An Upstream-Downstream Approach for Disaster Management Information Systems Design

Craig E. Kuziemsky
Telfer School of Management
University of Ottawa
kuziemsky@telfer.uottawa.ca

Tracey L. O'Sullivan
Interdisciplinary School of Health Sciences
University of Ottawa
tosulliv@uottawa.ca

Wayne Corneil
University of Ottawa
Institute of Population Health
wcorneil@uottawa.ca

ABSTRACT

Information is an essential part of disaster management. Information systems (IS) are a key means of providing the right information at the right time to support response to a disaster, and fostering collaborative facilitators such as situation awareness, common ground and communities of practice. However for these collaborative facilitators to support 'downstream events' (i.e. disaster response) they need to emerge and be grown from 'upstream' activities such as user engagement. Subsequently IS design requirements for disaster response are embedded in the community where a system will be used and it is from the community users and their needs that IS requirements must emerge. This paper presents an upstream-downstream approach for disaster management IS design. We describe four phases to user centered information systems design to support disaster management and provide a case study of using this approach in action to design an IS to enhance community resilience.

Keywords

Disaster and emergency management, participatory design, systems design, user engagement, awareness

INTRODUCTION

Disasters, such as the oil spill in the Gulf, the floods in Brisbane, and more recently the fires in Slave Lake, and earthquake, tsunami, and damage to the nuclear plant in Japan provide examples of how collaborative action is dependent on information management to minimize damage and long term effects after adverse events. It has been suggested that collaboration, communication and coordinated response are keystone components for resilient communities and effective emergency response (Norris, Stevens, Pfefferbaum, Wyche, and Pfefferbaum., 2008). Because disaster and emergency management has an element of uncertainty, is often time sensitive and entails multiple types of actors (e.g. volunteer and paid, government and non-government) (Waugh and Streib, 2006) across geographical and policy boundaries (Ansell, Boin and Keller, 2010), the task of building resilient communities is complex.

Information is the most vital resource during a disaster (de Faria Cordeiro, Marino, Campos, Marcos, and Borges, 2011). Information is the building block of collaborative facilitators such as awareness and common ground, which are important in disaster management as it frequently crosses jurisdictional borders and requires multiple sectors to work collaboratively to ensure appropriate and timely service provision to meet basic needs and facilitate prompt recovery after an event (Chandra,Acosta, Stern, Uscher-Pines, Williams, Yeung, Garnett, and Meredith, 2011; Galton and Warboys, 2011). The process of exchanging information ensures actors have knowledge about who they are working with (i.e. their community of practice), the tasks they are working on (awareness) and that they share the common knowledge to conduct communication activities (common ground) (Carroll, Rosson, Farooq and Xiao, 2009; Kuziemsky and Varpio, 2010). Poor information sharing and access can cause a variety of issues. For example, during both the 9-11 response and Hurricane Katrina, there was poor intersectoral information sharing about the capabilities of hospitals, and health systems were overloaded when

urgent demand exceeded available service capability (Oster, Nierenberg, Menlove, Chason, and Pruden, 2002). Similarly after the earthquake in Haiti it was a struggle to provide services to citizens because many of them were not registered, and essential information, such as detailed medical histories were not available (Levy, Blumberg, Kreiss, Ash, and Merin, 2011). However many of the problems during the response phase of a disaster relate to challenges with coordination across sectors, or lack of awareness about what people or services can and cannot do. In a response to a disaster actors need to know what resources are available and needed, where citizens at-risk are, and what the capabilities are of hospitals and other facilities.

Therefore there is a need to proactively ensure the required information and collaborative facilitators (i.e. awareness and common ground) are available at the time of a disaster. Although awareness and common ground are used to support a particular collaborative moment they are not developed in the moment. Awareness develops over a trajectory (Carroll et al., 2009). Similarly common ground has been shown to have developmental properties that grow over time including social fabric (Kuziemsky and Varpio, 2010). Awareness or common ground may be used downstream in the response to a disaster but their development needs to start upstream (Carroll et al., 2009). Therefore efforts at developing collaborative facilitators should focus on the upstream activities, actors, resources and protocols from which awareness and common ground emerge and develop.

Studies have advocated for Information Systems (IS) design to contribute to disaster response by making information available about resources, and facilitating communication and collaboration across different parties (Chan, Killeen, Griswold, and Lenert, 2004; Orthner, Mishra, Terndrup, Acker, Grimes, Gemmill and Battles, 2005; Troy, Carson, Vanderbeek, and Hutton., 2008). As more IS support is required in disaster management, we suggest lessons can be learned from system design efforts in the healthcare field, particularly those which have failed and can provide insight about potential pitfalls. Healthcare and disaster management are both collaborative intensive domains with multiple users and extensive communication requirements. Health IS design is often problematic with studies estimating that most health IS fail in some way (Heeks, 2006). A 2011 paper identified that the key issues in electronic health record implementation are not technical but rather there is a need to design technology from a 'bottom up' perspective that emphasizes user needs and the definition of a business case for how technology will aid in supporting strategic directions for health care delivery (Rozenblum, Jang, Zimlichman, Salzberg, Tamblyn, Buckeridge, Forster, Bates, and Tamblyn, 2011). Stakeholder engagement is similarly recognized as an essential building block in community development initiatives, regardless of how community is defined for a given system (Chandra, Acosta, Stern, Uscher-Pines, Williams, Yeung, Garnett, and Meredith, 2011). Community is often not defined by jurisdictional or geographic boundaries but rather is defined as a group of people who have a common domain of interest in creating resilience and disaster response. However, community engagement in emergency planning initiatives is a relatively new concept and is appearing more in the literature, as the expertise of community organizations and the voluntary sector is gaining recognition (Enarson and Walsh, 2007). Drawing upon lessons learned from health IS design we suggest that systems design methods that emphasize user needs and community engagement should be used.

We represent the existing literature on information needs and collaborative facilitators for disaster management in figure 1. Upstream we have the pre-event phase (i.e. planning and preparedness) while downstream we have the response and recovery phases. Across the continuum there are people, protocols, resources, information, activities and policies of disaster management. Downstream is where collaborative facilitators to support disaster management including situational awareness, common ground and communities of practice are applied. However these downstream facilitators get their meaning and relevance from upstream user engagement and integration of people, policies and protocols. We emphasize that collaborative facilitators such as awareness, common ground and communities of practice are used in both upstream and downstream events, however we believe the development of these facilitators must take place ahead of a disaster with a focus on establishing networks, helping people understand functional needs, and engaging people.

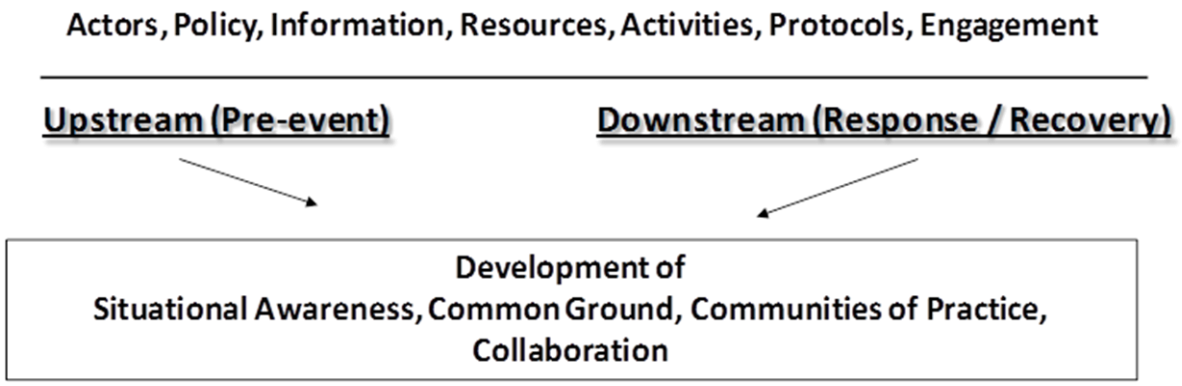

Figure 1. Upstream and Downstream Facilitators of Disaster Management

With respect to IS design, we believe requirements to support awareness, common ground and communities of practice are embedded in the user community where a system will be used. It is from these communities and the needs of users in these communities that IS requirements must emerge. Systems design to support downstream activities must emerge from upstream user engagement. User centered system design methods include participatory design and approaches from fields such as Human Computer Interaction and Computer Supported Cooperative Work (CSCW). The commonality in all these approaches is the emphasis on understanding of how actors engage with technology to complete tasks. A shortcoming with these approaches is they do not articulate the specific details of how to engage users, nor how to use user engagement to derive system design requirements. On the other hand community based engagement methods such as community-based participatory research (CBPR) methods are well-established (Israel, Eng, Schulz and Parker, 2005) and should be incorporated into IS design protocols. We believe IS design methods need to bridge user-engaged design methods such as participatory design and community engagement methods such as CBPR. The purpose of this paper is to describe how CBPR methods were bridged with user engaged IS design as an upstream approach to building community resilience. The approach emphasized ongoing user engagement to derive systems design requirements. We also provide a case study of using the approach for the design, implementation and evaluation of a prototype disaster management IS in one of our study communities.

METHODS

This paper uses a case study of the Enhancing Resilience and Capacity for Health (EnRiCH) Project, a CBPR project involving 5 communities in Canada. The partnerships were established with the communities for the purpose of the project and ensuring stakeholder input and engagement has been a central component in each step of the design, implementation and evaluation of an intervention to promote resilience through community engagement, awareness and collaboration. The specific methods used in each phase of the intervention are described in a separate paper. Through extensive consultation with the communities, an intervention centred on the development of an information management system was designed for the communities to map assets that could be used to assist high risk populations during a disaster. Participatory design (PD) was the overarching method used in the project, and was chosen because of its ability to ensure the usability and utility of the designed technology by engaging end users in the design process (Spinuzzi, 2005). PD is also useful for acquiring an understanding of the traditional, tacit and often invisible ways that people perform their everyday activities (Spinuzzi, 2005). PD is an ideal system design method for engaging the diverse actors involved in disaster management.

Our study had three overall objectives. First was data collection for asset mapping and community needs assessment. Second was to do initial analysis of the data to identify needs and then return to the communities to discuss and validate the needs. Third was to formalize the needs into requirements to be used for systems design of a prototype disaster management information system called the EnRiCH High Risk Identification Tool (EHRIT).

The above objectives were formalized into five steps which bridge the upstream to downstream phases of development outlined in figure 1. The first two steps involved a literature review and asset / need assessment in each community. In step 3 we developed a preliminary framework to categorize functional capabilities, based on the findings from steps 1 and 2. Step 4 was a consultation with an expert panel, which provided further feedback to refine the functional capabilities framework. Finally, the fifth step was to conduct pilot testing of the framework by developing an online collaborative tool to map community assets. This bridged the upstream and

the downstream aspects of systems design as the tool was brought into the natural environment in one community, to determine what works, what doesn't work, and how to adapt it to the community's needs. We briefly describe the five design steps below.

Steps 1, 2 and 3 - Asset / Need Assessment and Framework development: Following approval from the university research ethics committee, we recruited participants from emergency management, health and social services sectors in each community for the asset / need assessment phase of the project. These groups were specifically recruited because they were identified as the end-user of the information system. Nine focus groups were conducted across the five communities, using a Structured Interview Matrix (SIM) facilitation format (O'Sullivan, Amaratunga, Phillips, Corneil, O'Connor, Lemyre, and Dow, 2009), which is a consultation technique designed to enhance participation and engagement with large groups of participants. In the case community described in this paper, there were (n=41) participants who attended one of the 2 sessions held in that community. The data from the SIM sessions were collected in 3 stages: a) 1:1 interviews conducted by the participants b) small group discussions; and c) plenary discussions. The interview (field) notes collected by the participants and the audio recordings from the group discussions were transcribed verbatim and double-checked by another member of the research team for accuracy. Emergent themes were identified through discussion amongst the research team using conventional thematic analysis until consensus was reached. The emergent themes were used to inform the development of the framework and asset-mapping intervention.

Step 4 - Expert Panel Consultation: Following the development of a preliminary framework to identify and describe functional capacities, a 1.5 day meeting was held with 20 community and academic partners. During the meeting, the framework was presented and discussed by the group to determine its accuracy, appropriateness and feasibility as a tool for mapping capabilities and educating the public about support needs for high risk populations. The framework was refined and the asset mapping spreadsheet was modified based on the discussion from the expert panel.

Step 5 - Pilot Testing: Once the components of the functional capabilities framework were refined and the online collaborative asset-mapping task was designed, our team initiated prototype IS design and pilot testing of the IS in one of the target communities. This process is currently underway, however preliminary process data has been collected and analyzed to enable us to report on the role and value-added from end-user engagement throughout the upstream phases of this IS design.

RESULTS

The objective of this paper was to study and model IS design to support disaster management from an upstream and downstream perspective based on data collected during the design of the prototype tool. After analyzing the data we identified four phases to user centered IS design to support disaster management: 1) user engagement and needs, 2) requirements, 3) design and implementation, and 4) evaluation (see figure 2). These phases are shown extending the upstream-downstream model from figure 1, and while they are shown sequentially, each phase actually loops back as refinements require further engagement and identification of system requirements, and adaptations to design and implementation. For example, evaluation is ongoing throughout the process. The two-way arrows between the phases indicate that they are iterative and can be implemented simultaneously. We have also shown user engagement and needs as central to the other phases. Each phase and corresponding system design aspects are described below figure 2.

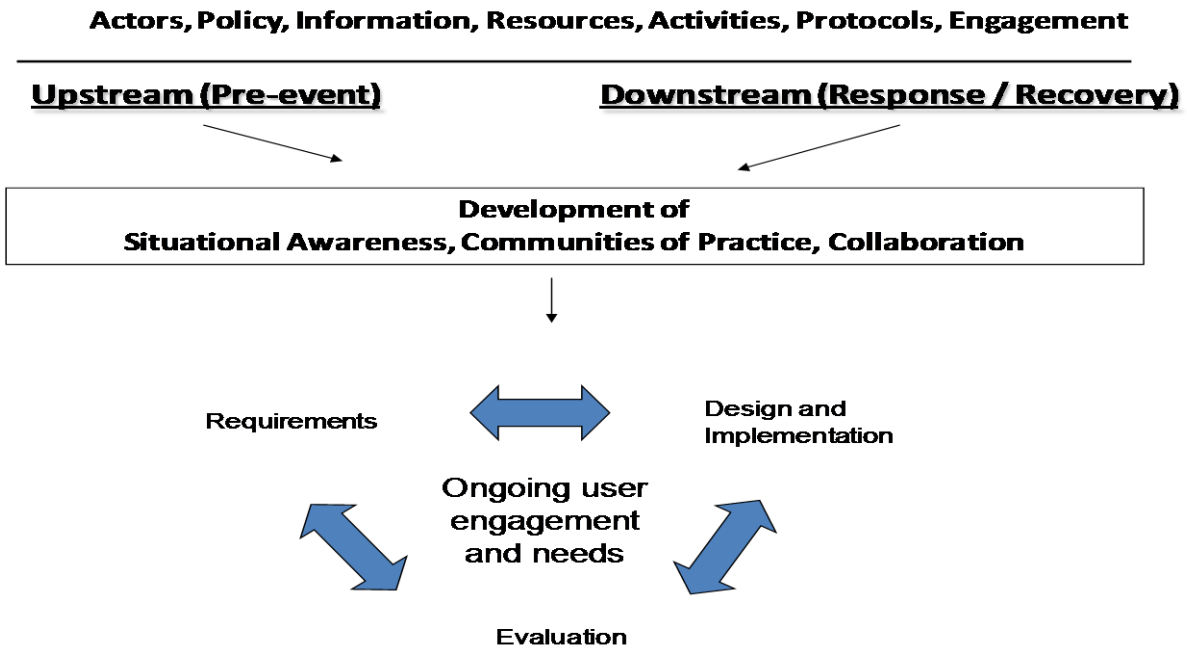

Figure 2. Upstream-Downstream User Engaged Systems Design

User Engagement and Needs Phase

Engagement and need assessment is the first phase of our systems design approach but as described above it is also an essential part of all phases. There were two key outcomes that emerged from the user engagement and needs phase. First was the engagement of the community to begin the development of awareness, common ground and communities of practice, and to ensure they can be sustained as the process proceeds. Second was identification of the needs that are necessary to support the community in a disaster via an information system. In this study, several categories of user needs were identified including communication and information needs, the need for identification and access to services, awareness, organizational adaptation, transboundary integration, and relationships and trust.

In the EnRiCH Project, user engagement started by bringing together community stakeholders for a full day asset / need assessment which involved consultation to discuss the strengths, weaknesses, opportunities and threats related to supporting high risk populations in disasters. This process was designed to engage the users and form communities of practice with representation from organizations that are not traditionally invited to disaster planning activities (eg. community associations representing people with disabilities). It was also deemed to be necessary to shift the focus from the traditional one on hazards and risk management of critical infrastructure to encompass a population health focus to include social infrastructure. This was a key learning on the part of all the communities with the shift from seeing communications as a technological issue to be solved, to one related to social networks and culture.

This first phase is where collaborative facilitators such as awareness, common ground and communities of practice first develop. Because disaster management is a journey and not a destination we needed to grow these facilitators and to have the users be active participants in a community of practice. In order to build a community of practice a key requirement was to ensure all participants felt a sense of belonging in the group. This was accomplished in several ways, depending on the functional needs of the participant and the dynamics of the group. For example, there were participants who had had a stroke and were concerned about their ability to keep track of the information while collecting field notes during the interview step in the SIM session, due to limited fine motor control when writing, or difficulties multi-tasking. These individuals were paired with another participant to accompany them and take the field notes so they could focus on engaging in the conversation with the person they were interviewing. There were many individuals representing organizations not typically involved in disaster management activities, therefore they did not know any of the other participants at the beginning of the session. Our research team made a conscientious effort to introduce them to other participants at their table and facilitate networking, to ensure they felt welcome within the community of practice that was being created.

There were other examples where efforts to accommodate participants with functional limitations were not as successful. For example, during preparations for a consultation with community stakeholders in one of our study communities, our team was informed that two of the individuals who would be attending have limited to no vision and would require support to ensure they could participate fully. In working with the individuals and a community organization that assists people with visual limitations, we determined that the software we had used for other participants, to enlarge the font, would not suffice for these participants because they had no vision at all. In addition, they preferred not to have a notetaker sit with them, because they were self-conscious of appearing to need special assistance to complete the task. After several discussions about potential solutions, the participants eventually decided they would not participate. It was unfortunate that with the initial design of this tool we had not achieved accessibility for this group of people.

Requirement Phase

Several types of awareness including awareness of services, information and people was the predominate requirement which emerged from the asset and need assessment phase. Many participants in the community were not aware of the organizations that assist people with functional limitations. Others were aware of organizations but not of the services, or they knew the services they needed but not how or where to obtain them. Our objective was to develop a system to support the development of situational awareness about functional capacities and appropriate supports, and to assist communities with mapping these types of resources to the people who need them in advance of a disaster. The user needs from phase 1 were used to develop requirements for a disaster management information system named the EHRIT. The first task of this phase was to organize the user needs from the data collected in phase 1 into a set of categories to assist communities with framing supports for people with limited functional capacities. The categories we identified are: communication, awareness, mobility, transportation, psychosocial, self-care & daily living tasks and safety & security. The categories were a template for the communities to start with but in keeping with the PD method the communities were encouraged to adapt them to meet their own needs.

The above categories represent the general user requirements for the EHRIT. However there were other systems design requirements necessary to design the EHRIT. These additional requirements pertained to how the EHRIT would be used and were classified as group and individual requirements. Group system design requirements included the ability for the system to support different types of media. Text, video and audio all needed to be supported. Another group requirement was the need to transfer the collaborative energy from the user engagement meetings to the online communication of the EHRIT. During the user engagement meetings in phase 1 it was apparent the people enjoyed the collaborative environment as they were actively engaging in conversation. Therefore if people were going to participate in an electronic community of practice we needed to ensure the EHRIT could provide some means of mimicking the face-to-face user experience. For example, we needed to provide awareness of who else was online (i.e. a buddy list). Another group requirement was the need for interoperability across different settings and locations. Our community consists of public, private, paid and volunteer people so the EHRIT had to be accessible to everyone. The final group requirement was the need for the EHRIT to be configurable across different settings. Our objective was not to develop new software for this system, but instead to incorporate existing tools into an integrated system tailored to the groups' needs. That would allow them to let them tailor the EHRIT to meet their specific needs.

Individual system design requirements included the need to have individual control of information. Despite the fact that EHRIT is meant to support group collaboration and communities of practice it is used by individual people. Some people wanted automatic notification (i.e. push of information) when new content is added or when a new comment is posted. Others did not want notification but rather preferred to acquire updates on their own time (i.e. pulling of information). Another individual requirement was the ability for users to tailor their online experience to their individual preferences (i.e. change background, add photos).

Design and Implementation Phase

The requirements identified during phase 2 were used to design a prototype version of the EHRIT. The first task in this phase was to develop a logic model (intervention framework), which was then used to design a computer based version of EHRIT. There were two key factors that influenced the software package we selected to develop the EHRIT. First, because the design requirements were different in each community we needed to be able to design the EHRIT with flexible functionality. Second, some of our participants are government workers, others represent non-governmental organizations, therefore the restrictions on the type of software that can be used on their computers varied from organization to organization. Third party software and social networking applications (i.e. Facebook) are often not accessible on workplace PCs.

Google Docs was selected as the application platform to pilot the EHRIT as it could provide the functionality that was identified in the requirements phase, was free of cost and easily accessible to all users. Perhaps most importantly it is not overly complex to use and is user friendly and intuitive for most people who have basic

computer skills. Google Docs also enabled us to bring together traditional and non-traditional responders to an application that is compatible with their existing ones so if they want they can easily import information and documents. It permits all the participants to control the type and level of privacy they wish to have over confidential or personal information they which to share. People are able to configure their profile to personalize their online experience thus bringing their individual uniqueness into the community of practice. Finally it allows multiple people to contribute to a document through versioning control. Finally Google Docs supports all required types of media (i.e. text, audio and video) and has a feature where people can select if they wish to receive notifications when documents are updated or if someone has responded to a comment. The notification feature is completely customizable and supports both pushing and pulling of information depending on a person's preference.

We created a separate EHRIT tool for each community. The tool has two main categories of functionality. First was to serve as a common source of documents. The documents included a spreadsheet to be populated by each community about assets in the community, to serve as a repository of resources to be used in an emergency. The spreadsheet will be customized in each community based on their own needs and preferences. Other documents included disaster management protocols or training documents. Second is to serve as a communication medium to enable the group to communicate synchronously and asynchronously through blogs and messages. When users first access the EHRIT they are able to see who else is logged in (synchronous buddies) but they can also see who edited documents and posted comments (asynchronous buddies). Prior to implementing EHRIT we conducted interviews with each participant to identify any concerns, potential barriers, as well as functional limitations which could affect the user's participation in the training session and subsequent use of the tool. For example, several of the community members have self-identified as having a disability, such as limited fine motor control for typing due to a stroke or cerebral palsy, or limited vision which required advance uploading of the presentation or software to assist with viewing the font on the online tool. Other participants were concerned about their computer skills and whether they would be able to keep up with the group.

The pilot implementation was a full day training session in one of our communities. One of the researchers did a presentation of the EHRIT after which the community participants tried out the various features. We ensured that all participants had an account and could access the EHRIT. There were three key intended outcomes from the implementation. First was to ensure the participants knew about all the functionality of the EHRIT and how to configure it to meet their needs. Second was to ensure everyone had access to the EHRIT. Third was to allow the community to spend time developing common ground on how the EHRIT would be used (eg. discussions about protocols for postings and comments and general guidelines on how often people should be using the EHRIT.

Evaluation Phase

During the training session, we used a think-aloud protocol (Kushniruk and Patel, 2004) to document thoughts and conversations among the participants as they learned about the tool and then actively used it online. The results from the think-aloud process were used to refine the EHRIT in real time during the session, and afterward as the online component of the pilot testing continued. For example, while learning about the content of the framework, several participants identified examples that could be added to each functional capacity category. Wording that was used to explain some of the concepts in the framework were also discussed, in terms of whether it was easy to understand, or politically correct to describe a particular concept or sub-group of the population. As feedback was received, the content was revised and participants could observe the documents online to see how their comments influenced the development of the tool. This activity demonstrates to participants that their views are important in the development of the system and fosters a sense of contribution and belonging in the group, both which contribute to the quality of common ground and the development of communities of practice.

One month after the launch of the prototype EHRIT we conducted a formative evaluation consisting of (n=27) phone call interviews with the participants who had attended the training / orientation session, to identify any concerns or problems, and to understand their experience of using the tool to map assets and foster collaboration among the group. Problems associated with accessing the documents online were identified and our team provided technical support to guide the participants as they worked with the tool. Several participants who had indicated they were uncomfortable using computers reported that the training session was slightly overwhelming and they did not feel confident to use the system on their own. To accommodate their needs, they were teamed up with other members of the group who were comfortable using the system, to meet face-to-face and have personal assistance. We also learned that other members of the group were enthusiastic about the system and had figured out ways on their own to access the tool from their phones. At least 2 participants had applied their knowledge of the tool at work for use in other contexts, such as creating their own Google Docs sites to use with their co-workers.

We do acknowledge potential problems with this type of system in a disaster context given that is reliant on power and internet connectivity. Several studies have discussed the fallibility of community based ISs that fail to take into account that disasters that may render such systems inoperable or simply not useful in downstream (i.e. acute crisis) events (Franco, Zumel, and Beutler, 2007). The value of a PD approach was evident through the discussions with the group about how the utility of the system might be protected given the probability that a crisis may include loss of power or internet access. The group determined that periodically backing up the asset-map as an electronic file and printing out a paper copy were important precautions to ensure the information stored in the tool was accessible in any type of disaster where it would be needed. Google Docs also has a benefit in that it is 'Cloud-Computing' based and can be accessed from anywhere, including mobile PCs. Cloud computing has advantages over traditional emergency plans or systems which were resident on a host server or single system.

Discussion

This paper presents an approach for user engagement to support systems design for a disaster management information system. The key message from our study is that extensive user engagement must start upstream and systems design requirements must emerge from the user engagement. Collaborative facilitators such as awareness, common ground and communities of practice get their meaning from the lived experiences of the people who are involved in the collaboration. It is from those lived experiences that system design requirements must be gathered. Our approach extends existing research on user involvement systems design methods such as participatory design (PD). While PD emphasizes user involvement, it does not provide details on how to use the method in practice. Our approach and case study describe specific activities and what the system design outcomes are at each phase of our approach.

Although disaster management can learn from IS design in other sectors, there are key differences in disaster management compared to other sectors such as healthcare or banking. One difference is that disaster management has a heterogeneous user community (i.e. paid, volunteer, private sector, government). Defining requirements and designing technologies to support that array of users is a challenge. Another difference is that in healthcare or banking you often start with a defined user group (i.e. physicians, nurses, account managers) who may have to use the system as part of their job requirements. Systems design to support community groups, in particular volunteer groups, is different in that people cannot be forced to use a system but rather must be engaged upstream in order to generate energy and motivation to use a system. In our study we conducted extensive upstream engagement with our user groups before and during systems design. We also had a hands-on system implementation to ensure everyone was trained and could access the system. Yet despite those efforts our formative evaluation still identified issues that limited use of the EHRIT.

Figure 3 summarizes our findings as an information systems design model to support community needs. A key message is that the needs in each community are unique and a gap will develop when user needs do not align with requirements. System design can miss the mark if not tailored to the needs of the people who are expected to use it. As shown in Figure 3, we presume, IS requirements and community needs must meet upstream at a common point. The community needs must be the starting point for IS requirements, and these requirements must be modified as community needs are continually identified to be in tandem throughout the IS design process. If community needs and IS design requirements stay together and form a common horizontal line (checkered middle line in figure 3) throughout the design process, it is more likely that the IS created will meet user needs for downstream support. User engagement throughout the systems design process is necessary to keep the line horizontal. Alternatively, the further downstream you start IS design, the bigger the gap will be between the community needs and IS requirements (shown in figure 3 as divergent lines) and subsequently the more challenging it will be to design a system that supports all users needs. The collaborative facilitators (i.e. awareness, common ground and communities of practice) will still form, but the quality of the facilitators may not be as good because they were formed with less user engagement. Overall the collaborative facilitators supported by an IS will only be as good as the user engagement and needs from which these facilitators arise. Given that disaster management is about people, we must ensure that user engagement begins as far upstream as possible.

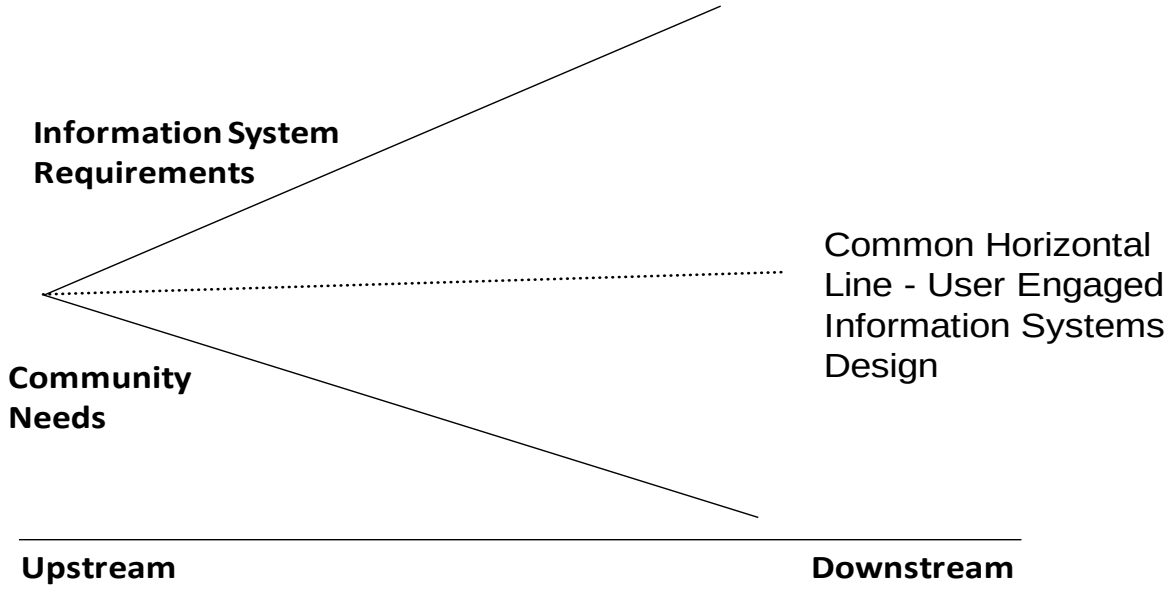

Figure 3. User Engaged Information Systems Design Model

One limitation of the paper is that the results are derived from one research study. To date we have only piloted and done preliminary formative evaluation of the EHRIT in one study community. We therefore we cannot comment on the effectiveness of our IS design approach in different contexts. We have also only evaluated our approach in the upstream phases of disaster management (i.e. planning and preparedness). Evaluation of the EHRIT in table-top exercises to provide an evaluation of the EHRIT in downstream activities will be done in all our communities as part of our ongoing research program. Evaluating the EHRIT during mock disaster drills is also a possibility. Future work could also entail applying our user-engaged approach to other collaborative settings.

CONCLUSION

Designing ISs for disaster management is as much about engaging the users as it is about designing the technology itself. Although awareness, common ground and communities of practice are necessary facilitators of collaboration, there is an overall lack of research showing how to engage users to develop these facilitators as part of upstream systems design. In fact, we suggest user engagement is an essential precursor to designing an IS to support collaboration and it must be actively pursued before any technology is designed.

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