastrophic incidents, keeping track of all ongoing and planned actions within the own organization and across organizational boundaries is a

challenging task. Deciding which action to take next, while considering the dependencies to other actions, is the central and most important task the command staff has to tackle.

Researchers have proposed a number of strategies to support the command staff. Especially the use of techniques from business process management has recently gained attention (cf. [8]). The main challenge, when bringing these techniques to disaster management, is to allow for more adaptability and flexibility to the rather rigid perspective of traditional process engines, taking the rather unpredictable nature of disasters into account (cf. [4, 9]).

While the use of formal process descriptions improve the overview on planned and running actions and the involved resources, it does not provide contextual information, e.g. about objects related to the action or the environment of the location where the action is carried out.

Especially two types of information sources could be leveraged for this purpose: First, the Linked Open Data Cloud, which currently contains about 31 billion triples and 500 millions of links[1], provided in particular by governmental agencies (cf. [2]); second, user-generated content, available on various social media platforms. With the increasing adoption rates of smartphones and decreasing costs for mobile internet access (cf. [3]), this data contains a growing number of reports from crisis situations (cf. [10] for reports on the use of Facebook and Twitter).

In this paper, we describe how both kinds of information sources can be integrated into process support systems via an ontology-based tagging mechanism for process models. This tagging mechanism allows pulling relevant contextual information at runtime (i.e., during the disaster response operation), and thus provides a broader information base to decision makers in disaster management.

Approach

With regard to the four phases of disaster management [11], our approach can be separated into modeling and annotation of activities, which are carried out in the preparation phase, and, process instantiation and execution, which happen in the response phase.

Thereby, the preparatory steps form the basis for the automatic provision of relevant context information during response time.

[1] http://www4.wiwiss.fu-berlin.de/lodcloud/state/ [retrieved 2011-11-30]

Modeling and Annotation (Preparation Phase)
Formal descriptions of the respective processes are prerequisite for any process support system. While this formalization is currently not a common practice in disaster management, a number of researchers have highlighted the benefits it would bring to the domain (cf. [5, 8]). In particular, it will facilitate a more precise tracking of planned and ongoing activities and the employed resources.

As a starting point for formal process descriptions, existing textual representations of emergency plans can be used. However, while traditionally process modeling is typically done by system analysts, we recommend a collaborative approach with a high degree of end user involvement, e.g. [7], to make sure, that process descriptions represent the understanding of actual disaster management practitioners.

The result of the collaborative modeling is a set of process descriptions, which cover typical processes carried out in crisis situations. Figure 1 shows (parts of) such a process model for a dyke fortification. Others may cover the transportation of injured people, or for restoring the power supply.

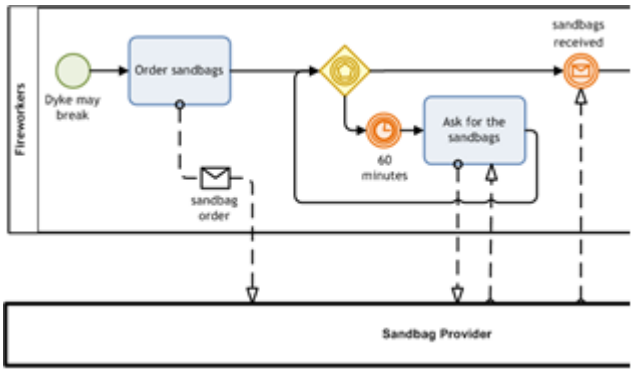

Figure 1: (Parts of) a process model for a dyke fortification activity.

To enable the automatic provision of relevant context information during process execution), the resulting process models need to be annotated with a set of tags that work as information filters. We propose that these tags should refer to concepts from a domain ontology for disaster management (e.g. [1]).
Using concepts from an ontology offers two benefits over plain text. First, concepts are language independent, thus contextual information can be retrieved from foreign data providers. Second, ontologies allow retrieving information for related tags (e.g. parent concepts) for cases in which no information is available for the original tags.

With regard to the example in Figure 1, the *order sandbags* activity could be annotated with the concept *sandbags*, but also with *national guard*, because in disaster situation, dyke fortifications will often require large numbers of personnel to execute the task that cannot be provided by the regular emergency management organizations.

Process Instantiation and Execution (Response Phase)

During the Response Phase, relevant processes are instantiated as parts of a global process, describing the necessary steps to cope with the crisis.

We propose that these process composition steps should be assisted via a process repository, in which previously modeled processes can be found via a comprehensive search interface, and subsequently be placed within the global process via drag&drop. We will subsequently refer to these processes as *subprocesses* to distinguish them from the global process.

Using Linked Open Data as a source for contextual information

While the subprocesses are executed, relevant contextual information is retrieved providing support to the decision maker and the personnel in the field. An activity might contain descriptions, where background information could be helpful. For example, if a fire is near a chemistry plant with sulfur reservoirs, the decision maker can be provided with the chemical properties of sulfur to make danger estimation. Using Linked Open Data, this additional information can be provided dynamically.

Furthermore, based on the proposed annotations, data sets with general knowledge, e.g. DBPedia[1], Freebase[2], or OpenCyc4[3] or Linked Open Government Data (LOGD) [6] could be linked to the activities in the processes, and crawled for background information during execution time. Figure 2 shows an example for such, potentially valuable, background information from the city of Vienna: maps of the city quarters are provided as part of a Linked Open Government Data initiative. As shown in the example, current traffic information (green for free streets, yellow for those with more traffic), and road blocks (red) could also be included. This information could be beneficial to decision makers in the command staff when planning routes to bring injured persons to the nearest hospital (marked with blue H's on the map).

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1 http://dbpedia.org/ [retrieved 2011-11-30]

2 http://www.freebase.com/ [retrieved 2011-11-30]

3 http://sw.opencyc.org/ [retrieved 2011-11-30]

Other important information may include contact persons of public buildings, e.g. the president of a university building, which is endangered by a fire. Using LOGD, this information is provided by the university administration, and a direct contact could be established to secure the university buildings.

Figure 2: Example information retrieved from Linked Open Government Data from the city of Vienna[1]

Contextual information should be presented in a non- obtrusive way, e.g. as information boxes near the current activity to show that there is additional information available. Figure 3 shows a design concept that illustrates how this may look in a process support system.

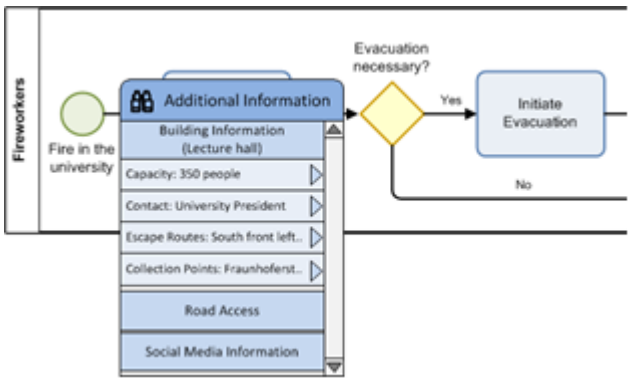

Figure 3: Design concept of a contextual information window for a decision gateway in an evacuation process.

Using user-generated content as a source for contextual information

[1] http://data.wien.gv.at/ [retrieved 2011-11-30]

As initially stated, user-generated content might also provide valuable information for decision makers during the execution of business processes. For example, common social platforms could be crawled in the response phase, searching for text, audio and image information related to the current incident; the relevant information could be extracted using a combination of the tags (provided in process models), spatial and temporal information. This way, the command staff may retrieve additional information that is difficult to gather when personnel is short, e.g. blocked roads after a hurricane.

Using contextual information from existing IT systems
Other important context information might come from internal IT systems. For example, the local energy network operators can provide spatial information of areas with power outages. This information allows the command staff, for example, to judge whether a specific hospital can currently support injured persons.

Conclusion & Outlook

In this paper, we presented an approach to broaden the information base for decision makers in disaster management. Our approach is based on the idea of process modeling for disaster management, but extends it with an ontology-based tagging mechanism, to provide users with contextual information that helps them to make quicker and more informed decisions on the next steps to take. We discussed how Linked Open Government Data, user- generated content and information from existing IT systems can be used to provide this contextual information without additional efforts for disaster management organizations.

For the future, we will also consider a retrospective phase in our approach: after a crisis has been resolved, insights from the execution could be used to adapt processes. In a manual retrospective, new tags may be created, and tags, which were found to provide little valuable information, can be erased. Also, the processes may need to be adapted, e.g., if activities were missing.

Furthermore, based on usage logs, machine learning algorithms could be applied to identify valuable information sources by their usage. In this case, activities could be annotated automatically with useful tags.

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Speeding-Up Innovation Cycles in Emergency Management Using Mobile & Social Software

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Abstract. Mobile and web-based applications strongly gain influence in generating information relevant for fighting large and catastrophic incidents. Currently this information is not directly consumable for the command staff in emergency response organizations. We present ongoing work tackling this problem and sketch future research directions.

Previous Work

Crowd-sourced Incident Reporting & Rating

Currently ongoing research aims to improve the situational awareness of emergency responders. We build a platform for crowdsourcing incident reports by citizens and enabling the emergency management community to rate the submitted reports with respect to their relevance for the work of the command staff. We aim to support this collaborative crisis management process by using recent developments of mobile devices and social networks. The current research work takes place at SAP Research [1] in Darmstadt within the InfoStrom project [2].

The first part of this research resulted in a research prototype that is ready for field-testing. It features two core pieces of functionality – a mobile app & a community- based platform.

Mobile app for citizen-submitted incident reports. Citizens can submit information on incidents either by taking pictures, shooting videos, recording audio messages or describing a situation in text or by selecting information exchanged on social networks. Examples are reporting on a power outage in a home or reporting a fallen tree that blocks after a storm. The incident reports, either from just generated photos, videos or texts or existing information on social networks, gets directed to emergency responders to make them aware of this information. This functionality is included in a mobile app that gets distributed to citizens for free by the administration (local, regional or national) or companies, e.g., in the customer service app of a utilities provider.

Community-based platform to crowd source the relevance rating. Our platform enables a community to rate a large number of incoming incident reports for relevance. A potentially large volume of incident reports comes in with an unverified level of quality using the mobile app for incident reporting. Emergency responders can utter demand for help for handling the reports specific to a particular incident. This triggers a community rating process. Members of the community start rating existing incident reports with regard to the requested information. Multiple submitted ratings indicate how relevant the particular report is with respect to the information need of the command staff is. Emergency responders can access the ranked incident reports at any time. The reports appear in descending relevance, i.e., the most relevant reports appear at a glance. The community consists of, for example, trained, voluntary firefighters not at the incident location, i.e., spatially located out of reach of the incident but who are willing to help.

Consumerized Business Applications (Web 2.0, Viral Software)

The authors have vast experience in building consumerized web-based business applications. Web-based applications targeting end-consumers need to satisfy high usability standards, as many applications under the buzzword “web 2.0” expose. This trend now applies as well to business software, which for various reasons didn’t focus on usability in the past.

Core of this trend, see e.g., [3] is that for example social network functionality is integrated into business applications, e.g., an activity stream in a project management application. Another important aspect are features which make the application viral, i.e., users refer or invite other users, so that the application gets propelled through users.

In particular, the authors created a meeting management platform to increase knowledge worker productivity. The platform implements support processes to reduce the administrative time spent with preparing, executing and post

processing meetings of knowledge workers. Knowledge workers reduce their administrative overhead for meetings and thus can focus on the meetings' content.

At the core, knowledge workers can create meeting notes. The platform transforms these into a layouted protocol, extracts action items and can distribute action items to meeting participants.

The platform thereby incorporates functionality for collaboration (meeting participants interact on meeting content) and virality (invitation to meetings). Furthermore, a large amount of the design effort went into securing usability as described above.

Open Research Issues

User-Driven Problem Identification & Prototyping
We see the need of a collaborative problem identification process that helps improving and speeding up the software development process for the emergency management domain.

Currently, the need for IT-based solutions within the emergency management domains is not clearly visible. Core questions are:

- Which domain problems do need to be tackled based on IT-systems?
- How important is each of the problems?

In addition, understanding the problems within the emergency management domain require deep process knowledge of the specialists in this domain.

On the other hand, the trend towards mobile applications has lowered the entry barrier for new software vendors entering a market, as mobile applications tend to cover focused parts of processes and thus are of lower effort than, e.g., complete business suites.

Implementing a user-driven problem identification & prototyping process helps to identify and publish the domain's problems, which in turn can be better tackled by software developers. It fosters the understanding for current needs in the emergency management domain.

The emergency management community has a large number of voluntary members who can contribute to such an effort, e.g., in Germany there are about 1.3 million voluntary firefighters alone.

The proposed collaborative problem identification process focuses on the domain's problems and the corresponding descriptions as this leverages the emergency responders expertise best. The approach explicitly doesn't focus on describing solutions in the first place, as this would require deep information science expertise.

In a second step, this approach can be extended into developing a solution. In these later stages of software development, such as requirements gathering, software evaluation and testing, the community can prioritize and assist.

Prioritize Solution Development with Crowd Funding
Crowd funding allows the collection of funds for an identified domain problem or similarly for a proposed software solution from a large number of people. Such a platform covers the full software development process of problem identification to solution along with setting financial incentives.

Crowd funding platforms (e.g., [4], [5]) support the process of collecting money from multiple people for a particular topic. A vendor submits a funding-topic, in this case either the problem description with a call-for-solutions or a defined proposal for a software application tackling an emergency management problem. People interested in this funding-topic, including private persons and corporations, can invest into it by donating a chosen amount of money. The platform then can alert those people who have prioritized the related problem beforehand. The vendor can perform further marketing via the platform by promoting the funding-topic on social networks like Facebook & Twitter.

Using existing crowd funding platforms can quickly set up crowd funding for the emergency management domain. By combining it with the above described user-driven problem identification and periodization platform, the problem gets a chance to get funded. This funding is an alternative means for prioritization, as people spend money for the problems most relevant to them.

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Survivor Confirmation at Higher Educational Institutions as A Socio-Technical Testbed for Large-Scale Emergency Response

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Abstract. This position paper proposes a Large Scale Message Notification and Confirmation Service in a daily-emergent continuum and its system architecture for survivor confirmation at higher educational institutions. It is derived from experiences and lessons learned using Nagoya University's home-grown Survivor Confirmation System in annual disaster drills since 2006 and the real usage at the Sendai Earthquake (what we call Great East Japan Earthquake). Higher educational institutions consist of diverse communities like faculty, staff, students, administrators. Also, they have further outside stakeholders like parents, alumni, detonators. This diversity of higher educational institutions can provide a small set of human society. In the sense, we think that survivor confirmation at higher educational institutions is a very good socio-technical testbed to seek an effective way for large-scale emergency response.

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Background

Nagoya University Survivor Confirmation System

Recently in Japan, a lot of commercial-based solutions for Survivor Confirmation Systems have been offered from ICT service providers, and some of them have been adopted at higher educational institutions. In the United States, this trend is also shown in the result of Campus Computing 2011 Survey that more than 60% in average have an operational campus-wide emergency notification system[1].

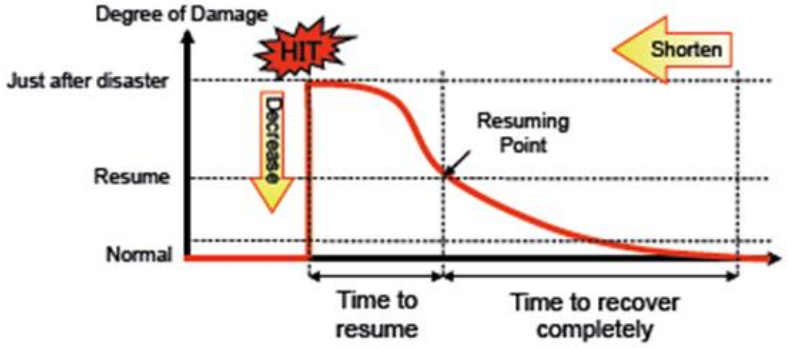

Figure 1: Recovering process after disaster.

However, most of them are dedicated to use only in crisis situations that rarely happen, and it is difficult for higher educational institutions to let constituencies teach how to use such a rarely used Survivor Confirmation System, because the constituency is transient, in special, almost quarter of students are constantly joining and leaving. In addition to it, the high procurement and maintenance costs are also preventing the introduction of Survivor Confirmation System.

Due to these reasons, in 2006, Nagoya University decided to develop a home-grown and really-operational system that satisfies the following conditions [2]:

1. Survivor Confirmation System must be embed on to commonly and daily used system at Nagoya University and must be accessible anytime and anywhere,

2. Basic personal information such as full name and affiliation must be regularly maintained as a daily business,

3. Security and privacy concerns for personal information must be fully assured.

After disaster, firstly, it is mandate for institutions to recover required lifelines such as electricity, water and communication lines to resume normal activities as soon as possible. Besides, top-level administrators must have dependable and

concrete information on how many constituencies are able to come to campus, in order to make a decision on the resume of teaching and learning as fast as possible (See Figure 1).

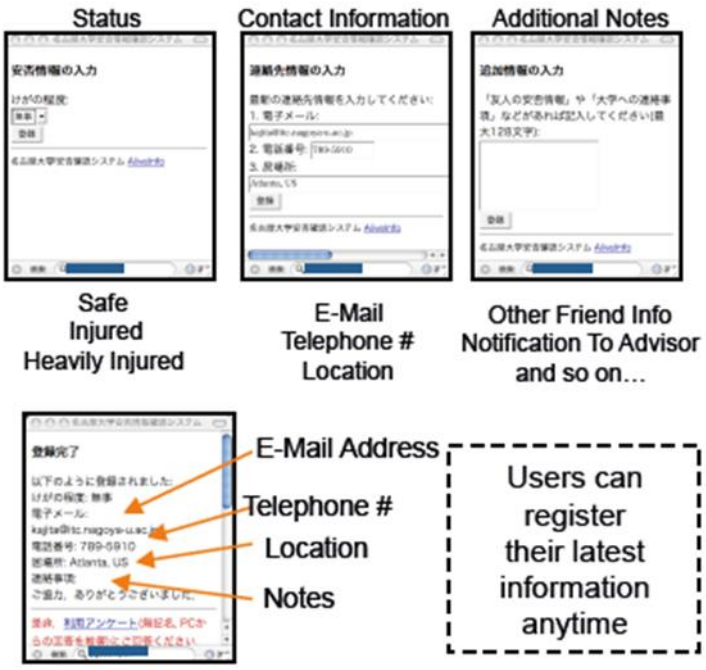

Figure 2: Screen shots to input survivor confirmation information.

As the result, Nagoya University Survivor Confirmation Sys- tem had been step-wisely developed to implement the following functionality on top of Nagoya University Portal, target- ting on the resume of normal acitivities rather than search and rescue mission just after disaster:[2, 3, 4, 5]

- User authentication is required to input survivor in- formation by using University-wide ID, e-Mail address registered in advance, or birthday,

- A sub-system of Nagoya University Portal is implemented at Academic Center for Computing and Media Studies, Kyoto University, in order to realize the robustness for service delivery using a Service Delivery Network (SDN) inter-connected by a VPN connection,

- Users can access by using not only Web browser but also cellar phone,

- Personalized view is provided through “Disaster” tab for general users and “Disaster Management Office” tab for Survivor Confirmation System administrators,

- Users can input survivor information, contact information and additional information such as other's in- formation, and these can be input anytime and any number of times (See Figure 2),

- Users can search registered survivor information but the number of query results is restricted to only three due to privacy,

- The system can transmit messages to call for inputting the survivor information by using registered e-Mail addresses for PC and cellar phone.

Usages in drills and Sendai Earthquake

Since 2006, Nagoya University has been conducting annual earthquake disaster drill with survivor confirmation registration drill. In addition to it, a solo drill for survivor confirmation registration has been conducted the beginning of spring semester. Through these drills, we have reached the level where about 8,000 constituencies[1] out of 24,000 register their information in 2010 drill.

The Great East Japan Earthquake (Sendai Earthquake) happened at 14:46 on March 11th in 2011. The level 4 in Japanese earthquake intensity scale was measured even at Nagoya where the main campus of Nagoya University is located and over 600km away from the seismic center. Although there was no severe damage on campus fortunately, Nagoya University had started announcing the request for survivor confirmation information as the damages in Great East Japan were broadcasted on televisions. After call for input, the number of input was turned to increase, and attained about 13,000 after a month at last. Since the number of call has reached to the plateau, other methods like telephone contacting through student affair offices at each department were concurrently performed, and 100% confirmation for students attained[2] by the middle of May 2011[6].

Lessons learned and research issues in crisis situation

Through these experiences on the system development and its usages, we have learned the following points:

- Gathering and maintaining reachable e-Mail addresses within a daily activity is mandate,

[1] At the latest drill held on October 2011, the number increased to 10,371.

[2] Three undergraduate students of Kyoto University were died during their graduation trip to Sendai.

- Survivor Confirmation System should be integrated with daily used system like Institutional Web Portal, not as a separated system rarely used,
- Low-tech and expensive methods like telephone and post-card should be prepared because the system-based survivor confirmation is not able to confirm all of con- stituency perfectly,
- The robustness of Survivor Confirmation System un- der crisis situation must be attained.

To improve these lessons learned, the following research issues must be addressed:

1. How we can reach a large-scale but transient constituency and maintain the connectivity,
2. How we can incorporate a rarely used information sys- tem within daily used information system,
3. How we can passively and automatically gather constituency's status in an inexpensive way.

To tackle these issues, we would like to propose a Large Scale Message Notification and Confirmation Service in a daily-emergent continuum and its system architecture for survivor confirmation at higher educational institutions as shown in Figures 3 and 4. In special, activity information from social media and logging information from institutional information systems could address effectively to know the latest status of constituency automatically. And also, we are planning to implement it as an open source software to share and cooperate the instances among multiple institutions for the robustness under crisis situations.

Acknowledgements

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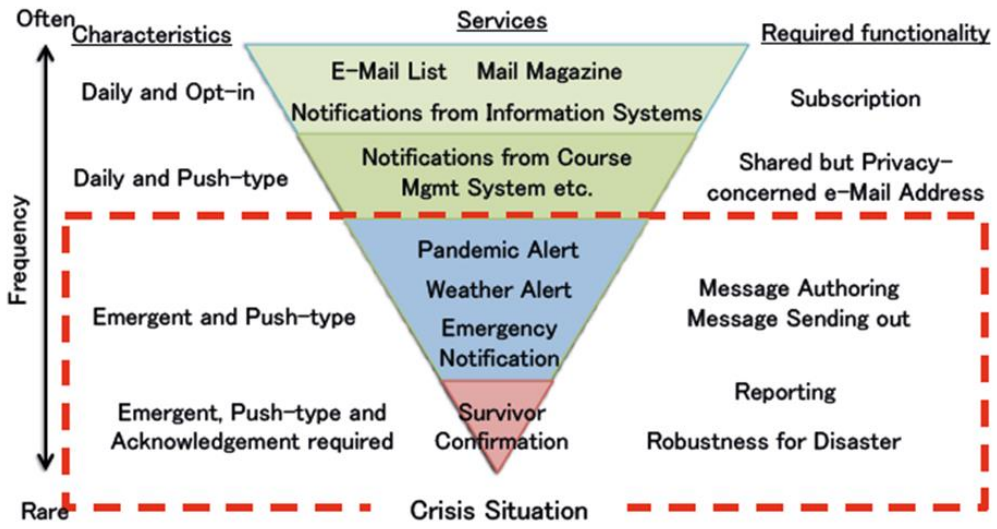

Figure 3: A Large Scale Message Notification and Confirmation Service.

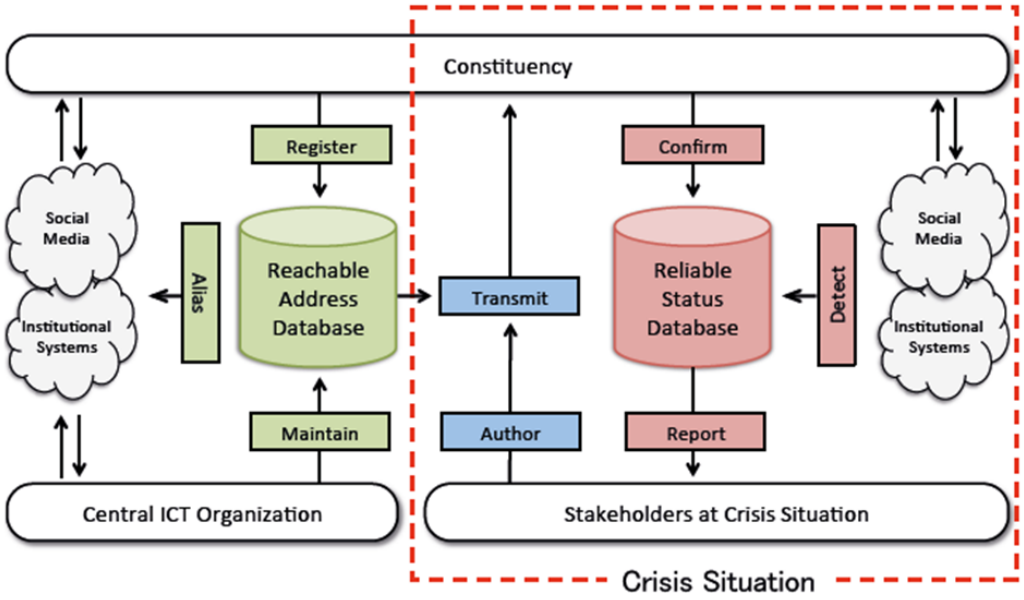

Figure 4: A system architecture for Large Scale Message Notification and Confirmation Service.

Repairing Human Infrastructure During Crises

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Abstract. Infrastructure in a society takes on different forms: physical, technological, and human, or social. These three forms of infrastructure are intertwined and interdependent. When one infrastructure is damaged in a natural catastrophe or war, then this can affect how the other infrastructures function. We are interested in how, when the human infrastructure is damaged, people can switch reliance to the technological infrastructure to be resilient. Since 2008 we have conducted interviews with people who experienced the 2006 Israeli-Lebanon war and the 2nd Gulf war in Iraq. There are many novel and emergent ways that ICTs have been used by our informants to repair and rebuild their social infrastructure. This research suggests models and new technology designs for crisis informatics.

Considering Infrastructure in Crises

Infrastructure is generally defined as the underlying framework of a structure or system. A society relies on infrastructure to function, ranging from power grids to provide electricity to highways for transportation. People and their connections to each other also constitute an underlying foundation for society, a social infrastructure. In studies of crises, most attention has been given to single "types" of infrastructure without a lens on how infrastructures of a society can be intertwined and related to each other. In this position paper I will focus on the

physical, technological, and human (or social)[1] infrastructures and how they exert mutual effects during crises. By physical infrastructure, I refer to the physical foundation of roads, buildings, bridges, sewers, water pipes, etc. By technological infrastructure, I primarily refer to computing infrastructure supporting communication and the sharing of information, consisting of routers, servers, computers, wireless connectivity, landlines, satellites, cell phones, television, and so on. ICTs would be a part of technological infrastructure.

But human infrastructure in my view has not received enough attention during crises, particularly in its foundational role in a society and its relationship to other types of infrastructure. We consider the human infrastructure to be the underlying foundation of a social system constituted by the pattern of relationships of people, through various networks and social arrangements. It is not just a single person's social network that constitutes human infrastructure but rather a *network of networks*, *or arrangements*. It is not any single group or social network that exists as human infrastructure, but rather the holistic constellation of networks, groups, relationships and patterns of communication that exists as a framework for any society or social unit.

Residents in a society depend on human infrastructure for a range of activities in their daily lives, i.e. for work, socializing, education, health care, entertainment, transportation and so on. The human infrastructure can be comprised of family members and friends, work colleagues, neighbors, doctors, shop and restaurant owners, taxi drivers, policemen, administrators, and so on. Human infrastructure is far broader than a social network. For example, an administrative assistant in one's workplace may not be part of one's social network but this person is part of the human infrastructure, as he or she supports the functioning of the workplace by delivering messages, dealing with financial or travel information, scheduling meetings, and conducting other support activities. Similarly, a pharmacist, nurse, or doctor may not be members of one's social network but they support people in maintaining and restoring health and supplying medications. Without an intact human infrastructure people cannot carry out familiar routines.

Commonly though, relationships concerning infrastructure are not so clearly delineated. For example, communication among people involves all three infrastructures. People may use cell phones or email to communicate or they may travel on roads using cars or public transport to meet each other. Depending on conditions people may also change how they use and rely on infrastructure. For example, if in a war zone one road is destroyed, then in order to meet people might take an alternative road that is still intact. Alternatively, people may cease

[1] I use the terms 'human' and 'social' infrastructures interchangeably here.

travel and instead use email or telephone to communicate with others without physically meeting.

Star and Ruhleder [8] describe how human infrastructure is interwoven with technological and physical infrastructures. They describe how infrastructure is generally invisible (such as plumbing) until it breaks down when it then becomes visible. When a computer network goes down then suddenly people become aware of it. Especially in a war environment, when roads are not passable or when electricity is not available then the physical and technological infrastructures becomes highly visible. As infrastructures are intertwined, changes in the use of one infrastructure may also affect how other infrastructures are used. For example, when a new technology is adopted, new conventions of practice must be developed which in turn can change collaborative relationships. Whereas physical infrastructure is slow to change (e.g. a new building requires time for design and construction) human infrastructure is highly dynamic [3]. People can readily reconfigure social arrangements, and consequently communication and coordination. My interest is in how the social infrastructure can reconfigure to adapt to an environment that is affected by a crisis.

When human infrastructure is affected at a micro level (e.g. when an individual cannot meet face-to-face with colleagues and the individual must find new ways to communicate remotely with colleagues), then this new communication pattern can have an amplifying effect on practices at a more macro group or even societal level. An example is when critical mass in the adoption of a communication technology occurs.

We argue that when one infrastructure is damaged, as in a natural catastrophe or war, then people can change their relationship with a different infrastructure to be resilient, i.e. as a supporting structure to carry out their activities [1]. For example, if during a war a teacher and classmates are unable to travel to school, then students may switch to using the Internet to interact with others, e.g. by sharing coursework or getting lessons online.

Our view is that in times when the human infrastructure is disrupted, it must be rebuilt, reconnected, or "rewired". In many cases of environmental disruption, the technological information and communication infrastructure remained intact but it was the human infrastructure that was disrupted. The events of 9/11 and the 2006 Israeli-Lebanon war are examples showing that while Internet connections and cell phone reception were still available (after 9/11, the technological information and communication infrastructure in the World Trade Center area was destroyed while the surrounding area technological infrastructure was intact), the human infrastructure was severely affected. After 9/11, thousands were killed, entire

companies such as Cantor Fitzgerald were destroyed, and many remained missing for days after the attacks [5].

Infrastructure Repair

Since 2007, we have been conducting "ethnography at a distance" to understand how people use ICTs to repair their human infrastructure during an environmental disruption. We have conducted over 130 semi-structured long interviews with people who lived in Israel during the 2006 Israeli-Lebanon war, and in Iraq, during the 2nd Gulf war. Details of the methodology and the research settings can be found in [4,6,7]. Wars differ from other types of disasters such as weather events as there are continual threats and emergencies. Following Powell's model [1] we focus on activities that occur after the acute emergency stages. Thus, we are focusing on activities in the recovery phases of a disaster.

ICT to repair Infrastructure

In our data we discovered emergent uses of available ICTs to improvise new coordination patterns. These uses of ICTs were used for a range of activities such as responding to threats and creating new structures for education. I will detail a few of these examples to illustrate the intertwining of the technical with the human infrastructure.

One example of an emergent use of ICT was the use of SMS for siren warnings. The origin of this new practice began in a few villages in the north of Israel in 2006 during the Israeli-Lebanon war. The villages switched from audio siren warnings to using SMS to relay warning messages. One informant described that her village did not even have a working siren warning and they only received siren warnings through SMS on their cell phones. Sending SMS siren warnings increased people's competency to react. The direct intent of the message was as a cell phone notification that informed them to take shelter. These SMS warnings however were also used as awareness notifications. When people traveled away from their homes they could still receive the SMS messages and could find out if their neighbors or if their homes were within siren range. Importantly, people also passed these SMS siren messages on to others, such as their children or parents, to notify them of impending rockets. Thus, people utilized their human infrastructure in conjunction with the technological information and communication infrastructure to expand their capacity for time and location awareness of potential rockets. Using SMS enabled people to notify others in their social network (and beyond) about the warning who were not even present in the threat area. It also served as a redundancy mechanism as people would send duplicate SMSs to

others in addition to the official SMS notification, to make sure they were aware of it.

Another case is from Iraq. Prior to the war Iraqis could freely travel on roads. When the war started, travel on roads became dangerous not only due to bombings but also due to roadblocks which were operated by various sects and insurgents. In order to travel to work and to attend school our informants described how they set up cell phone networks in which individuals would call others within their community (e.g. their neighborhood, workgroup, or university) who they knew would be traveling the same route that they had, in order to help others avoid dangers and delays they had encountered. Students would call to inform other students that there were no classes because of roadblocks or explain less time consuming alternate routes. This network helped people decide which direction was the safest to travel. Whereas today there are similar types of route notifications on the Internet such as map mashups, these mashups may not be customized to a person's particular travel route. In Iraq, this practice was based on available technologies (cell phones) that were widely adopted. This use of cell phones shows again how people changed their reliance to a combination of the technological and human infrastructure to enable them to restore (at least partly) their ability to travel.

Psychological resilience

ICTs also provided psychological support in navigating through dangerous areas. For example, one informant, who is European, was working in Israel when the conflict broke out, and chose to remain. He described how he relied heavily on his cell phone and a web cam to communicate with his family in Europe before and after making the 45- minute drive to work, and before going to bed. Other informants reported using their cell phones more heavily during the war to call relatives before they drove somewhere, e.g. to work. Many other examples of a similar vein were reported. In these cases, people used ICTs to connect to others in their social network to help them to be psychologically resilient in the environment.

ICTs to restore social interaction

Informants in both of our countries reported that they changed their mode of interactions with friends and family, from meeting far less face-to-face to using technology to interact. This change was most pronounced in Iraq where culturally people were accustomed to meeting face-to-face. After the war in Iraq started, the level of trust in unfamiliar people declined rapidly as strangers could be insurgents, spies, or terrorists. Even students at the university reported that they did not trust other students. As a result people began to rely more heavily on ICTs to socialize: adopting email, Instant Messaging, social networking sites, and

Internet chat rooms. Medical students reported starting an online forum to discuss coursework. The Israelis also reported changing their social practices from meeting face- to-face to online and telephone interaction. All our informants reported using cell phones to a far higher degree during the war than before or after the war. When people went into bomb shelters in Israel they made a series of quick phone calls to close friends and relatives to let them know they were safe.

Informants also reported switching to virtual work practices to be resilient in the environment, as many could not physically travel to work. Working with colleagues online instead of meeting face-to-face enabled people to continue to work independent of their disrupted physical environment. Though virtual work practice is common in many western cultures, virtual work practice was very new for our informants. For example, five Israeli researchers were able to continue working on a research article with laptops and Internet connections, even though they were all constantly changing residences. An Israeli army reservist was able to seamlessly continue to work with his colleagues when he was called into the army. A CEO of a small company was able to continue working virtually as she continually changed residences. Informants in Israel reported that they were able to continue working even in bomb shelters with laptops and Internet connections. Some described how their international colleagues did not know that they were interacting from a bomb shelter. In fact, as some informants described, it was precisely their aim to create an impression among their business partners and clients that they were resilient in work and not affected by the physical disruption in their environment.

Iraqis also reported developing virtual work practices. A journalist explained how two reporting groups in northern and southern Iraq began to use the Internet and cell phones to communicate rather than traveling across the country. Other journalists informed us that Internet access at home allowed them to extend their working hours beyond the limit imposed by the curfew and daylight hours by continuing their work from home. Other professionals reported that they could continue working using their laptops even when there was a power outage.

Human Infrastructure

Any type of environmental change can provide a trigger for new practices to develop. Crises in particular provide slippage or opportunities for people to develop new practices. The human infrastructure as it existed before the war in both societies developed rifts due to the continual threats which made it difficult to conduct normal routines. For Iraqis, the degradation of trust restricted people's face-to-face interaction. The use of ICTs enabled people to repair these breaks in the infrastructure so that they could continue their routines.

Work organizations have given attention to developing effective plans for coping with major environmental disruptions, e.g. short term plans for evacuation and saving lives, protecting buildings from further harm, and longer term plans for rebuilding the technological information and communication infrastructure. What is less common, however, are for organizations to consider plans that exist for rebuilding the human infrastructure. Our data show that repairing the human infrastructure through using technological resources is a way for people to be resilient who are facing continual threats in their society. Though not a silver bullet, ICTs provided a range of alternative resources for people to use to continue to act. Many of our informants relied on cell phone usage which remained in service much of the time even when the Internet was down (in Iraq).

Further Issues to explore

I am interested in exploring more deeply the relationship of technological resources and the human infrastructure in crisis settings during the recovery stage of disasters [1]. Future work I am interested in is:

- The relationship of the technological and human infrastructures in nonwestern countries. Although the Internet is becoming a global phenomenon, in many countries, such as Iraq, the Internet is used by only a small percentage of the population. One of the challenges new technology users face is the steep learning curve involved with understanding and being able to utilize such technologies.

- Data-mining of social media. Internet archives, such as the blogosphere or forums in the aggregate can provide a view into how a society is experiencing a crisis. There is a large potential to study what large-scale social media data can reveal about how a society reacts to a war or other crisis.

- Mobile technologies in the recovery process. The use of mobile technologies continues to grow globally and their use during disruptions becomes increasingly important. Countries are also moving quickly towards more sophisticated 4G platforms. This expands the possibilities of how smart phones and new applications might support the repair of routines, e.g. in administering health advice.

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Framework for the Analysis of Coordination in Crisis Response

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Abstract. Social Media play a critical role during crisis events, revealing a natural coordination dynamic. We propose a computational framework guided by social science principles to measure, analyze, and understand coordination among the different types of organizations and actors in crisis response. The analysis informs both the scientific account of cooperative behavior and the design of applications and protocols to support crisis management.

Introduction

Social media completely revolutionize the creation, distribution and consumption of information. The function of social media such as Twitter in crisis response is particularly salient in a number of recent crises, such as the Haiti (2010) and Japan (2011) earthquakes, as well as Hurricane Irene (2011). While social media enable coordination among the residents of a threatened community, the message traffic is not directly useful to the organizations that can provide service and aid. Two challenges to the exploitation of

social media for emergency response are the volume of message traffic and the inability of the resource- limited, formal emergency response organization to respond to every hint of need. But the new paradigm also presents the opportunity to enhance the effectiveness of resource allocation, by tapping otherwise unused resources and distribution processes in the community at large. The combination of challenge and opportunity heightens the need to study and build models for effectively coordinated operations of emergency response organizations, community resource providers and resource seekers.

Our dictionary[1] definition of coordination *is the harmonious functioning of parts for effective results*. We note the entirely proper absence of organizational and intentional properties in this definition. Coordination can occur top-down and intentionally, in the well-defined hierarchy of a formal organization. But, coordination also occurs bottom-up and fortuitously, among a loosely coupled set of independent actors. For example, a Twitter business conversation between a customer and a vendor evolved into a safety check during the California mudslides in 2009 (refer figure 1). We believe that orthogonal organizational properties shape coordination behaviors, and potential coordination challenges, within and between cooperating agencies. In the remaining paper, we describe our approach with related work and then conclude.

Approach

To ground our recommendations for the design of applications and protocols to support crisis management in a scientific account of cooperative behavior, we propose a comprehensive framework (refer figure 1) for data collection and analysis:

A.) Domain Knowledge driven data collection and Semantic Analysis to extract key nuggets: In the absence of pre-specified communication protocols in crises, the social data from various platforms (microblogs, blogs, forums, SMSs etc.) provides a deluge of raw data, not all of which is relevant to emergency response. This deluge challenges the identification of needs, resources and emergent coordination in the community. Our analysis leverages a detailed event model, mined from community knowledge bases such as Wikipedia to identify and interpret contextually relevant social data. Semantic analysis techniques can be applied to identify and extract resources (important entities), actors (people and organizational affiliation) and key information for actions- spatial and temporal information. Moreover, Semantic analysis helps in extracting relationships between the key nuggets [6,7,10,14].

[1] From Merriam-Webster, http://www.merriam-webster.com/dictionary/coordination

B.) Coordination analysis: We argue that detecting emergent coordination is key to maximizing the efficient deployment of limited emergency response resources. We categorize organizations based on degree of pre-established communication protocols, defined reporting hierarchies and explicit purpose.

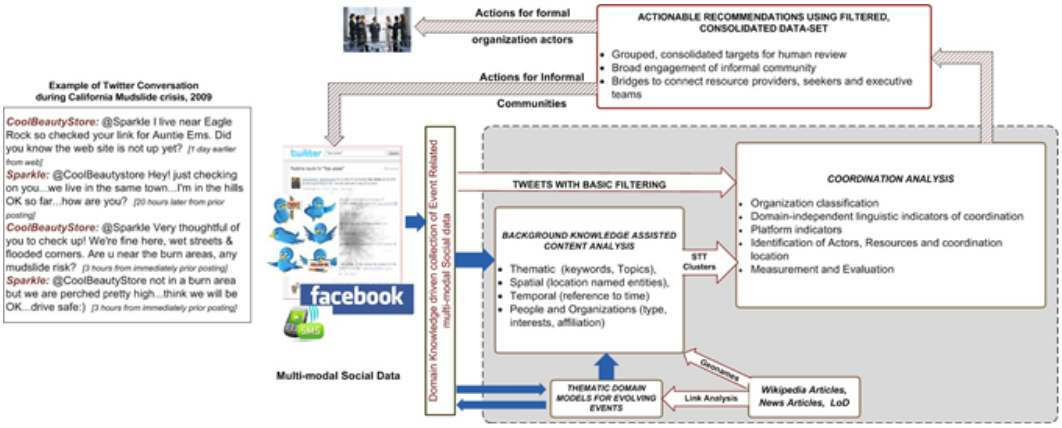

Figure 1: Coordination analysis framework and example Twitter conversation. [*STT Clusters: Spatio-Temporal-Thematic Information Clusters]

For instance, Federal Emergency Management Agency (FEMA) is a *Formal organization*, local churches are Informal and the Red Cross is a *Hybrid*. Formal organizations, whose raison d'etre almost completely reflects emergency response, likely define and impose a coordination protocol. Informal organizations arise from agencies with independent purposes, such as manufacturing, veterinary care, restaurant services, special interest clubs, and religious congregations, which lack a coordination protocol. Instead, they have common knowledge of community leaders and resources. Hybrid organizations, such as the Red Cross, have knowledge of the formal system structure and defined procedures. However, because hybrids import external labor from surrounding communities, they lack the common knowledge that grounds the informal organizations.

We suspect that recommendations that hinge on imposing low-level communication templates on informal organization will fail because they are brittle under stress and non-standard circumstances [12]. Alternatively, we focus on detecting and extracting patterns of coordination in communications within the informal organization. The multi-layered approach to the analysis of communication characteristic of contemporary psycholinguistic theory supports our approach [1,2,8]. Properties of an exchange, including opening and closing phrases, anaphora and deixis reveal the existence of coordination, and hence the emergence of a new informal community to effect a result. We have developed

and tested promising domain-independent heuristics based on these properties using Twitter conversations during the 2011 Japan and New Zealand earthquakes. A Signal Detection Theory analysis [13] quantifies the diagnostic success of these heuristics. Platform assisted conventions like # (hashtags), @ (for addressing/ mentioning another user) do mediate the detection of coordination, but do not function effectively on their own. When combined with user profiles and spatial-temporal nuggets, we can highlight pockets of need and coordination for further review by the formal organization.

Conclusion

We propose a framework to identify and analyze relevant coordination in the informal community. We leverage an event-specific domain model to identify relevant exchanges, followed by domain-independent language analysis of emerging informal organizations. This framework filters information for the formal organization to enhance response time and the deployment of scare resources.

Acknowledgements

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Behavioral Patterns in Online Crisis Communications

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Abstract. Members of the public play a critical role during times of crisis and mass emergency. Traditionally, activities of civilians in areas affected by a natural hazard or other disaster agent have involved search and rescue operations, provision of food, water and other essential supplies and additional material offerings. However, the increase in the use of social media and microblogging services in recent years has allowed for new and different types of contributions by those directly and indirectly affected by a disaster, as well as those removed from the situation and who find themselves wishing to help or participate in some way. This increase in the use of social media has led to an increase in the amount of information that spreads in these time- and safety-critical situations. Finding ways for affected populations to cull through and quickly locate personally meaningful information is critical; in this paper, I discuss foundational research in this area.

Introduction

Mass emergencies are often portrayed as situations of chaos and confusion [3]. When an earthquake strikes or a hurricane makes landfall, it is frequently the case that people are adversely affected and the built environment is damaged. However, as opposed to these hazard agents creating a state of pandemonium and extreme disorder, sociologists of disaster point to the orderly, systematic and *predictable* behavior that ensues soon after the impact period has passed [1,3].

Human Behavior in Mass Emergency

Sociologists have long drawn attention to the regularities and patterns in human behavior that are made apparent when disasters occur. Though some disasters are expected (such as regular flooding or wildfire events) they are not events that occur with temporal precision. People cannot mark their calendars with the exact day and time a disaster will occur; they cannot know the severity of an event prior to impact. Yet, as Russell Dynes explains, despite the lack of ability to forecast disaster events and the effect they will have on the social and built environments, these situations are *repetitive* [1]. What this implies is that there are generalizable structures in how the events unfold and in how affected populations react.

Human Language

The patterns that exist in human behavior during times of mass emergency extend beyond physical actions performed in particular situations. The way we communicate through language is also rife with pattern. As Charles Fillmore states: "a grossly underestimated portion of speech behavior consists of the performance of rehearsed speech routines." [2]. What Fillmore is indicating through this assertion is that much of the language humans produce is formulaic and automatic. When we communicate about a topic, we do so with a degree of predictability—in both grammatical construction, and word choice.

Twitter Communication in Crisis

The research I report on here involves incorporating elements of both the sociology of disaster and linguistics. Past research by colleagues and myself has shown that in mass emergency situations, people in affected areas turn to the popular microblogging service Twitter to gather and disperse various types of information [5,7,8]. In continuing with this vein of research, and performing discourse analysis on communications sent during six particular mass emergency events via Twitter, I have identified twenty- seven types of information that contribute to situational awareness.[1] Furthermore, this analysis has revealed regularities in the amount that these types of information communicated in particular emergency events. For example, during two separate flooding events that took place in the Red River Valley region of the United States in 2009 and 2010, I find that for each flooding event, over 40% of the information contributing to situational awareness are comprised of three information types. This indicates

[1] Situational awareness is the combination of knowing what is in one's vicinity, understanding how elements are positioned in relation to one another, and knowledge of environmental factors [4].

that during massive floods, Twitter users are largely interested in communicating particular types of information. It is these common elements of disaster situations that provide researchers with understandings of how we can contribute to disaster mitigation and recovery through the use of technology. By first making sense of what information people care about in times of mass emergency, and then identifying generalizations and patterns in how information types relate to specific disaster events, we can begin the process of building computational tools that can automatically extract those particular pieces of information that affected populations find personally meaningful in particular time- and safety-critical situations. Previous research has shown that it is possible to automatically classify tweets that contain information relevant to situational awareness [6]; the goal is to now expand upon and broaden this research.

For example, we can imagine a time in the near future during a massive flood in which threatened populations need to know the level of a river as it relates to their location, where shelters are set up, or which roads are closed. These are all types of information broadcast via Twitter. The goal is for an individual who finds him/herself in a dangerous situation to be able to locate the particular information he or she needs to make the most informed decision. By using our knowledge of both the information people communicate on Twitter, as well as how that information is constructed linguistically, we can begin to form the foundation of tools that can provide important, detailed information to those faced with the need to make quick, informed decisions.

Conclusion

I am interested in further theorizing about the structures in behavior we can identify during times of mass emergency. My approach involves taking into consideration the behavior people exhibit when they use Twitter in times of mass emergency, and thinking about how we can use behavioral patterns to not only create computational tools, but in how we can extend current sociological theory.

Acknowledgements

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Experimenting Crisis Response Coordination

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Abstract. Coordination within and between organizations in dynamic situations, such as a crisis response, is still an important problem in CSCW research. Recent examples, such as the response to Hurricane Katrina, show typical coordination problems arising in this context. They lead to no efforts, double efforts and conflicting efforts. This means that the responders cannot help the people as much as possible. We assume that some of these coordination problems are related to the tools used for coordination. Modeling coordination explicitly can help to overcome the problems with current tools, such as telephone, fax or e-mail. We present our implemented concepts for modeling coordination in dynamic situations explicitly and explain challenges with respect to their evaluation in form of interviews and experiments.

Introduction

Developing and evaluating information system supporting coordination of a crisis response is a challenging topic. Moreover, the situation becomes even more difficult if we consider the inter-organizational dimension of this problem. However, recent disaster examples, such as Hurricane Katrina have shown that there is a need for designing and evaluating information systems addressing this problem [10]. There, we find typical coordination problems. For example, people were rescued from an area and left on highways without anyone taking care of them or providing shelter. Some areas were searched several times, but others not at all. Coordination problems lead to no efforts, double efforts or conflicting efforts. The

result of them is that people cannot be helped as much as possible. Based on our interviews in the SoKNOS project [4], we assume that some of these coordination problems are related to the tools used for coordination in a disaster response. Examples for these tools are telephone, fax, e-mail, notes, Whiteboards or radio. While they allow ad-hoc coordination in nearly every situation, they only enable the users to coordinate in a very unstructured way. According to Malone and Crowston, coordination is about "managing the dependencies between activities" [8]. However, when using current tools, the dependencies between activities are not made explicit. They may exist in the head of people or are hidden in unrelated messages. Thus, we propose to model them explicitly with information system support.

We describe in the next section our framework for explicit modeling of coordination in dynamic situations. The disaster response is critical example for this. Afterwards, we present how the framework can be extended to the inter-organizational level. Finally, we discuss our efforts to evaluate our concepts implemented in a distributed collaboration service. We explain challenges with respect to interviews and experiments with students.

Modeling Coordination explicitly in dynamic Situations

Modeling coordination explicitly has been subject to intensive research in the CSCW community. There, many different types of workflow systems have been proposed (cf. [4] for a more detailed overview). These systems allow modeling coordination explicitly by describing graphically the activities and dependencies between them. This has several benefits. It is clear for the user, what has been done, what is currently going on and what are the next steps. The models can be evaluated according to certain correctness criteria, e.g. freedom of deadlocks. Furthermore, their execution can be tracked by a system and the users are aware of the status of the activities. Hence, we find already several proposals to extend these system for dynamic crisis response management (e.g. [7, 5, 2, 6]). Nevertheless, only recent work explores the problems of these systems in the crisis response in more detail [4]. Given the limitations of the existing approaches, we designed our own approach based on user interviews in the SoKNOS project. For instance, we identified the problem of shifting goals in a dynamic situation. Shifting goals imply that the current set of activities needs to be reassessed. This includes also their dependencies. For example, let us assume a disaster response to a flood (cf. SoKNOS use case [4]). The military fills and transport sandbags for the fire brigade. The fire brigade uses this sandbags to build a dam. However, the flood gets worse and the goals shift towards evacuating a residential area. This

means building a dam is canceled and evacuation is initiated. However, the organizations need also to take into account that filling and transporting of sandbags need to be cancelled, otherwise conflicting efforts take place (i.e. typical coordination problem). Clearly, this is a simplified example, but in reality there are more dependencies and activities. Thus we think information system support is necessary. We describe in the subsequent sections how such information system support can be designed and evaluated. These concepts have also been implemented in a distributed collaboration service.

A Framework for explicit Modeling of temporal Coordination

Our framework allows modeling of activities and temporal dependencies between them. Examples for temporal dependencies are that activities have to start at the same time, can overlap or have to finish at the same time (cf. for a complete list [4]). It is not obligatory to model dependencies and only the ones perceived as important by the user need to be defined. It is also not necessary to provide concrete quantitative points in time (e.g. they start at 12:02), because we assume this is very difficult to define in a dynamic situation. The model can be verified for correctness to make sure that the activities can also be executed given the temporal dependencies. Furthermore, it is possible to keep track of the execution of activities (i.e. their state changes). This allows also detecting deviations between the model and how activities have been executed. Shifting goals leading to a reassessment not taking into account all dependencies can thus be detected and highlighted to the user. We provide now an illustrative example how this framework works in Figure 1.

We see there the evolution of the model for a response to a flood disaster in four stages. In the first phase, the fire chief has modeled the activities “Protect Area from Flood” and “Build Dam”. A dependency is established between them. This dependency says that the activity “Build Dam” should only be executed if the activity “Protect Area from Flood” is executed. The verification procedure does not return any errors in the model. At the moment, both activities are in state “Execute”.

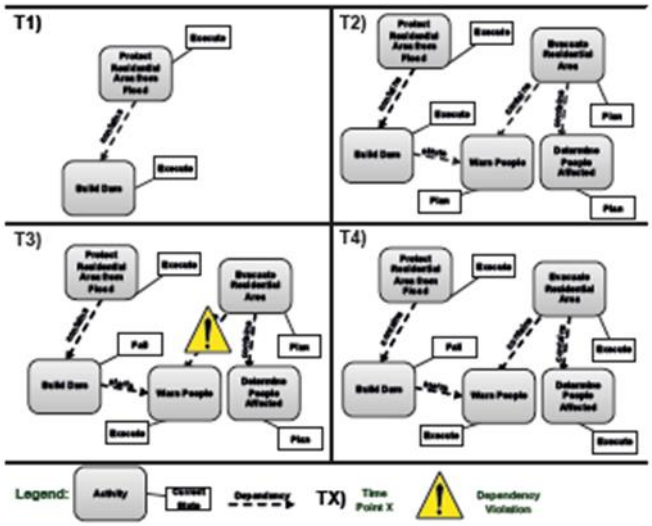

Figure 1. Example Model of our Framework

In the second phase, further activities are modeled: “Evacuate Residential Area”, “Warn People” and “Determine People Affected”. These activities are in state “Plan”. Further, dependencies are modeled between them. The verification procedure confirms the correctness of the model. In the third phase, the activity “Build Dam” is changed to state “Fail” and the user changes the activity “Warn People” to “Execute”, because the goal shifts from protecting the residential area to evacuating it. This leads to a violation of the dependency between the activities “Warn People” and “Evacuate Residential Area”, because the latter is still in state “Plan”.

The user resolves this in the fourth phase by executing the activity “Evacuate Residential Area”.

Extension of the Framework to the Interorganization Level

Given our interview results (cf. [4]), we came to the conclusion that our framework would be most useful when using it on the inter-organizational level to facilitate coordination between organizations. Hence, we developed a concept to enable inter-organizational coordination with our framework. Here, we need to consider that privacy, regulatory, strategic or other reasons prevent that everything can be shared between everybody. For example, the military cannot share everything what they do with the fire brigade.

The basic idea of our concept for the inter-organizational level is illustrated in Figure 2. Each organization has its own workspace, where it models activities and

dependencies. Selected activities can be shared between people of different organizations. This means that they are replicated in the different workspaces of the organizations and that updates, such as state changes, are also replicated when they occur. Dependencies can be established between shared and internal non-shared activities. In the example in Figure 2, the military has shared the activity "Transport Sandbags" with the fire brigade. It is replicated in both workspaces. They fire brigade has established a dependency from the shared activity to the activity "Protect Residential Area from Flood". The shared activity is changed to state "Execute" by the military and this state change is propagated to the workspace of the fire brigade.

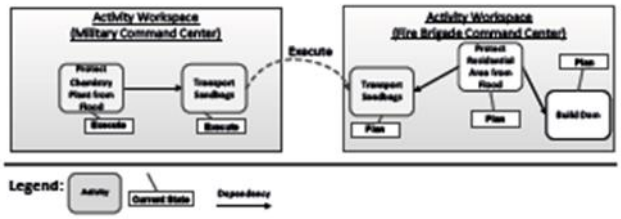

Figure 2. Example for Sharing Activities Between Different Organizations

Of course, replication means that there can be conflicts. These conflicts may lead to a diverging view on activities or dependencies in different workspaces. However, we argue that there is a need for a converging view in order to avoid coordination problems. Contemporary tools do not address this. For instance, in [4] we identified conflicting state changes of one shared activity (e.g. it is changed into "Fail" in one workspace and into "Cancel" in another) or different causal order of state changes leading to a different view with respect to the violation of dependencies. We also described how these conflicts can be detected and handled automatically to ensure eventually a converging view.

The Challenge of Evaluation

Evaluating crisis management software is not an easy task. There are several possibilities. We investigate in this section three different methods for evaluation: Expert interviews, disaster exercises and experiments. Afterwards, in the next section, we describe the design of our own experiment to evaluate the concepts implemented in a prototype mentioned before.

Expert interviews can be used to gain a consensus about advantages and disadvantages. Based on our own experience [4], this can provide useful hints. However, we noticed also cultural differences with respect to risk attitude towards using new software. Some experts were more reluctant to accept new technologies as part of their work.

Disaster exercises are probably as close as possible to a disaster response. However, their goal is usually not evaluating tool support. Thus many complex factors come into play that makes it difficult to assess the contribution of a tool with respect to coordination. Furthermore, they are usually costly and difficult to repeat. This is particularly true for inter-organizational exercises.

We think experimental results are complementary to evaluations in disaster exercises. They require fewer resources and can be repeated more often. Additionally, they can focus on the tool to be evaluated. However, results from experiments cannot be transferred to conclusions with respect to the tool support in a disaster response. Nevertheless, they are useful to interpret the results obtained in a disaster exercise or expert interviews. Experiments have been already described for evaluating tools and concepts in the area of information systems for crisis response (e.g. [9]).

Design of an Experiment

Although experimental research is important, there are not many experiments described with respect to interorganizational coordination in dynamic situations. We find some experiments about dynamic process management in the literature, but they do not address the inter-organizational dimension. Thus, we designed an experiment to assess and compare different tools for this purpose. In order for the experiment to be successful, it must demonstrate the typical coordination problems, as described before, can be reproduced. We conducted the experiment successfully three times to confirm its design. Further experiments are currently conducted to assess and compare different tools including our own prototype.

Details

Our experiment design is inspired from the LEGO serious play™ experiments in management science [1]. There, LEGO®[1] has been used as a tool to describe and evaluate business strategies. Contrary to existing work, our experiment requires to coordinate actions in the real world and not coordinating work on a digital artifact. We expect that this would lead to a higher probability that coordination problems will occur and think it is more closely to the disaster exercise case.

During the experiment, five student teams had to coordinate the construction of a LEGO® object: architect, builder, assembler, transporter and engineer. Each team

[1] LEGO® is a trademark of the LEGO Group of companies which does not sponsor, authorize or endorse this publication (see http://aboutus.lego.com/corporate/fairplay.aspx)

was located at a different site and could not see what the other team was doing. They had to coordinate through an assigned tool (e.g. chat tool). A LEGO® object consisted of LEGO® components, which consisted of standard LEGO® bricks. The architect team had the specification of the LEGO® object. It instructed the builder team to construct components and the transport team to transport them from the building site to the assembly site.

There, the architect instructed the assembler how to create an LEGO® object out of the components. The builder team had only the specification of the LEGO® components. The engineer team had to construct another LEGO® object, which was related to the object of the architect team. It requested LEGO® components from the builder team and assembled them itself. Since not every team knew what the other team was doing or their specifications, we expected that typical coordination problems would occur. Shifting goals can be simulated in various ways, for example, by change of specification or change of teams.

Outcomes

In order to assess the experiment design, we generated three different outcomes of the experiment. The first outcome was a survey conducted before and after the experiment. The survey conducted before the experiment assessed the expertise of the participants. Dörner showed that experienced managers have better skills to solve problems in experiments than students [3]. However, valid conclusion can be still derived from student experiments. The survey after the experiment tried to assess which coordination problems could be related to the tools used and which ones had other reasons. For instance, we asked each team what were the main problems and what were the problems faced with each team. They had also to provide input on advantages and disadvantages they faced with their tools. We found out in the surveys that indeed problems occurred due to the tool used, but other problems had their cause in misunderstandings.

The second outcome was the data gathered from the tools used for coordination. We show in Figure 3 an example for a coordination problem caused by the chat tool used. The architect team got confused, because the builder team confirms twice that the same blue component has been completed, but it never receives information about the white component. This led to further confusion. Further conflicts have been identified in the data gathered from the tools.

Figure 3. Example for a coordination problem when using the chat tool

The third outcome was the objects constructed by the efforts of different teams. It turns out that the objects were very close to the specification, but did not fit exactly. For instance, in one case one part of the object has to be hold by the assembler team so that it does not collapse. We could not exactly identify the root cause for this, because it could have been also a misunderstanding between architect and assembler team. Further interviews with each team member could have identified the root cause.

Summary

We described in this section the design of an experiment to evaluate tool support for inter-organizational coordination in dynamic situations. We demonstrated that the experiment can reproduce typical coordination problems. Furthermore, we explained how it is possible to determine if the root cause for these problems is the tool or something else. Thus, we validated the experiment design. Further experiments will allow us to assess and compare different tools for inter-organizational coordination in dynamic situations.

Conclusion

We presented in this paper the problem of inter-organizational coordination in dynamic situations. Dynamic situations have been characterized by shifting goals of different organizations that lead to coordination problems. We argued that adequate information system support can avoid some typical coordination problems in this setting. Afterwards, we explained our own concepts for addressing these problems. They have been implemented in a distributed collaboration service [4]. Finally, we addressed the problems of evaluating these kinds of systems. We described in more detail the design of an experiment to assess tool support for inter-organizational coordination in dynamic situations. We confirmed the validity of the experiment by conducting it three times. Further

executions allow assessing different tools. Future versions of the experiment can enable us to assess different aspects of our concepts, such as the synchronization mechanisms on the inter-organizational level. The challenge here is to produce synchronization conflicts without forcing the user to create them consciously.

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Crowdsourcing in Crisis Informatics for Disaster Relief

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Abstract. In this paper, we present observations and lessons learned in crowdsourcing from our experiences with the Great East Japan Earthquake and Tsunami. Based on our experiences, we identify a set of future crowd sourcing research directions in Crisis Informatics for disaster relief.

Introduction

The destruction of the Great East Japan Earthquake and Tsunami on March 11th, 2011 created a challenge in crisis informatics. It became much more difficult to find and share necessary information as needed in the disaster area compared to normal times. The main cause was that information was posted in many different media types (e.g. text, audio, PDF, images) across many different websites. As a result, information was inaccessible to many users

Social networking services like Twitter showed that crowdsourcing services were most robust and effective for refugees to know and share a part of the distributed information like information about emergency shelters and delivery of relief supplies [1]. But the existing crowdsourcing services did not satisfy all of people's

information needs. Therefore, there will be good opportunities for research to provide more effective crowdsourcing solutions for better support of disaster relief efforts.

In this paper, we present some lessons learned in crowdsourcing from our experiences with the recent Japan large disaster. Based on our experiences, we identify a set of future crowdsourcing research directions in crisis informatics for disaster relief.

Case Study of East Japan Earthquake and Tsunami

The Great East Japan Earthquake and Tsunami on March 11th, 2011 created over 300,000 refugees in the northeast area. Many of them were forced to live awkwardly in emergency shelters for 3 to 5 months until temporary housing could be built.

Immediately after the disaster, many refugees were in shelters without knowing whether their family was alive or not. They needed to visit many other shelters by themselves until they confirmed their family's safety because each shelter posted a handwritten list of refugees' names in the shelter on its wall. Under this very stressful situation, we found refugees tended to rely on paper media for information exchanges because of lack of electricity, vulnerable telephone networks as shown in [1], and lack of people skilled at retrieving information online. Google deployed a mashup of Picasa with the Person Finder [2] very quickly to support refugees' effort to find their families (See Figure 1). This allowed anyone to share photos of the lists of refugee names. Crowds of people could digitize the names in the lists and post them into Person Finder.

Figure 1. Screen image of Picasa-based crowdsourcing.

Offices in some towns visited refugees' living places and surveyed their sensitive personal information (family members, living environment, health and mental condition, and so on). The survey results were managed in handwritten forms, making it difficult to reuse the information and find people who needed mental care. We worked with a town in the disaster area and deployed a crowdsourcing service to digitize these handwritten survey forms. We also preserved privacy by employing only a limited number of IBM employees and exchanging data using a secure protocol among a server, the town office and IBM because it was important to protect sensitive personal information even during emergency.

The tsunami also caused the terrible failure of cooling systems at Fukushima Daiichi Nuclear Power Plant, resulting in a large nuclear disaster. Due to the disaster, some electric power companies were forced to do planned blackouts to keep the supply of electric power stable. In this situation, refugees needed to gather a wide variety of information from various types of data sources by reading a poster on the shelter's wall, hearing it from the radio or another person, or using their mobile phones. The data sources included the local government (relief goods, temporary housing), the national government (radiation dose), electric companies (planned blackouts), and so on.

Some refugees could use Sinsai.info [3], a mashup of the crowdsourcing Web platform Ushahidi [4] and the free geographic database OpenStreetMap [5], to gather the above information linked with locations on the map (See Figure 2). Sinsai.info was useful for finding some local information, but it did not emerge as the primary information source for disaster relief. Many other competing websites also provided similar information and refugees did not know which service to use

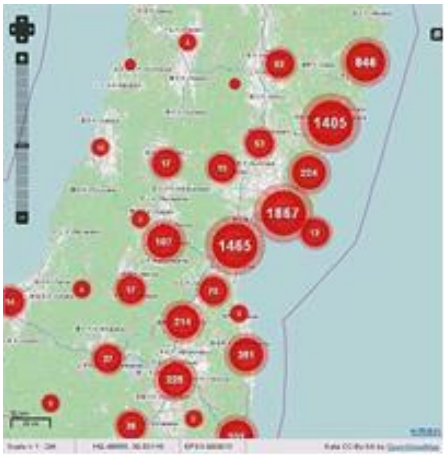

Figure 2. Screen image of sinsai.info.

Moreover, mobile information access was made more difficult due to the wide variety of data formats used to make information available: handwritten paper, images, video, audio, PDF, and so on. For example, one government website provided only PDF files of scanned images of papers immediately after the disaster with no textual transcription. Refugees with typical feature phones were unable to read the information because their devices could not support displaying PDF files.

These services showed that crowdsourcing has the potential to make image-based media types more accessible and the ability to gather local information efficiently from various data sources. But the existing crowdsourcing services did not satisfy all of people's information needs. Therefore there will be good opportunities for research to provide more effective crowdsourcing solutions for better support of disaster relief efforts.

Our Research Directions

Based on our experiences, we present a set of future crowd research directions in crisis informatics for disaster relief.

(R1) Creation of powerful and efficient crowdsourcing service: We plan to use crowdsourcing to break two of the major barriers to information availability: transcribing various media types into text information to make it more accessible and gathering information from multiple websites to make it available in one place. Our experience with crowd-based digitization of handwritten survey forms gives us a basis for exploring the first challenge. For the second, we plan to build on the CoScripter web scripting system [6] (See Figure 3) to enable the crowd to create scripts for scraping information from multiple websites by demonstration.

Figure 3. Screen image of CoScripter web scripting system.

(R2) Support of quick development and deployment: Getting a system up and running quickly after a disaster can prevent distribution and duplication of the same information. The ability to respond quickly after a disaster occurs may be improved by having common components for crowdsoucing services, such as an execution engine for CrowdLang [7].

(R3) Creation of reliable and secure crowdsoucing service: Gao et al pointed out that appropriate verification process are required for generation of reliable information in crowdsourcing [8]. We also found that preserving sensitive personal information will be required to prevent leakage of the information in digitization based on our experiences in development of our form digitization. For example, we can ensure quality assurance by assigning the same small task to multiple people recursively until all of them return the same result or adding a validation by domain experts. We can also preserve privacy by separating a large task into smaller pieces, each of which does not have sufficient information to identify a person. Figure 4 shows an example of digitization processing flow

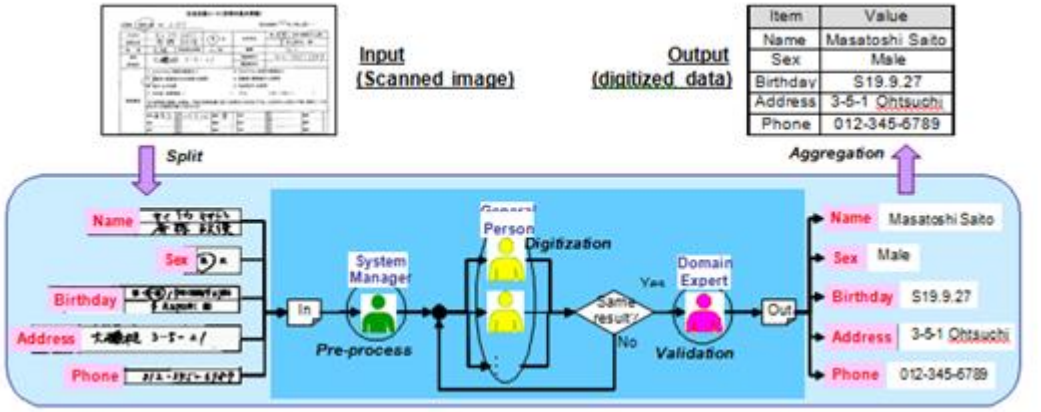

Figure 4. An image of digitization processing flow.

(R4) Optimization of work assignment: Since many of the affected people in crowd have a variety of abilities, optimized work assignment to the appropriate persons' group based on their skills and their experiences will be required to utilize the power of crowdsourcing efficiently. For example, we can reuse the concept of efficient workforce deployment in a service development shown in [9].

(R5) Sustainable service support: Support of collaboration and coordination among people in crowd is missing in the existing crowdsourcing services as shown in [8]. For a sustainable service, it is important to provide the service with collaboration and coordination support even at normal times for smooth collaboration among people in crowds. This enables seamless transition from at

normal times to in emergency case with less training under stressful situation as pointed out in [10].

Summary

In this paper, we presented lessons learned in crowdsourcing from our experiences with the recent Japan disaster. Based on our experiences, we have identified a set of future crowdsourcing research directions in crisis informatics for disaster relief.

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Disaster Symbols and Cultural Responses

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Abstract. Symbols carry meanings which are unique to certain cultures. Often, people in disaster situations and others affected by disasters experience them with symbols in order to cope with their situations. This study examines the meanings of symbols that emerged in social media after a disaster event. This study will explore the usefulness of understanding symbols and the underlying culture and history of the region and the characteristics of people for design of future disaster-related systems. I address that social media can be a valuable medium for collecting data which arises immediately after disaster events when fieldwork has not yet be started due to on-going rescue and clean-up operations. Furthermore, understanding the culture and history of the region and the characteristics of people is crucial for the design of future systems since one of the unique aspects of disaster research is that it is based on a culture's very specific circumstances.

Introduction

The Great East Japan Earthquake or the 2011 Tōhoku Earthquake (magnitude 9.0) that occurred on March 11, 2011 caused unprecedented structural damage and casualties (15,891 deaths, 3,929 missing, 5,940 injured [6]). A disaster may stem from nature or human-made errant technology. The Great East Japan Earthquake not only destroyed people's lives by the earthquake and the subsequent massive tsunami, but also threatened them from damage to the Fukushima Daiichi Nuclear Plant. People who lived far away from the disaster areas, such as the Tokyo metropolitan area, were also affected since they needed to conserve energy due to

the inoperable nuclear plant. Because of the intensity of the earthquake and tsunami and the significant damage and casualties, people throughout Japan were emotionally shaken and economically, socially and politically impacted.

This paper describes the early phase of studying symbols that emerged in a variety of social media immediately after the Great East Japan Earthquake and people's responses to these symbols. Symbols which appear in social media provide researchers significant insight: prior research on disasters [11, 13, 15, 18] present that social media can be useful for information dissemination and community building. Yet, the role of social media during and after disaster events is not limited to these aspects. Symbols that emerge in social media provide emotional support and identity formation and affirmation to people in crisis and to others who are impacted by disasters. People often seek emotional and spiritual support online [10]. Emotional and spiritual support is important as well as information since people feel most uncertain and vulnerable immediately after the impact of disasters. Second, symbols and underlying culture and history provide insight for designing systems that can support people in certain cultures to rebuild their lives and to prepare for future disasters.

Geertz [2] describes culture as "an historically transmitted pattern of meanings embodied in symbols, a system of inherited conceptions expressed in symbolic forms by means of which men communicate, persuade, and develop their knowledge about and their attitudes toward life." Symbols draw upon the surplus of meaning which can be grasped with conjunction of metaphor and metonymy (Ricoeur cited by [3]). Symbols carry a particular meaning which can be recognized only by those who share a culture [4]. Symbols and their meanings are often passed from generation to generation.

Disaster research is unique because of its context or circumstances. Therefore, researchers need to have two types of training—research methods in general and understating how the circumstances surrounding disasters impact research [14]. Thus, understanding culture and history of the disaster area and the characteristics of the people is crucial for disaster research. Symbols in social media can be one of the tools for researchers to understand the specific culture, history and the people of disaster areas.

Disaster Symbolism

This study was inspired by Hoffman's [5] study of the Oakland-Berkeley Firestorm of 1991 and the symbols that emerged after the disaster. In her study, Hoffman explicates how people in crisis experience disasters with symbols in order to cope with their situation. They need to have a direction of how to deal

with the disaster in order to survive. Symbols make abstract concepts, emotions and beliefs more describable and easier to embrace. Symbols which arise during or after disaster events reveal people's cultural responses to disasters.

Symbols which emerge in response to disasters may appear in a variety of forms—words, images, gestures, natural objects, songs and so on. A variety of symbols emerged after the Great East Japan Earthquake. One particular symbol that often emerged on the Web was the red disc as shown in the Japanese flag (see Figure 1). The red disc connotes the Land of Rising Sun or revival. The Miracle Lone Pine—a 260 year old single pine tree which escaped being swept away by the massive tsunami while the other 70,000 pine trees along the coastline of Rikuzen Takata City disappered—became a symbol of revival , hope and tenacity. The word "rebuild" or "revival" connotes special meaning to Japanese who learn their long history of struggles against countless natural disasters from their elders and their educational system. Another word often emerged after the disaster was "ganbarou" (loosely translated in English as "let's hang in together" or "let's do our best"). "Ganbarou Tōhoku" or "ganbarou Japan" became a slogan and a variety of stickers and banners appeared in numerous places. These words and phrases often imply unity and endurance

Figure 1 – The Red Disk and the phrase "Ganbarou"

These symbols teach us the history, culture and characteristics of Japan. Throughout its history, Japanese learned how to cope with disasters and how to rebuild their lives after each disaster. One significant reconstruction in their recent history was the era after World War II [1]. Although endurance and unity may be considered as virtuous characteristics of the Japanese, the ability to adapt to changes is not known as a Japanese characteristic [1]. Since the Meiji Restoration of 1868 which ended the feudal Tokugawa Shogunate and fostered industrialization in Japan, the Japanese have continuously accepted and adapted to enormous social, economic and political changes.

Data description and methods

A variety of public-initiated information was entered into social media immediately after the Great East Japan Earthquake. Some examples are YouTube videos of the large-scale tsunami washing away a small town and tweets that were

hashtagged as #prayforjapan. Without a doubt, social media provided public massive information immediately after the disaster. At the same time, the disaster helped increase the use of social media significantly. For instance, while the average tweets per day was 18 million before the March 11th earthquake, on March 11th, the number of tweets increased to 33 million in Japan and the average number of tweets per day since then were 22 million in March and April [17]. Overall, 177 million tweets were sent out on March 11th. Some organizations, such as Google, Twitter and Softbank, started their own support sites to aid people in crisis and also to promote their activities. For instance, on March 19th, the Japan Ground Self-Defense, the main organization for rescue and clean-up operations for the disaster, opened its own Twitter account (@JGSDF_pr) which immediately gained more than 100,000 followers.

During the initial exploratory stage, several YouTube videos that were posted within a few weeks after the disaster and comments that were posted within six months were collected and analyzed. Compared to other social media, YouTube has the attribute of persistence. This attribute allowed people to revisit the YouTube sites many times as they needed and to post comments even several months after the disaster. Because the collected data is relatively small, I adopted qualitative research methods, primarily document reviews. Qualitative research methods have gained popularity in various disciplines, including disaster research in recent years [12]. Using ATLAS.ti qualitative software, comments were open-coded and then categorized into several groups. Since I am fluent in Japanese, I skipped translating these comments into English. I directly placed English codes to the comments in Japanese on ATLAS.ti.

You Tube video – Let's rebuild together

In this section, I present an analysis of one of the YouTube videos that were uploaded immediately after the earthquake and comments posted at this site during the following six months. These comments reveal symbols and people's responses to these symbols. The comments also show how people tried to seek spiritual and emotional comfort and to reconstruct their cultural values and identities. This YouTube video demonstrates that social media can be used for purposes other than information dissemination and warning and response activities. Researchers can learn from these symbols in social media about the culture, history and the people in disaster areas and the nation.

This YouTube video is a one minute news video clip from a Japanese network television. Three seniors—one man and two women—had survived the tsunami by escaping to the third floor of a building. When they were rescued three days later by the Japan Ground Self-Defense rescue team, a news reporter asked the old man

if they were alright. This man responded with a big smile, “Yes, we are… We’ve lived through a tsunami from that Chile earthquake [in the 1960]… so, we’re alright… Well, **let’s rebuild all again!**” This news clip was posted on YouTube on March 12. This particular video site received over 2.3 million viewers and more than 3,100 comments. About 32 similar YouTube videos or videos which contain this phrase “Let’s rebuild together” were also remixed [9] and posted.

Among the comments posted to this YouTube site, higher occurrences of codes were identified as follows: 136 occurrences of the word or phrase “rebuild”, “let’s rebuild,” and “revival”; 127 occurrences of “Japan,” “Japanese,” “Japanese spirit,” and “proud to be Japanese”; 67 occurrences of “ganbarou”; 54 occurrences of “the word” or “one word” both of them imply “let’s rebuild”; 44 occurrences of “thanking to this old man” and 37 occurrences of “the old man’s smile.”

The majority of the comments were posted by Japanese who were not in the disaster areas. Yet, they were clearly shaken by the earthquake and tsunami because of the magnitude of this disaster. Some of them had either friends or family members in the disaster areas whom they could not get in touch with. These comments often show they were influenced by other people’s attitudes, words and actions which were strongly associated with their cultural value system. It could be the old man’s smile and the words “let’s rebuild together” that affected them These attitudes, actions and words needed to be shared with other Japanese who could comprehend the meanings of these symbols.

These comments were grouped into several categories, as described in the tables above. The comments posted at this YouTube video site were short and a number of categories and codes were relatively small. The majority of the people who commented at this site were encouraged by this old man’s phrase of “let’s rebuild” and his smile. The emotions identified in these comments are “moved,” “encouraged,” proud to be Japanese,” “cried,” “tearful” and “ashamed for being depressed or not taking action.” Some of the people who commented at this site connected the reconstruction era of Japan after WWII to this old man because of his age. Others posted that the younger generation would rebuild Japan after this disaster just like their older generation did. The phrase “let’s rebuild” is the most meaningful symbol at this video site.

One must caution that the majority of people who commented at this site were not people who were directly hit by the earthquake and tsunami. They were strongly impacted by the disaster due to its magnitude; therefore, they needed emotional and spiritual support. Nevertheless, these people will not need to endure months or possibly years to rebuild their everyday lives. People often tend to beautify disasters [5]. Some Japanese even declared that the earthquake helped them to

reflect on their troubled past decades and restart anew [8]. Researchers need to be aware that data collected from a variety of social media at different times may reveal different perspectives of the disaster, based on the degree of impact on human subjects caused by the disaster.

Categories – Example of Posts
Let's Rebuild – "Let's rebuild together! Wonderful word. I was encouraged."
Japan and Japanese - "I am proud of be Japanese, just like this wonderful person [the old man]"
Taking actions – "I was tearful when I saw his [the old man] smile. Since I do not live in the disaster area and live comfortably, I should be the one who encourage the people like him. Instead, I was encouraged by him… since I live overseas, I can not conserve energy or participate in blood donation, so, I donated money. I will regularly donate until the destroyed towns will be reconstructed…"
Old, experienced generation rebuilt Japan – "These people [like this old man] supported Japan after WWII. I like to believe this kind of spirit still exists in Japanese identity."
Young generation will rebuild future Japan – "Thank you, Granpa! Please live long until we rebuild Japan!"
Criticism to politicians – "The prime minister Kan could not capture the heart of Japanese despite he practiced his speech numerous times. But, this person [the old man] captured people' heart with one word. Speech without the spirit can not penetrate people's minds."

Table 1 – Comment Categories[1]

Symbols, culture, history and social media

One unique aspect of Japan is that abundant cultural symbols that exist because of its long history and the extensive use of social media.

First, I address the usefulness of collecting data in social media for disaster research. Researchers generally encounter difficulties in conducting fieldwork immediately after disaster events for several reasons. Their fieldwork may interrupt rescue and clean-up operations. Disaster survivors are not emotionally ready to talk to outsiders or do not even have time. Therefore, later in the emergency phase or early in the recovery phase is considered a better time to talk with survivors of disasters [14]. Because of the impromptu nature of social media, they can capture useful and unique data generated immediately after the impact of disasters.

[1] These comments are in Japanese and translated into English by the author

Second, I point out the significance of analyzing symbols that arise after disasters. Symbols carry specific meanings which may be passed from generation after generation in certain cultures; thus, symbols give insight to researchers to better understand certain national and regional cultures, the people and their history. One must carefully observe which symbols emerged and increased the number of appearances after disasters to find out its implications of these symbols.

Third, I address the importance of understanding national and regional culture and the history and characteristics of people who are affected by disasters. These factors should be well considered for design of future systems which are used in various stages of disasters, ranging from rescue and clean-up phases to disaster-preparedness and long-term recovery planning. Otherwise, these systems will not effectively support people of disaster regions. For instance, Japanese corporations and municipal governments have been considering to use a concept of smart city to rebuild the destroyed towns [16]. The concept of smart city may be relatively easily acceptable to the people in Japan and its various levels of governments even in rural areas since they are accustomed to rapid technological and social changes.

Conclusion and future research

In this paper, I presented symbols that emerged in one YouTube video site. The phrases “let’s rebuild” and “ganbarou” connote special meanings to Japanese culture and history. Symbols that arise immediately after disaster events provide insight in understanding the culture and history of the nation and region.

My future research will explore additional data in a variety of social media, ranging from YouTube videos, blogs and Twitter. In order to supplement the data from social media, I also plan to conduct interviews of people who experienced the impact of this disaster, after the one year anniversary of the disaster.

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InNEED: Managing Natural Disasters Through Community Self-Organization Using Mobile Technology

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Abstract. With recent frequency of natural disasters, a global ethos of pre- emptive crisis management and the development of resilient communities has become essential. Research in disaster sociology describes an organic process of community collaboration and resource sharing that occurs during and after disaster situations. InNEED is a survivor-driven system that functions through community mobilization. The design leverages mobile technology as a medium to build connectivity at a time when network infrastructure is not reliable.

Introduction

"Disasters will continue to occur. But their damage can be mitigated by relief efforts that are well-planned and executed in concert with the local population. Digital media technologies offer a unique opportunity to advance these goals with the right on-the-ground coordination." [1]

The surge of major natural disasters over the last decade have put into question existing natural disaster management systems and infrastructures worldwide. Current UN-led efforts seek to define comprehensive eco-systems that would enable resiliency through a combination of community and government

collaboration and technological innovation. The 2004 Asian tsunami, 2005 hurricane Katrina, 2005 Pakistan earthquake and 2010 floods and most recently the 2011 Japan earthquake make clear the need for advances in the theory, process and technology of natural disaster management.

This position paper presents InNEED, a design solution that approaches disaster management through the lens of disaster sociology [2]. Highlighting the potential of community collaboration as a tool for building resiliency, and with a focus on pre-emptive thinking, the system considers mobile technology as a tool to engage and empower the public to become part of the solution. This paper outlines the theory underlying InNEED, presents the research questions and design process, describes the current manifestation of the design, and our current questions.

Background

We considered multiple natural disaster case studies, particularly Hurricane Katrina and the 2010 Haiti Earthquake, in tandem with the technological innovations that surfaced during these times. We extensively looked at the Ushahidi platform [3], CrisisCommons [4] and Guarldy [5] amongst others. We analyzed these case studies through the lens of disaster sociology and attempted to identify the pros and cons of the systems. Our research made evident a gap in the relationship and coordination between the technologies used to mitigate disaster management, the institutions (governmental / non-profit) and the citizens. This realization led us to consider specific theories and case studies grappling to bridge the gap between the various players of disaster management.

Research in disaster sociology shows that ad-hoc organic processes of community building and resource sharing emerge at times of crisis [6]. In her recent book A Paradise Built in Hell, Rebecca Solnit describes at length how in the aftermath of natural and man-made disasters, individuals and communities band together to help each other [7]. This stands in contradiction with the commonly held belief of crowd panic, chaos and looting that is perpetuated by top-down organizations. Solnit, gives the example of the spontaneous cooperation and successful evacuation of Lower Manhattan during the September 11 attacks where nearly half a million people fled Manhattan on boats emphasizing the self-organizational ability of the community. Solnit argues for the recognition and nurturing of altruistic human behavior to create more resilient communities.

We were also inspired by current global discourses in disaster management and resiliency, particularly the UN's 2010 global awareness and implementation campaign *Making Cities Resilient*, which aims to raise consciousness and

commitment towards sustainable development practices to reduce disaster risk and increase the wellbeing and safety of citizens [8].

We therefore argue for a pre-emptive solution that enables bottom-up community collaboration using readily accessible technologies and infrastructure. Current disaster management systems place little emphasis on the engagement and empowerment of survivors even though research validates their contribution during times of disaster. Our design work was focused on addressing this lack of community involvement and resulted in a system that facilitates and leverages an organic process of survivor engagement post-disaster.

Design process

InNEED's 5-month design process incorporated theoretical and technical research, weekly brainstorming sessions, interviews with experts in the field and iterative prototyping. Prototypes were continually refined by reflecting on the unpredictable nature of natural disasters, the limitations of technology and current disaster management set-ups, and the uncertainty underlying community self-organization.

Our case studies and technological infrastructure scenarios highlighted the complexity and breadth of disaster management. However, we identified that basic survival, information dissemination and maintaining connectivity were among the most fundamental needs of natural disaster situations that could be supported by information technology. We therefore designed a service that would

- accelerate, facilitate and organize outreach,
- provide access to updated and pertinent information,
- mobilize a community by making it an actionable resource,
- use readily available technology, and
- be geographically pervasive

InNEED prototype

Leveraging everyday technologies, personal mobile devices are used at the point of disaster when there is little or no connectivity to the outside world. Reflecting on our design requirements, InNEED therefore consists of three main features: a *survival toolkit*, a *community profile directory*, and a *community message board*. During periods of limited or no internet connectivity, the system functions through the use of community base-stations comprised of a generator, router and server (e.g. a desktop or laptop computer). As Figure 1 illustrates, survivors use their mobile phones to access the key resources of InNEED. They use a map to locate base-stations in order to access network features like the message board. The

system piggy-backs on the mobility of persons between base-stations in order to share data across a wider area.

Figure 1. The InNEED system is comprised of strategically-placed base stations and a mobile application.

We elicited feedback from subject matter experts on both the conceptual and technical elements of the design, including researchers in human-centric computing systems, academics and practitioners in disaster and emergency managements and volunteers in disaster management non-profit organizations.

From these discussions, the following questions and opportunities for refinement emerged:

- How might we evaluate the robustness and utility of the concept as a disaster management system?

- What is the definition of 'community'? Is 'community the right word to use in this context? How is 'local' defined?

- What are the parameters of grassroots collaboration – what is the level of support and contributions envisioned? Outside of a disaster situation, what is the incentive for community members to participate in such a system?

- Will people really be using their cellphones during a disaster situation? How can we prove or rationalize this?

- Who is managing the application? If it is a grassroots initiative – who owns it? What are the privacy concerns in such a concept?

Understanding that the system would need to meet a certain level of robustness in order to be perceived as a legitimate preparedness system, we carefully considered these questions of functionality and reliability. We outline relevant details of InNEED's design here.

InNEED's System Functionality

Centralized information storage and dissemination. Despite the primary emphasis on a survivor-driven system, we envision that InNEED would require formal organizational support, to manage and coordinate logistics and infrastructure for most communities before a crisis occurs. This is to address fundamental differences between communities pre-crisis vs. in-crisis. An organization (likely governmental) consisting of personnel with disaster response and emergency training would be responsible for holding and protecting personal information provided by community members through a voluntary opt-in mechanism. This organization would work in close collaboration with local and international emergency organizations to determine what information should be released to the public (depending on the disaster type), and at what point of the occurrence of the disaster.

Predetermined base stations. In order to ensure substantial network coverage, the locations and provisioning of network nodes or base-stations would be determined in advance, and likely housed in strategic locations such as community centers, schools, etc.

Mobile interface. InNEED's system leverages the ubiquity of cell- phone devices and their potential versatility at times of crisis. Therefore, the system's mobile application would be pre- downloaded and installed on neighborhood member's cell-phones devices. In order to make the system accessible to people who may not have subscribed before the occurrence of a disaster, a web-based mechanism will be available to users.

Robustness and Usability

To assess robustness, usability and privacy questions we implemented a functional prototype. The outline below walks through two hypothetical scenarios outlining the multi-layered functionality of the system and its application in a disaster situation.

InNEED Hypothetical Scenario #1

Consider two fictional characters John, who works in neighborhood X and Mike who works in neighborhood Y. Both John and Mike are members' of InNEEDs'

system and have pre- downloaded and installed the mobile application on their cell- phone devices. Since InNEEDs' base stations have been pre- determined and set-up in various locations through the city, when an earthquake or any disaster situation occurs, through organizational efforts and community collaboration, the system goes online.

In order to maintain privacy, the system has been designed such that it sends a key code to its members only when a disaster situation has been declared. When entered into the application, the key code enables John and Mike to access the previously locked database of member profiles and community message board.

Figure 2. A key code is sent to the members to unlock the system.

InNEED's system leverages the brief moment of connectivity that is available during disaster situations before infrastructure collapse. Through GPS technology, the application is able to gather and provide key information to its users including member locations and their online / offline status. At this point, John and Mike get an aerial snapshot of the nearby community and are able to benefit from and provide multiple levels of information.

Figure 3. Levels of information include online / offline status of members, map of base stations and up-to-date GPS location of members at time of disaster.

In our hypothetical scenario, John is anxious to get back home to his family and is looking for a ride. Once he is logged into the system, he accesses the community message board and posts a message requesting for a ride in the direction of his house. His message is stored in the database of neighborhood X where he works.

Figure 4. John posts a message on Neighborhood X's message board.

While he is waiting for a response, John starts to look for alternative help. As he walking through the city, he enters into the vicinity of neighborhood Y and is able to connect to their base- station network. The data that he is carrying from neighborhood X's community message board gets transferred to neighborhood Y's network. This allows Mike to see John's message. Mike is able to send a direct ping to John, letting him know that he can give him a ride.

Figure 5. Using the community message board, Mike sends a direct message to John.

InNEED Hypothetical Scenario #2

InNEED's mobile application can be used and accessed in multiple ways; the following scenario considers Patrick, a chef by occupation who lives in neighborhood M. After the earthquake, Patrick realizes that he has both the ability and the resources to open a soup kitchen for his neighborhood. At this point, Patrick does two things: updates his member profile by listing himself as a food provider and posts a message on Neighborhood M's community board announcing that the is serving food at a certain time and location.

Figure 6. Patrick updates his member profile.

Figure 7. Patrick posts a public message about his soup kitchen.

Prototyping through multiple scenarios allowed us to clearly identify the subtleties in the levels and types of personal data that would be useful in disaster situations. It also made evident the malleability of the data based on the type disaster at hand. For example, Patrick is perhaps only able to set up a soup kitchen in / nearby his house because the road infrastructure is still intact. In the case of a flood, the opportunity may not have been there. Or for example, John was able to post a message on the community board shortly after the occurrence of the disaster only because the severity of the earthquake did not damage the base station near his office building. If the disaster would have damaged the network node near his location, he would have had to go look for a working network in the city to get connectivity.

Workshop Questions

Our refined design was presented to two panels of design experts, the first in the Design Exchange in Toronto, Ontario in April 2011 and the second at the annual Microsoft Research Design Expo in Redmond, Washington in July 2011. The project was well- received. Feedback largely reflected three areas we identify as discussion points for the workshop, *robustness* and *privacy*.

Robustness. Suggestions were made to integrate other networking approaches such as ham radios and ad-hoc mesh networks to expand the networking potential during times of collapsed infrastructure, and to further consider how the system might gracefully degrade, for example as generator power becomes unavailable. Robustness is a concern in a more general sense as well, in terms of the range and severity of disasters a system like inNEED can help to address, and adapting to varying levels of community involvement and preparedness in different areas.

Privacy. The issue of personal privacy before, during, and after a crisis was acknowledged as needing further research. While our design emphasizes controlled and localized access to another person's personal data only when it is contextually relevant to a crisis, it introduces privacy concerns and a potential risk

to personal security. Related to this is how to encourage opt-in before a crisis occurs, and how to permit opt-in after one has occurred.

Conclusion

In conclusion, we envision InNEED as a bottom-up, collaborative solution rooted in disaster sociology research. The system finds a niche within the ethos of self-organization and resilience and bridges the gap between pre-crisis and post-crisis disaster operations. Through calculated and timely technological innovation, the design solution aims to build a pre-emptive system that aids in natural disaster management through community led initiatives.

Acknowledgments

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Social Media for Supporting Emergent Groups in Crisis Management

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Abstract. The great importance of Social Media for our today's life causes an increasing use of internet-based platforms in crisis situations. Our work intends to show how so-called Emergent Groups, which arise as a result of crises, consist of private citizens and are not yet institutionalized organizations, can be supported by Social Media. At first, our litera-ture review's objective is to define the term 'Emergent Group' and to outline their usage of Social Media as well as software-based requirements and suitable concepts to sup-port such groups. A following quantitative and qualitative empirical analysis of a tornado crisis in the USA enables a closer look at especially virtual working Emergent Groups. Building on our literature review and empirical analysis, we discuss implications, derive further requirements and present a concept for the design of appropriate Social Soft-ware. We finally conclude by giving some potential re-search issues.

Introduction

Crises, whose magnitude can be so large that public authorities and rescue forces are overwhelmed, occur regularly. The Japanese earthquake and tsunami 2011 is a striking example for that. Particularly in these situations, it is important that the people affected have the ability to help themselves. The many capabilities to interact which are provided by Web 2.0's Social Media, can stimulate collaborative crisis management by citizens. "*Emergent groups can be thought of as private citizens who work together in pursuit of collective goals relevant to*

actual or potential disasters but whose organization has not yet become institution-alized" (Stallings & Quarantelli 1985). The fourfold typology of the Disaster Research Center (Figure 1) indicates that these groups emerge in order to manage new tasks with the aid of new structures. They have the ability to start from scratch and define its tasks in accordance with the interests of the group members.

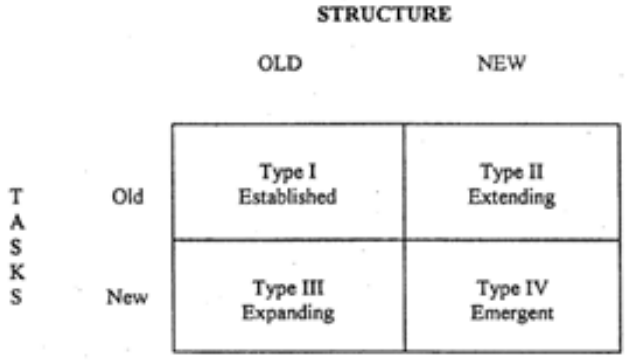

Figure 1: DRC Typology (Quarantelli 1995)

Emergent Groups - which correspond to the term 'Self-Help Communities' (Figure 2) - represent communication relationships between private citizens who are not part of the official crisis management's organizations.

Figure 2: Communication Matrix for Social Software in Crisis Management (Reuter et al. 2011)

Use of Social Media by Emergent Groups

Nowadays, Social Media is widely used by private citizens collaboratively coping with a crisis. As it is common to distinguish between real and virtual communities, a distinction between real and virtual Emergent Groups seems reasonable. Virtual Emergent Groups originate in the Internet and mainly carry out

their activities online, whereas real Emergent Groups use the Internet as a potential supportive resource among many others. The following literature review illustrates how Social Software is used by both real and virtual Emergent Groups. The studies are categorized in four chosen types of Social Software which are frequently mentioned in research papers.

Microblogging is a widespread, internet-based interaction tool. The most popular Microblogging-Platform is Twitter. Because of its simplicity, its prevalence and the option of mobile use, Twitter is a relevant Social Software in crises (Reuter et al. 2011). Studies show that Microblogging is used for collecting and distributing information, communicating, answering help requests (Starbird & Palen 2011), serving as resource for situation updates (Vieweg et al. 2010), coordinating actions, exchanging opinions and emotionally coping with a crisis (Qu et al. 2011).

Social Networks are a more complex form of internet platforms. They enable its users to connect with each other and provide a great variety of interaction tools. The most popular Social Network is Facebook with over 800 million users worldwide. Social Networks are intensively used to create collective intelligence, serve as information source and contain quality control mechanisms (Vieweg et al. 2008).

Wikis are an additional alternative for supporting people affected by a crisis (White et al. 2008a). They are especially useful when creating collective intelligence but have deficits in the aspects of communication and, as a consequence, of coordination. 'Scipionus' is an example for a crisis-related wiki. It deploys a visual interface which allows its users to publish and edit information on the Google Map Interface (Palen et al. 2007)

Crisis-related internet platforms, which are specifically customized for crisis management, can be seen as a fourth type of relevant Social Software. 'Sahana' is an example for such a platform which has already been used in several crises. It addresses "the common coordination problems during a disaster from finding missing people, managing aid, managing volunteers, tracking relocation sites, etc. between government groups, the civil society (NGOs), and the victims themselves" (Van de Walle & Turoff 2008).

Requirements and Concepts for Software-based Support

The ways of using Social Media mentioned above provide insights into the areas of requirements for software which is able to support Emergent Groups.

The usage of wikis shows the need of citizens to collect, find and distribute *information* during a crisis. At this, meta-information such as context, validity, source, credibility, and timeliness (Palen et al. 2010) as well as the existence of a given structure to manage information is essential for reducing information overload. Palen et al. (2010) present an 'Information Integration Landscape', whose core task is to collect information from the Internet, to add meta-data and to structure and visualize information in order to make it accessible. Starbird and Stamberger (2010) propose the use of a particular hashtag-syntax for tweets during crises. A standardized hashtag-syntax would be machine-readable and could help to collect more relevant information.

Social Software is not only used as information- but also as *communication*-platform via public forums or peer-to-peer-communication. Communication is vital for generating information, emotionally coping with a crisis and coordinating activities. In this area, capturing the group's will out of various topics and opinions is a big challenge, which especially becomes necessary when it comes to decision-making. White et al (2008b) suggest a 'Dynamic Delphi' system which enables its users to develop, discuss and vote on ideas in an iterative process.

Activities of *coordination*, which can be observed on Twitter or Facebook, exhibit a third area of requirements. Be-cause of the strong need for coordination in the case of collaborative self-help activities and its high complexity, this area seems to offer major support potentials. Jaeger et al. (2007) have developed a so-called 'Community Response Grid' which facilitates resident-to-resident assistance. Bui and Tan (2011) present a template-driven processing embedded in a workflow system.

Stress and time pressure due to the crisis situation and its usage by amateurs make an *intuitive design* of a Social Software essential. An iterative design process including potential users is to be recommended. Newlon et al. (2009) have developed an interface-prototype on which all relevant areas are visible at a glance.

Virtual Emergent Groups are especially involved in the area of information in which collective intelligence is created. Real Emergent groups particularly require the area of coordination.

Case Study: Use of Twitter during the Tornado Crisis in the USA on April 27./28., 2011

Twitter is applicable for studying virtual Emergent Groups because it is intensively used during crises and the communication of its users takes place publicly. Starbird et al. (2010) present four different types of information: generative, synthetic, derivative and innovative. So-called 'retweets', which are re-published tweets written by another user, match the derivative information. They can be seen as a recommendation system for information and authors (Starbird et al. 2010). The following empirical analysis aims to focus on the functioning of - especially virtual - Emergent Groups which use Twitter as a working platform.

On Wednesday, April 27, 2011, and on the following day, 211 tornados were registered in the USA. High damages on people (more than 340 died) and material damages on houses, streets and cars were reported. The data collected dates from Thursday when several tornados, tornado warn-ings and tornado watches were active and relief forces searched for dead people and survivors in many cities. In this time, the existence of Emergent Groups is very likely. The data was collected with the aid of 'The Archivist' which uses the Twitter Search API. Our search keyword was "tornado". 79,318 tweets were accumulated which were published between 12:17 (EDT, 2011/04/28) and 03:16 am (EDT, 2011/04/29) and written by 59,282 different users. Information about the user name, the publishing date, the recipient, and the tweet type is available.

Preliminary Results

The following analysis part intends to categorize users, who are actively involved in crisis-related self-help activities on twitter, into different user-types in order to figure out which kind of users a Social Software for Emergent Groups has to support. The relevant criteria are the behavior of the users and the content of their tweets. Because we wanted to ex-amine the most active users on twitter, we analyzed and allocated those 'twitterers' who published most tweets (41 users, 1982 tweets, 2.50% of all collected tweets) and were retweetet the most (51 users, 7742 retweets, 22.32% of all retweets).

The analysis provides four types of users which are given following names: the reporter, the retweeter, the repeater and the helper. As the categories are not disjoint and users can belong to more than one of them, the sum of their percentage is over 100%.

Type name	Characteristic	Task	%
The reporter	Is often retweeted	Generates information	68
The retweeter	Publishes many tweets	Distributes information	16
The repeater	Publishes many tweets	Spreads a message	19
The helper	Is often retweeted and publishes many tweets	Involved in help activities	28

Table 1: Types of twitterers

The *reporter* makes sure that information enters the twitter-space and provides generative, synthetic and innovative information. They often correspond to organized news channels, which per definition cannot be part of an Emer-gent Group and can rather be seen as intermediaries be-tween such groups and the official crisis management. Eyewitnesses, who report about the crisis on the Internet and are an important component of an Emergent Group, as well belong to the category of reporters.

Many users concentrate on retweeting information, which was brought in by the reporters, and are called *retweeters*. They produce derivative information. Their task is to distribute the most important information (e.g. emergency appeals, warnings, news, photos) inside the twitter-space.

The *repeater* possesses only one or very few main messages (e.g. charity appeal, political opinion) which he wants to make known to many twitter-users. That's why they repeat the message again and again. A popular method is to write to prominent twitterers who have a high number of followers in order to win the attention. They provide generative as well as synthetic information which they then try to distribute.

The *helper* is the kind of twitterer who is involved in various helping activities and can be especially distinguished by their tweet-content. They make emergency appeals, show ways of donating clothes or participating in search and rescue groups, give advice about correct behavior or emotionally support victims. Participants of real Emergent Groups use twitter to publish their status and belong to the category of helpers, too. Helpers are less fixed on information processing, but are more involved in communicating, connecting with other people and coordinating activities.

The categories presented here show typical and definable ways of using twitter as a social platform in crises. The analysis reveals that every twitterer, who is particularly active within a crisis, can be matched to at least one of the categories mentioned above.

Discussion

The objective of a Social Software for Emergent Groups should be to support the members of both virtual and real Emergent Groups in their common procedures and behaviors. Because such groups have positive effects on crisis management, their existence should be promoted by appropriate software. The connection of virtual groups, which increasingly emerge, and real groups, which work locally, could create synergetic effects. The identification of types of twitterers is mandatory for this effort.

Besides the four areas of requirements (information, communication, coordination, intuition), further areas can be added: In order to generate synergetic effects between virtual and real communities, *internal connections* between these two types have to be considered. The cooperation between Emergent Groups and the official crisis management could be fostered by finding *external points of intersection* between them. *Promoting the existence* of Emergent Groups can be stated as a further area of requirement.

We designed and implemented a first prototype of a social platform for citizens, which helps them to organize them-selves in local crisis situations, and evaluated its usability. Challenges are aspects like improvisational practices (Ley et al. 2012), the different use of terminologies (Reuter et al. 2012) or different approaches of aggregation of information in different scenarios (Christofzik & Reuter 2013). The resulting design concept can be visualized as in following figure:

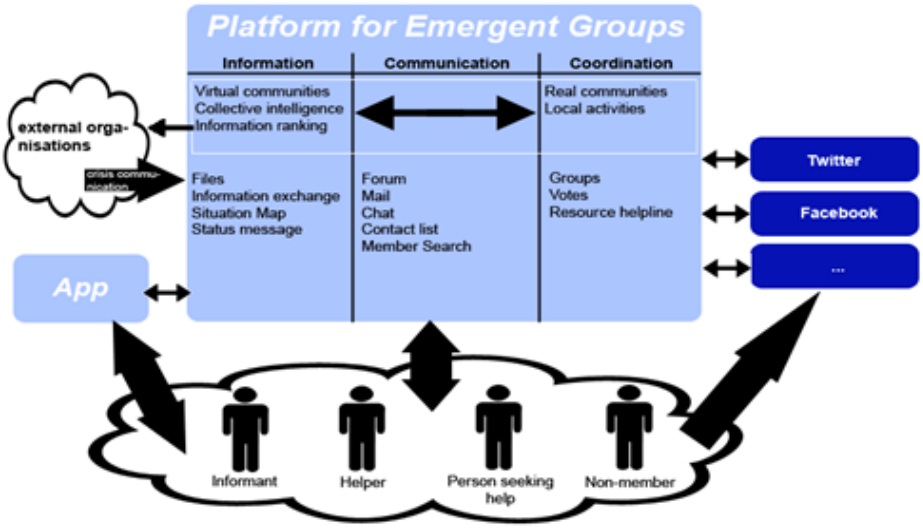

Figure 3: Design concept of a Social platform for supporting Emergent Groups in crisis management

Conclusion

Our work seeks to examine the internet-based functioning of virtual and real Emergent Groups and has stated seven different areas of requirements for its software-based support. We have designed, implemented and evaluated a prototype of a social platform which plans to support both types of such groups as well as to promote their existence.

Our work shows a number of potential research issues in the area of supporting Emergent Groups with the aid of Social Media. Improving the implemented platform in an iterative process including potential users (in particular the types of users we identified) and further studies about real and especially virtual Emergent Groups could improve the knowledge about their functioning and reveal further support potentials. The seven areas of requirements mentioned above (information, communication, coordination, intuition, internal connections, external points of intersection, promoting the existence) offer potentials for deeper research and suitable software concepts. For instance, interfaces between a social platform for Emergent Groups and popular Social Networks (such as Twitter or Facebook) should be found in order to increase the acceptance and usage of the platform by designing it as an integrative component of the common procedures. Increasing the acceptance would automatically shift the focus on an adequate marketing strategy and on promoting the existence of Emergent Groups.

Acknowledgments

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Work and reflection in crisis informatics

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Abstract. Our research focus is on the design of systems that can be used to support reflection on action in the context of crisis management. In particular, we are interested in discussing issues at the intersection between cooperative work and cooperative learning in crisis situations. Our contribution is based on initial user studies we have conducted with Italian emergency organizations and the development of a Mobile Augmented Reality browser that we have developed for supporting crowd management.

Introduction

Our perspective on crisis management stems from our research on support for reflection. More specifically, we are interested in learning that is based on experience and that is highly situated in specific social and physical contexts.

Learning is recognized as an important aspect of dealing with crisis. This might include training of emergency personnel, training of volunteers, training of citizens for preparedness and, more recently, to make them more active participant in crisis management, especially considering the growing space of possibilities offered by social media [1].

In our research we focus on learning, and more specifically on reflection on action [2], based on revisiting experiences with the goal of learning. We believe that this is an important complement to traditional training because crises are rare events

and it is important to learn from each single occurrence. Despite protocols are carefully designed, each event is highly situated and might lead to unexpected situations; individuals might react differently than expected; teams might inter-act differently than planned; …

Reflection can help workers, and their organizations, to improve their crisis preparedness and learn how to perform better in the future. Debriefing session with emergency workers gathering together are often the venue to do collaborative reflection, but they need to
be fed with information useful to trigger reflection. This is challenging because crisis work is highly distributed (in time, space, competencies, roles, …) and it is therefore difficult to capture the relevant data, accounting for multiple perspectives. Focus is often on organizational level, neglecting citizens and workers on the field, while giving them voice might lead to important lessons learned.

To support debriefing and reflection we have developed CroMAR [3], an App running on iPad2 for supporting reflection by allowing exploration and cooperation around information generated during a large event. Interaction is based on mobile augmented reality (see attached figures).

CroMAR: Supporting reflection on crisis

In CroMAR, information is organized around the geographical location(s) where an event has taken place. Mobile Augmented Reality is then used to visualize the information *after* the event to reflect on it. Mobile Augmented Reality represents an interesting alternative to other types of information visualization, e.g. timelines or tag clouds, because it can be used to promote reflection in the specific location of the event by augmenting it with relevant information. In this way, we can expect the reflection process to be naturally grounded in a context that helps to make sense of the information and reflect on alternative paths of action. Though the system has functionalities that might be relevant for reflecting on any working experience with a strong physical nature, the system has been specifically developed for reflection on emergency work, in particular in relation to crowd management.

Crowd management involves a number of actors with different roles. Since discrepancies are important triggers for reflection, information visible in CroMAR comes from different sources in order to highlight different point of views of an episode, e.g. textual and multimedia tweets from citizens, data from supporting applications, sensors (attach.- Fig. I). In our perspective, the creation of the

information necessary to promote meaningful reflection and learning is a highly collective process.

We also look at reflection on the event as necessarily cooperative. To promote cooperation and reflection, CroMAR provides different modalities of navigation (attach.- Fig. II); the possibility to tag available information, to start video calls, to share specific views with other workers via email (attach.- Fig. III). We are also currently implementing collaborative editing of lessons learned during a reflection session.

Food for thoughts

At the workshop we are interested in discussing the relation between reflection and work, and on how participative reflection can lead to an improvement of practice.

What is the role of reflective learning in crisis work? How do we promote reflective practices? How can we assure that reflection leads to improved practices? This requires going beyond the predominant approach that looks at reflection mainly in terms of debriefing sessions and with an organizational perspective

Fully acknowledging the highly situated and distributed nature of crisis work, reflection must be also situated and must seek for the participation of multiple actors. We need to understand better which are the actors that under different circumstances can bring in relevant perspectives. How can they be motivated to join the process? How can they share their experiences considering their different perspectives? How do the necessary sense-making processes unfold and can be supported? Which forms of cooperation can support participation and knowledge construction?

Reflection can be supported with data that help recalling the experience in more details than one remembers. For multiple reasons, collecting this data might be challenging. For example, an ethnographic study among Swedish fire and rescue service workers has shown, as reported in [4], a limited use of formal documentation. The study also reports that much documentation is generated outside the official systems and on different media (computer, blackboard, pen and paper). In general, fragments of information come from actors operating in different contexts to achieve different goals. They are pieces of a puzzle that must come with an embedded context that allow setting them together in time and space to be compared, clustered, layered, shared and re-used across multiple representations. Pieces of information should not be seen in isolation, but as part

of a *Common Information Space* that supports reflection on the practice. In this perspective, the system should be able to support sense-making processes to allow meaningful action. This is relevant not only for reflection, but more in general for supporting work.

Citizens are an important, often neglected, source of information. As pointed out in [1, 5, 6], citizens not only report general information on what is happening during a certain situation, but they also actively provide information that is relevant for the operations. Citizens' contributions are also important for reflection because they bring in different perspectives, grounded in the territory, and provide input on how action has been perceived. How can citizens be motivated to provide information? How can they be trained to provide relevant information? Again, these issues are relevant for both work and reflection.

Reflective learning is often associated with creativity because it increases the capability of workers to think critically to their work and act differently in the future. What is the role of creativity in crisis management when people have to work under rigid protocols and the limited knowledge of each worker might make any unconventional decision dangerous?

Finally, crises are strongly situated in physical spaces where different organizations such as ER units, firefighters and the like, co-habit and co-operate. Multiple places can be associated with these spaces, shaped by the ongoing practices, often crossing organizational boundaries. The leading assumption behind the design of CroMAR is that these places are critical in supporting work and reflection. Crisis informatics can benefit from the understanding of places gained in CSCW, while enriching the current conceptualization.

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Call for Open Humanitarian Information

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Abstract. In this paper we describe the need for open data sharing amongst the humanitarian community.

Introduction

To effectively respond to major disasters, the response needs to be coordinated between the large numbers of response organizations. The key to effective coordination is access to the right information. Without a common operational picture the coordination becomes at best ad-hoc.

Attempts by the humanitarian community to coordinate the chaotic environment that follows sudden-onset disasters such as earthquakes or tsunamis have in many cases failed to be successful. Both real-time and post-disaster evaluations of large scale disasters in the last few years all point towards lack of information sharing between organizations as one of the key reasons for the lack of ability to effectively coordinate the response.

A few years ago when a response organization was asked to share information openly with another organization they often pointed towards lack of connectivity as a reason for not being able to share information easily. This lead to information simply being shared at the document level – through situation reports or maps where only the resulting data was shared – often in paper format with other agencies.

Advances in connectivity options as well as increased resiliency of mobile networks has lead to the "connectivity excuse" to no longer be relevant, yet we are not seeing organizations sharing beyond the document level. A shift in policy is required to push response organizations to share information more openly with other response organizations.

This paper discusses the need for an initiative that focuses on bringing the concepts of open data to the humanitarian information community. It will discuss the reasoning behind the need for such an initiative and also what the benefits of such an initiative would be.

It is important to state from the beginning that when discussing opening up and sharing data, this does not include sensitive and privacy related data, only operational data that can be utilized to achieve a common operational picture.

Open Data

One of the bi-products of the Freedom of Information Act in the USA was to provide free public access to federal data. Most of the states and local governments also implemented similar policies and that in turn lead to their data to become available for free to the public. Similar efforts in other countries also lead to the same policy change.

It was however only in the last few years, with the growth of data centers in the cloud that this public and free data became easily available. As the cost of making these large public data sets available became lower, more and more datasets became available online. At the same time the call for more transparency within governments lead to President Obama to launch an Open Government Initiative in January 2009 [1]. This initiative was then supported with the launch of the website **data.gov** that contains today over 390,000 datasets [2].

This push for transparency and openness was not limited to United States only and on September 20, 2011 the Open Government Partnership was formally launched, with 8 founding governments (Brazil, Indonesia, Mexico, Norway, Philippines, South Africa, United Kingdom, United States) endorsing an Open Government Declaration, and announcing their country action plans. This was complemented by the commitment of 38 other governments to join the Partnership [3].

At the same time there has been a push, both from donor governments and non-profit organizations to push for increased transparency and openness in development and humanitarian aid [4,5,6,7,8,9]. Most of these initiatives have

however focused on the financial aspects rather than the operational aspects of the humanitarian response.

Open Humanitarian Initiative

To meet the need for increased information sharing between humanitarian response organizations, there is a need for a broad ranging initiative that includes all the different participants in the humanitarian response system.

NetHope, a consortium of 34 of the leading international non-governmental organizations (NGOs) in the world has worked on bringing together those different participants around what is being called the Open Humanitarian Initiative (OHI). This initiative has the following main objectives:

- Improve information sharing amongst humanitarian organizations.
- Improve information management capacity both within humanitarian organizations as well as within governments in disaster prone countries.

In order to improve information sharing it is essential to:

- Increase the willingness to share information by showing humanitarian organizations the value they receive when information is shared.
- Drive a policy shift within the humanitarian community towards open data.
- Drive for standardization of how humanitarian data is represented during data exchange.
- Provide a common platform for sharing humanitarian data.
- Ensure the capacity to share, manage, analyze and disseminate humanitarian data is sufficient, both at the national and international level.

It is important that this new initiative focuses on all of these efforts since if one or more of these things are not addressed then the other efforts will not achieve the desired result.

It is also important that this initiative does not start from scratch, but rather builds upon other efforts already underway such as the various Open Aid initiatives mentioned earlier [4,5,6,7,8,9], the Common and Fundamental Operational Datasets Registry from OCHA [10], Open Data for Resilience Initiative (OpenDRI) from World Bank's Global Facility for Disaster Risk Reduction and Recovery [11] and the Humanitarian Exchange Language [Hendrix, personal communication].

Bringing everyone together

The most complex part of making an initiative like this successful is bringing everyone together and gets them to support a common vision. It is important that the initiative brings together all the different participants in the humanitarian system, such as the donor community, the response organizations, the research community, the private sector community as well as the digital volunteer and technology community.

Through a common theme like Open Data within the humanitarian community it is possible to break down the silos of information and start sharing non-privacy related humanitarian data. The response organizations most focus on collaboration instead of competition when it comes to information.

Once this data becomes openly available it is then possible to leverage the powers of mass-collaboration (a.k.a. crowdsourcing) and leverage the networked intelligence of digital volunteers that are passionate to help out in times of crisis.

Willingness to share

Humanitarian donors need to start pushing a policy of openness towards those organizations that they fund. At the same time humanitarian organizations need to have a change in mindset when it comes to the willingness to share. This change in mindset is best achieved by being able to show them the value of sharing that data. In order to show that additional value we need to have the ability to quickly leverage that open data to perform analysis and then disseminate it together with other shared data to provide actionable information that helps the response organizations do their work more effectively.

We must also help governmental disaster management agencies to lead efforts in their respective countries in opening up the data they work with. This work needs to leverage funding options and capacity building efforts that are already part of the Open Government Partnership.

Common Platform

It is time that the humanitarian community stops sharing documents, such as situation reports and PDF maps and start sharing data at the granular level, so that it can be transformed, analyzed and visualized in different manners. It is time for a cloud based, occasionally connected, common, freely available humanitarian data platform that has open APIs and shared data exchange standards.

It is also essential that the private sector takes a leading role in providing a platform like this to the humanitarian community, because most of the technology components required for such a platform already exist.

Information Management Capacity Building

Recent large-scale disasters, such as the Haiti earthquake and the Pakistan floods have shown that there is a lack of overall information management capacity worldwide to deal with the explosion of humanitarian data. It is important that we look both at short and long-term solutions for increasing this capacity. It is especially important that we focus on increasing this capacity in disaster prone countries

In the short-term it is important to provide one- semester university level courses in practical humanitarian information management to be delivered in disaster prone developing countries. These courses can have as a by-product a practical element that allows for collection and maintenance of core and fundamental operational datasets for the countries the course is run in.

Additionally there is a need for the creation of a training program for humanitarian organizations and national disaster management agencies in information management.

In the long-term there is a need to create globally recognized degree programs in humanitarian information management. Openly and freely available under-graduate and post-graduate curriculum should be created to support these degrees being offered, especially in disaster prone countries.

This capacity building effort needs to be created in collaboration with leading universities and humanitarian organizations and the target focus should be towards improving this capacity in disaster prone developing countries.

Conclusion

In order to successfully make a giant leap forward in how information is being shared within the humanitarian community, it is essential that all the parties involved stand behind an initiative like this.

Through a joint collaborative effort, it is possible for us to bring the humanitarian system into the information age and improve our response and thereby save lives and alleviate suffering.

Acknowledgements

NetHope thanks all those that have already voiced their support for the Open Humanitarian Initiative and those that have given feedback on it during its conception.

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Brainstorming for Japan: Rapid Distributed Global Collaboration for Disaster Response

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Abstract. With recent frequency of natural disasters, a global ethos of pre- emptive crisis management and the development of resilient communities have become essential. Research in disaster sociology describes an organic process of community collaboration and resource sharing that occurs during and after disaster situations. InNEED is a survivor-driven system that functions through community mobilization. The design leverages mobile technology as a medium to build connectivity at a time when network infrastructure is not reliable.

七転八起

Fall down seven times, get up eight. -- Japanese proverb

Introduction

The people of northern Japan suffered a series of cascading disasters beginning 11 March 2011: an earthquake leading to a tsunami, followed by human and technological emergencies on a massive scale. More than 13,000 people were killed, and more than 300,000 people were displaced. Damage from the tsunami led to a crisis at the Fukushima nuclear plant. Millions of Japanese, nationwide, were without power. A series of secondary and tertiary problems resulted in a

months-long crisis for Japan, with spreading societal, commercial, and financial impacts around the world.

Figure 1. Employees participated from 45 countries. Darker colors indicate more participants. Stars show the 23 countries from which employees made visible contributions. A few smaller countries are omitted for visual clarity.

Many people, nations, and organizations around the world responded with food, supplies, money, and people's time, labor, and expertise. This note describes one response in detail: the use of social media to develop ideas for response by employees in IBM, a multinational company. We intend this note as a "case," rather than as a formal CHI analysis. We will tell the story of the collaboration, connect that story to Related Work in CHI, CSCW, and related fields, and close with proposed topics for future research.

Palen et al. called for a vision of Information and Communication Technology (ICT) to support public engagement during emergencies [7]. In this work programme, they have documented ways in which "people are developing new practices for emergency responding, using ICT to address problems that arise from information dearth and geographical dispersion" in online communities that are defined in social rather than geographic terms [11]. They called for new designs and services that can increase citizen participation ([7]; see also [1]). Carver and Turoff argued for systems that support creativity and improvisation during emergencies [2]. Online communities are already doing this kind of work, often in a voluntary manner whose motivation has been described as "altruistic" [5,11]. Among these communities, online forums appear to be key resources [8]. In this note, we expand the scope of online communities and forums, and their types and manners of participation or contribution during emergencies.

Brainstorming for Japan

Like many people and organizations of good will, IBM acted to support the citizens and government of Japan in the early hours of 12 March, contributing technology, services, and consultation. After several weeks of intense relief work, managers at IBM began to discuss longer-term responses and proposals. They

decided to convene a voluntary brainstorming activity for employees called the Japan Forum.

Using IBM Connections, a commercial social media product, the managers created an online community for the brainstorming. In the discussion forum of that community, they posed four topics for discussion; the large response by employees allowed them to expand this list to seven topics.

Brainstorming at IBM

Employees were accustomed to conducting remote, online, asynchronous brainstorming sessions (forums) for small groups (10-500 employees during a customer engagement), medium sized groups (500-10,000 employees discussing a market segment, in some cases with client participation), and company-wide discussions (100,000 or more employees, business partners, and clients, working on new business concepts [4]). Common attributes were as follows:

- Forums were conducted in environments which supported tree-structured text-based discussions.

- Each forum addressed assigned topics.

- To create a sense of urgency, each forum had defined date/time limits. In the medium and large groups, these limits were enforced by the software, which did not allow participants to log in before or after the specified time. In the smaller, informal sessions conducted on IBM Connections, the limits were indicated but not enforced.

- Each forum had open registration to all employees and contractors. The larger forums had open registration for business partners and/or customers. The contents of the forum could be observed by anyone who had registered.

- At least 95% of participants in each of the forums were volunteers. A small core team established the problem(s)- to-be-addressed, and members of the core team modera- ted the forum as it took place. Often, an extended team of subject-matter experts was invited to participate; their participation was not mandatory. Any member of a forum was able to invite colleagues to join, and in practice many of the participants were in this peripheral group of com- pletely voluntary, socially-invited contributors.

Participation was thus a dynamic activity, driven by personal interest and passion. In the Discussion, we will return to themes of interest, practice, and volunteering.

Post-forum analysis was typically done by staff with specific skills. For the smaller- and medium-sized forums, the analysts were usually members of the marketing team who had organized the forum. For the company-wide forums, a team of specialists would work for hundreds of staff-hours on many thousands of contributions.

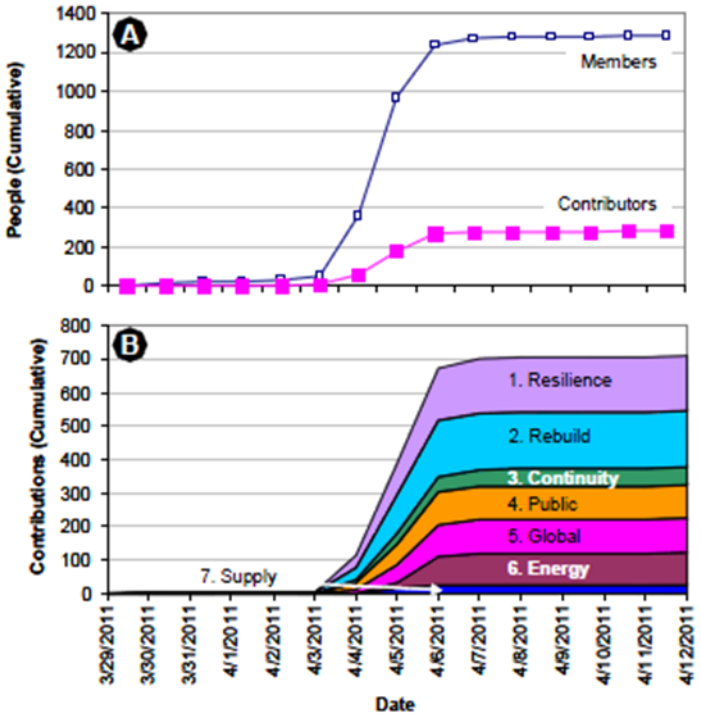

Figure 2. A. Growth of members and contributors during the forum. B. Growth of contributions in each of the seven discussion topics.

Conducting the Japan Forum

The Japan Forum was begun in the manner of a customer engagement. People in diverse organizations, who had a shared interest in emergency response, were informed of the forum, and were invited to recruit their colleagues. As we will show, the urgency of the situation led to a much larger response than a typical 100-person customer- engagement forum, with interesting outcomes.

The planners initially proposed four discussion topics: (1) Increasing resilience of Japan to future problems; (2) Leveraging technology in rebuilding; (3) Continuity planning; and (4) Addressing public perceptions. Three additional topics were added during the forum: (5) Engaging global support; (6) Managing energy consumption; and (7) Improving health and food supply chains.

Quantitative Results

Participation and Contribution. The Japan Forum was announced via an email appeal to several thousand employees, and it was featured on the IBM intranet homepage. At least some of the recipients informed additional employees. The day before the official beginning of the Forum, 47 people had registered. Four days later, at the conclusion of the Forum, 1250 people from 45 countries had registered (Figure 1). Among them, 275 people (20%) from 23 countries had made at least one contribution, for a total of 701 discussion responses (range: 1-68 responses/ person, median=1), during the three days of the Forum. The timeline of contributions is shown in Figure 2, which includes post-forum analytic contributions during the weeks after the conclusion of the forum.

Participation followed a long-tail distribution, with 135 people (52%) making more than one contribution, and only 37 people (14%) making 5 or more contributions. We note that 78 contributors (30%) wrote responses on more than one day. Thus, participation was global, with more than a quarter of the participants showing sustained interest.

Lurking. Like most commercial systems, IBM Connections recorded only active participation, with no record (other than membership) of the 1011 non-contributing participants (i.e., "lurkers"). We assume that they took an active interest, because they took the time to join the community – an effort that was as voluntary as contributing. See [6] for a discussion of how lurkers transport information from a lurked resource into active use outside of that resource.

Social Network Analysis. Except for the organizers who proposed the topics, each of the visible participants created a response to another person's contribution. These response relationships allowed us to calculate the social network connecting contributors, across the three active days of the forum. Figure 3 shows the dramatic increase in social network connections across the three days of the forum.

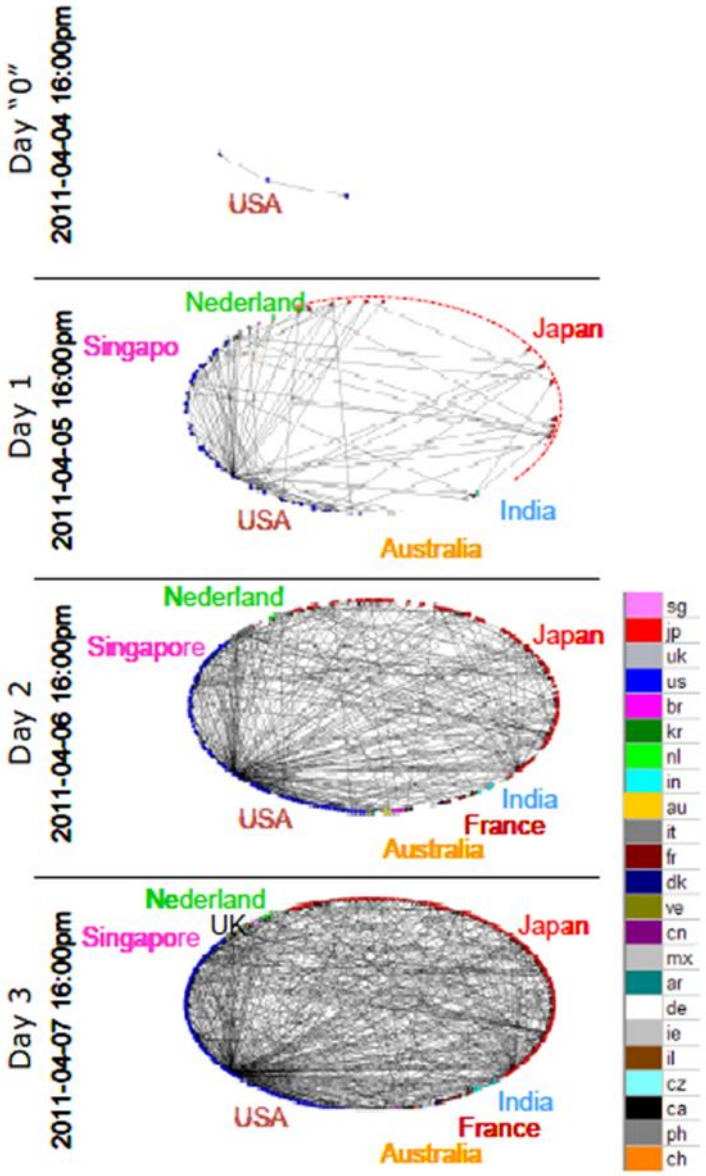

Figure 3. Growth of social network among the contributors, from "day 0" (the day before the brainstorm), to the end of the third day of the brainstorm. Country codes are from internet domain conventions (e.g., http://ftp.ics.uci.edu/pub/websoft/wwwstat/country-codes.txt, accessed 2011-12-20).

Qualitative Results

Employees' contributions in the brainstorm contained rich ideas. In this note, we can only summarize what was dis- cussed. We organize our report of the contents of the forum according to the conventional analysis of emergency management into four phases [3]: Responding (21.52% of contributions), Recovering (43.81%), Preventing (10.53%), and Preparing (49.23% -- note that 25.08% of contributions involved more than phase, so the percentages add up to more than 100%):

Responding. Brainstorming about how to respond to the current emergency involved many ideas, including:

- expanding available modeling tools to address the current conditions (e.g., using weather forecasting tools to predict radiation spread)
- repurposing existing technology for early sensing of tremors (e.g., accelerometers, disk shock-protectors)
- monitoring and modeling disease outbreaks
- managing electronic health care records during wide- scale technology outages
- providing telemedicine in the absence of power grids and reliable communication infrastructures

Recovering. While much of Japan's power generation was offline for safety checks, employees brainstormed about how to use the remaining power effectively:

- optimizing power usage at personal level and at regional level through "smart" utility management techniques
- improving power efficiencies in data centers
- using impact models to prioritize and schedule the needed rolling power outages

Information technology resources were limited, and there- fore part of the "Recovering" discussion considered:

- developing more resilient networking for cities
- providing rapid-recovery for city records
- expanding these capabilities to businesses, as needed

Preventing. While earthquakes and tsunamis cannot be prevented, damage from those events can be minimized:

- providing rapid-recovery for city records
- "hardening" and strengthening existing networks and storage redundancies by simulated emergency testing

Preparing. Because of history, Japan as a nation has com- mitted many resources to planning for future emergencies. Employees attempted the challenging task of adding to what the Japanese have already considered:

- studying best practices from other regions
- developing simulations to test resource resilience and social response

These and other ideas are currently under discussion as a kind of portfolio of potential joint work between the gov- ernment of Japan and IBM; details remain

confidential to both parties. This is a typical interim outcome from these kinds of corporate brainstorms, because of the substantial resources required to implement ideas of this scale. We regret that we cannot provide further details at this time.

Related Work and Conclusion

In [1], panelist Tiantian Wang noted the need to determine "What constitutes the disaster community?" What kind of entity was the Japan Forum? If it was an online community of interest or community of practice (e.g., [10]), its four-day duration was unusually brief. If it was a virtual team (e.g., [9]), it managed to be highly effective without a manager, an assignment, a task list, or a reward structure.

Based on the IBM experiences with forums [4], we suggest that this kind of limited-duration, low-commitment idea- generation collaboration is a distinct genre of online collaboration. Its distinguishing characteristics appear to include the brief timeframe, the brainstorming atmosphere of innovative thinking [2], and the ability of volunteers to make small contributions with very low cost-of-contribution [11].

This genre extends the space of online communities that form during and after emergencies and disasters [1,2,7,8]. Most research about "disaster communities" [1] has focused on people who are directly affected by the emergency. Our experiences expand the space of action for remote volun- teers from assistants/translators for people facing the emergency (e.g., [11]) to autonomous actors who collectively create new knowledge as a distinct type of contribution.

Implications for Design

Based on our case study, we suggest that systems and services to support this kind of volunteerism should allow people to join with a very low cost-of-commitment [11], and should recognize volunteers as participants whether they make visible contributions or act invisibly as engaged readers [6]. There appears to be no need for recognition, incentives, or rewards to motivate participation [4,11]. We speculate that the forums might be strengthened through a parallel community space that was designed for sociality [8,10], in addition to informational contributions.

Future Research Directions

In future research, we plan to conduct interviews to under- stand participants' motivations. We also plan to ask them about what additional information they

would find useful. We hope to offer forums outside of the enterprise setting, to test replication on the broader internet.

In summary, we have described a case in which a group of volunteers was able to organize quickly to develop creative solutions in the service of other people who were facing an emergency. We showed the breadth of volunteerism, the large volume of ideas generated, and the growth of social connectedness that took place in a matter of days. We used this case to propose a distinct genre of remote collaborative contribution during crises, and we sketched some potentially important attributes. We used this analysis to propose implications for design and future research directions.

Acknowledgments

We thank John Gordon for patient discussions about the business implications of this work.

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Digital Volunteerism: Examining Connected Crowd Work During Mass Disruption Events

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Abstract. My research examines the use of social media during mass disruption events, focusing on the work of digital volunteers. Specifically, I explore ways in which the connected crowd works to process a flood of data moving through social media platforms into useful information resources. I seek to unpack the popular crowdsourcing term to reveal the diverse information organizing and self- organizing behaviors obscured beneath it. By describing how the connected crowd currently helps to organize information, I hope both to help emergency and humanitarian responders better leverage this potential new workforce and to enrich our overall understanding of collaborative online work.

Introduction

My research examines the use of social media during mass disruption events, specifically focusing on the work of digital volunteers. Social media are enabling new, digital forms [7] of the convergence behavior long known to occur after mass emergencies and disasters [1,2,7]. They are also becoming sites for new digital volunteer organizations, like Humanity Road[1] and the Standby Task Force[2].

This research takes an in-depth look at ways in which digital volunteers are appropriating social media tools to help process data and self-organize during

mass disruption events. By describing how the connected crowd currently helps to organize information, I hope both to help emergency and humanitarian responders better leverage this potential new workforce and to enrich our overall understanding of collaborative online work.

I define mass disruption events as events affecting a large number of people that cause disruption to normal social routines—e.g. disasters (natural and man-made), mass emergencies, extreme weather events and political protests. I rely on the emerging field of *crisis informatics*, which examines the social, technical, and informational aspects of crises [3,8], to inform the work.

Background

Researchers in crisis informatics have demonstrated that social media platforms are becoming digital sites where people converge after crisis events [7,10]. This activity is a digital parallel to the physical convergence behavior long known to occur in the wake of mass disruption events [1,2]. Digital convergers participate in many of the same *informational convergence* activities documented in the pre-digital world [2]. They are also taking part in new information activities—e.g. providing information to others [6,8], helping to coordinate relief activities [11], and integrating and synthesizing information [9,10].

Informational Convergence: Problem or Potential

Fritz and Mathewson [2] viewed informational convergence as a problem for responders, explaining that local infrastructure could be overtaxed both in carrying and processing communications from convergers. In the Disaster Relief 2.0 Report [4], a report about interactions between humanitarian responders and digital volunteer communities after the 2010 Haiti Earthquake, responders claimed that data generated on social media by those affected as well as those who converged digitally added to responders' difficulties processing large amounts of data.

The information-processing problem has four key aspects: noise, lost context, veracity, and structure. Noise requires filtering, identifying the signal from within a vast and crowded information space. Lost context requires *recontextualizing*—restoring information to its original context or giving it new significance within a new context. To avoid dangerous implications of misinformation and disinformation during mass disruption events, information requires verification. Finally, for information to be aggregated, searched, and integrated into other resources, the unstructured communications of social media must be *structured* in a systematic way. Dealing with these issues requires a substantial amount of work, some of which is already taking place.

Communities of digital volunteers are emerging to take on some of this information-processing work. Soon after the 2010 Haiti earthquake, several groups of digital volunteer mobilized in attempts to contribute to the humanitarian response efforts [4]. For example, a group of remote volunteers organized around an Ushahidi instance to collect, process, verify, and map reports of immediate needs.

Research studies on digital volunteerism and crowd work during mass disruption

Through several empirical studies, my research addresses different aspects of digital volunteerism, exploring both the specific activities of information organizing and the dynamics of how people organize themselves to do this work. Due to its public broadcast nature, I rely on Twitter communications for many of these studies, as well as participant observation of digital volunteer communities and digital traces from other social media tools.

Tweak the Tweet: Deploying an Innovation for Structuring Social Media Updates

Tweak the Tweet (TtT) is an idea I co-created and proposed for using Twitter as a crisis-reporting platform [14]. TtT is a hashtag-based microsyntax that Twitterers can use to make their tweets machine-readable.

With the help of my colleagues at Project EPIC, I have deployed and supported Tweak the Tweet instances for more than 20 events in 2010 and 2011 [13], including the 2010 Haiti Earthquake, the 2010 Pakistan Floods, extreme winter weather in the U.S., the 2011 Alabama and Joplin tornadoes, and Hurricane Irene. I have implemented a system to collect, process, and geolocate TtT tweets, and during select crisis events I deploy that system to generate public maps[1] and spreadsheets[2] with the aggregated information. I continue to examine the rationale, implementation, deployment, adoption and use of TtT in crisis events.

Originally, we conceived of Tweak the Tweet as a technique that people affected by a disaster or mass emergency could use to report information coming from the ground. We were surprised during our initial deployments to find that the microsyntax was more often adopted by remote Twitterers, who in many cases where "translating" information found elsewhere on Twitter into TtT format and

[1] http://www.cs.colorado.edu/~starbird/TtT_Irene_map_byEvent.html

[2] https://docs.google.com/spreadsheet/ccc?key=0AkuhimfFYZrOdElsNEM4TlFJVWdKMHpJM0lpS0JjZ3c&hl=en_ US#gid=0

then retweeting it. These remote volunteers used TtT as a marker for information they felt was actionable and verified. For them, Tweak the Tweet served as both a filtering and structuring mechanism. Though the innovation was not originally designed for this purpose, the crowd appropriated the syntax for what could be considered as a "crowdsourcing" activity, or more descriptively, as distributed human computation.

Voluntweeters: Self-Organizing by Digital Volunteers during Disaster

In the initial deploy of TtT, during the early aftermath of the catastrophic earthquake that struck Haiti on January 2010, we (at Project EPIC) were surprised to find that the TtT syntax was adopted not by those on the ground during the event, but by remote individuals—digital volunteers— for whom the syntax was one component of a wide range of volunteer work that they were doing using the Twitter platform. This discovery led to further investigation of those digital volunteers [11]. Using Twitter data generated during the event and follow-up interviews with *voluntweeters*, we explored their motivations and activities, uncovering a rich ecology of digital volunteerism that included efforts to fill affected individuals' cell phones, verify and route information about immediate needs, and coordinate the movement of relief supplies.

Our research found that many of volunteers became connected via Twitter during the event, and circulated information within their digital volunteer networks. We examined how features of the technical environment—e.g. Tweak the Tweet, Twitter hashtags, an Ushahidi instance, and many others—provided structure for these self- organizing activities, and theorized that the voluntweeters had become an emergent response organization [11].

Humanity Road: An Organization of Digital Volunteers

In an ongoing ethnographic study, I volunteer with and do research as a participant observer within Humanity Road, a non-profit organization of digital volunteers who respond to crisis events using social media. Our mission at Humanity Road is to help "educate the public before, during, and after disasters on how to survive, sustain, and reunite with loved ones."[1] A large portion of our self-defined workload includes monitoring and aggregating information from multiple media sources, verifying it, and creating public resources.

We use a range of Internet-based tools, including several social media platforms to do this work and to organize ourselves to do this work. Twitter serves multiple purposes within our organization—e.g. a recruiting tool, a source of information during crisis events, a place to broadcast messages about evolving conditions or best practice preparation and response strategies for those affected. We use Skype

[1] http://www.humanityroad.org/AboutUs.htm

chat to coordinate our activities during and between crisis events, to train volunteers, and to foster a sense of community in informal conversations during down time. Shared Google Documents serve as temporary resources and sites of real-time information synthesizing.

On October 28 2011, after a 6.9 earthquake near the coast in central Peru, several volunteers mobilized within our Skype chat to respond to what we determined was an "urgent event." One of our leaders set up a Google Document, and seven team members quickly began working simultaneously to fill out a Google Document with information about the affected population, links to maps, GPS coordinates and statistics about nearby airports and hospitals, pointers to government media sources, a list of Twitterers who were tweeting from the area, damage reports, and other information our organization knows to be important to emergency responders, affected people, and humanitarian responders after an earthquake of that magnitude. Within minutes, this information was collected, synthesized, and copied over to our website as a public resource for the event[1].

The organizing and information processing activities of Humanity Road, like the one in the example above, can also be considered as distributed crowd work, a form of collective intelligence achieved by remote individuals connected by social media and other Internet-based tools.

Crowd Work during Political Disruption

In [12] we examined how, during political protest events, the remote crowd works to demonstrate solidarity with protestors and to recommend information coming from "the ground." This research adopted a perspective that considers the whole crowd as potential workers, using something as simple as Twitter's retweet mechanism to help organize the information space. In future work, I plan to explore the possibility of using collaborative filtering techniques based on our understanding of crowd work during mass disruption events to derive meaning from crowd activity, using features of crowd behavior—the micro-actions of recommending and routing information, following, and friending—to train machine learning classifiers.

Research questions for Crisis Informatics

This work derives from a perspective that views the distributed, connected crowd as a potential asset during crisis response. Generally, my research asks:

[1] http://www.humanityroad.org/_blog/Event_Diary

Q1. How does the social media-connected crowd act to organize the flood of data moving through those platforms into useful information resources?

One aim of this research is to help emergency managers, humanitarian responders, and others involved in formal response efforts better understand the current activities and future potential of digital volunteers. Like physical convergers and unwanted donations, digital convergers during crisis events can be viewed as another problem that emergency responders will have to manage. My research demonstrates that these groups are capable of many types of useful work during disaster events, especially the work of information processing. An overriding goal of this research is to bridge the problem-potential divide when it comes to how emergency response views digital volunteer communities.

A critical question that lies outside the current bounds of my inquiry, but will be vital for the crisis informatics community to address is:

Q2. How can emergency and humanitarian responders better leverage digital volunteer communities and the resources they create?

Related to this question, I believe, is an examination of the popular term, *crowdsourcing* [5]. Crowdsourcing has received a good deal of attention in recent years, particularly in conversations regarding emergency and humanitarian response to crisis events. The Disaster Relief 2.0 Report [4] used that term 28 times to describe work by "Volunteer and Technical Communities" to contribute to the emergency response efforts after the 2010 Haiti Earthquake. However, the term is often employed as a blanket descriptor, masking a range of diverse behavior.

My final question to the crisis informatics community is:

Q3. What is Crowdsourcing?

Another goal of my research, which could be a valuable aim of the emerging crisis informatics community, is to unpack this term and delve into the unique dynamics of the different systems, organizations, and self-organizing groups that leverage social media and distributed crowd workers to contribute to response efforts during crisis events.

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