Information Infrastructure for Crisis Response Coordination: A Study of Local Emergency Management in Norwegian Municipalities

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ABSTRACT

While great progress is made in terms of development and implementation on new ICT services for supporting crisis response coordination, the challenge remains on how to integrate these services within the ICT infrastructure in daily use by emergency responders. We report from an ongoing analysis of existing crisis response infrastructure in Norwegian municipalities, presenting an overview of current practice and related challenges. We argue for an information infrastructure perspective on the integration challenges, focusing on how new services based on geographic information systems and social media should be based on existing systems in use.

Keywords

Crisis response, emergency management, information infrastructure, coordination mechanisms, social media, GIS

INTRODUCTION

Available ICT services for supporting crisis response coordination continue to increase in number and sophistication. For example, a recent study identified more than 170 crisis management systems being developed and used in Germany (Neuhaus, Giebel, Hannappel and Färfers, 2012). Yet, the important challenge remains on how to integrate these services within the ICT infrastructure in daily use by emergency responders to enable effective coordination and information sharing (Turoff, 2002). Extended functionality of the systems often entails increasing complexity in use, making it difficult for 'part-time' crisis responders to become proficient in using these systems. In this research in progress paper, we argue for an information infrastructure perspective on this integration challenge, focusing on how new services should be based on existing systems in use.

The notion of information infrastructures has emerged as a way to describe the use of large-scale information systems: it changes the perspective from organizations to networks and from systems to infrastructures (Bygstad, 2008), and is increasingly used to distinguish between standalone information systems and interconnected socio-technical networks (Ciborra, 2001). Hanseth and Lyytinen (2004) have defined information infrastructures as shared, open, heterogeneous and evolving socio-technical systems of information technology capabilities. Moreover, Star and Ruhleder (1996) defined some key properties that characterize when a system becomes an information infrastructure. They emphasize how infrastructure is embedded in other structures, social arrangements and technologies and thus a fundamentally relational concept that occurs in relation to organized practice.

The following characteristics of infrastructures are relevant in the context of crisis management; First, information infrastructures cannot be built from scratch, but are always developed by extending and improving the existing infrastructure, also referred to as the installed base. Second, representations of infrastructures are multi-layered in such a manner that new layers are connected with existing ones, brought together to a larger unit, and becoming interdependent. Third, it takes time to build an infrastructure, and it is an ongoing, evolving and dynamic process (Ciborra, 2001).

Several studies have highlighted the need for improved communication, coordination and decision support systems in emergency management (Van de Walle and Turoff, 2007). This implies both the public crisis management as well as participation of the local community (Palen, Hiltz and Liu, 2007). However, the ad hoc nature of crisis management makes coordination particularly challenging. Coordination is defined as "the act of managing interdependencies between activities performed to achieve a goal" (Malone and Crowston, 1990, p. 361). Furthermore, artifacts such as procedures, classifications, planning tools and checklists, are described as coordination mechanisms that reduce the complexities of articulation work (Schmidt and Simone, 1996). Thus, we want to explore the current infrastructure in use and how this can form the basis for developing further mechanisms to support mutual understanding and coordination of local emergency preparedness.

We present preliminary results from our ongoing mapping of ICT infrastructure in use among crisis responders in Norwegian municipalities, and briefly discuss how an information infrastructure perspective may support further development and assimilation of such services to support the coordination challenges and information needs of these responders. The study is part of the SmartEMIS project conducted at the Centre for Integrated Emergency Management at University of Agder (Gonzalez, Granmo, Munkvold, Li and Dugdale, 2012), focusing on how mobile devices and social media can be applied for improving crisis response in the public, municipal sector.

MAPPING THE EXISTING EMERGENCY MANAGEMENT INFRASTRUCTURE

In this section we outline the preliminary results from our mapping of existing emergency management infrastructure at the municipal level. The results are based on semi-structured interviews with eight emergency management coordinators in seven municipalities in the Agder region in Norway, as well as the communication advisor at the county governor's office. The interviews lasted 40 minutes to 2,5 hours, and were tape recorded and transcribed.

We first briefly outline the organization of national and municipal emergency management functions in Norway, as a basis for explicating the emergency response coordination at the municipal level. Then we present an overview of the existing ICT infrastructure and information systems in use, and discuss affordances and constraints of these systems for coordination and information sharing.

Organization of local emergency management

The responsibility for emergency preparedness and crisis management in Norway is a public liability and organized by the Norwegian Directorate for Civil Protection (DSB). One of the key missions of DSB is to support and assist the county governors in following up civil protection efforts at regional and local levels. Moreover, the county governor is responsible for the supervision and coordination of local crisis management. For example, the representative from the county governor organizes meetings and exercises for key players in local emergency preparedness as well as a channel of communication between local and central authorities. Thus, they are the link between national and local agencies, as well as a support and driving force for local actors to carry out their duties and legal obligations to protect security and safety of the community and its assets. A basic principle in regional crisis management is the principle of subsidiarity; a crisis or disaster shall be managed at the lowest possible level. The overall responsibility for safety and security in the municipalities lies primarily with the political leadership, i.e., city manager and the mayor. However, coordination of local work is most commonly delegated to an emergency coordinator who is a key player in the coordination of local activities and resources. The scope and scale of this role varies according to geographic, demographic and environmental factors in the local community. Some municipalities are small and transparent while others are urban municipalities with a comprehensive infrastructure and services. For example, in the largest municipality in our study, there are two people (in 50 % and 20 % positions), who together perform these tasks. In smaller municipalities, the role of emergency coordinator may just be for example a 20% position. Yet, a common feature is that all emergency coordinators are engaged in various additional roles in the municipal agencies.

A legal obligation for local authorities is to carry out risk and vulnerability analysis, as well as an emergency plan. This implies mapping potential hazards that threaten the community, and developing a plan of action for the various risks as well as information about availability of resources across agencies. First and foremost, all municipalities are legally required to have an overall emergency plan. Furthermore, the various agencies such as fire, health, police, port authorities and power companies, are also obliged to have an internal emergency plan. For example, potential risk factors in the region are flooding, power failures, transport accidents (ferry, car, train) and epidemics. These kinds of emergencies require highly different resources and action plans. Still, all the various agencies are included in the overall contingency plan. Accordingly, it requires coordination and communication across organizational and domain-specific boundaries. As briefly outlined above, the position as

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emergency coordinator is comprehensive and diverse, and depends on cooperation and the flow of information across various sectors.

Existing ICT infrastructure in use

Local crisis management is complex and dynamic, aimed at increasing disaster resilience in the community. Hence, there is a need for information systems that promote planning, monitoring, and management of emergency response to continuously improve and adapt to changing circumstances. Table 1 provides an overview of ICT and information systems in use in the municipalities included in our study.

Main categories of ICT support	ICT systems in use
Information management	Crisis information management software (CIM®) • Logging • Reporting between organizational units Internal quality assurance systems • Emergency plans • Risk and vulnerability assessment • Logging
Mobile technology	Mobile devices (smartphones, iPad etc.) • Local notification list • Group alert systems • Population alert systems Satellite phone
Geographic Information Systems (GIS)	Electronic maps • Topological and demographical information
Social media	Municipal web pages • Information to the public • Hyperlinks to other official web sites Twitter Facebook

Table 1. Overview of ICT infrastructure in the studied municipalities

Most municipalities have completed an emergency plan, or are in the process of preparing such. This plan is usually stored in an internal electronic records management and archiving system. The system is mainly used for archiving of internal documents, but also for recording meetings and logging of issues and events (such as minutes of meetings related to crisis management). Nevertheless, the system is for internal use only and not particularly for contingency planning. To meet some of the needs and legal requirements to safeguard documentation and information flow in crisis management, the custom-designed CIM system for emergency management has been developed and adopted in Norway. CIM is marketed as "a web based set of tools for holistic emergency management" (www.onevoice.no), covering crisis management tasks such as risk and vulnerability assessment, emergency planning, quality assurance and non-conformity management, training and media handling. In addition, CIM enables integration with other systems, such as warning systems and geographic information systems (GIS). Most of the CIM tools are now also accessible from mobile devices. The Norwegian Directorate for Civil Protection has signed an agreement with the vendor of CIM, and since 2011 it has become available to all municipalities in Norway. So far, approximately 40% of all municipalities have adopted the system, supporting the information flow between municipalities, counties and national government. Generally, the uptake of CIM has so far been relatively slow, and the informants point to the challenge of getting the intended users engaged in a new system that is not in daily use. Effective collaboration with key crisis responders such as health, police and fire departments is also vital. However, while some police stations at the national level have adopted CIM, in the Agder region all emergency services are so far using their own

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customized information systems.

While the municipalities that have adopted CIM report to be quite satisfied, our study also shows varying use of the system. Some local authorities have made efforts to implement several modules that are available in the system, while others are still in the planning stage and do not have a coherent strategy for the use of CIM. Documentation and reporting of events, as well as logging are still the most commonly used features of the system. Additional functionalities such as group alert systems are under consideration. Still, manual notification procedures are most commonly used, i.e. notification lists are manually entered on mobile phones and used in emergency situations. One of the emergency coordinators emphasized access to information in real time as a major advantage. This municipality has adopted iPads, offering the possibility to read logs and take part in the action independent of time and place. For example, if the city manager is on travel or vacation, he/she is still able to participate in crisis management.

All municipalities are using electronic maps for different purposes. Several municipalities provide topological maps on their website with information about schools, sports facilities, accommodation, and so on. In addition, most municipalities are using GIS in spatial planning, which may also have an impact on emergency preparedness. Several GIS systems are in use, and so far integration of these systems with CIM has not been implemented locally.

Communication and information sharing to the local community is an important task for emergency coordinators. All municipalities have prepared an information strategy that is part of the emergency plan, where the local media and municipal website are the main channels for sharing information with the public. Several municipalities have also adopted social media such as Facebook, Twitter, and blogs in general, but not as part of the emergency plan. None of the municipalities have procedures in place for systematic monitoring of social media. While several of the emergency coordinators see how this could be useful, lack of resources and challenges of verifying the information are stated as barriers for such efforts.

IMPLICATIONS AND FURTHER WORK

As illustrated by our mapping, there are several systems in use and a lot of efforts for the development of ICT solutions for crisis management. The vision of a common crisis response system available for all emergency stakeholders still seems far away. We argue in this paper that taking an information infrastructure perspective on ICT support for emergency management may support further adoption of new ICT support, by putting emphasis on how these new services are integrated with the existing information infrastructure familiar to the emergency responders. Information infrastructures develop and grow, i.e. they are built through extensions and improvements of the installed base, and not from scratch (Ciborra, 2001). Further, our results indicate a need for improved support for establishing situational awareness, especially in crises involving many stakeholders. Guided by this, our further work will focus on three areas where we aim to contribute improved coordination support: extended functionality for crisis mapping, citizen involvement through social media, and event monitoring.

Taking into account that all municipalities are using one or more kinds of GIS in daily activities such as spatial planning, it is interesting to explore the possibility of extending this GIS infrastructure with shared representation and visualization of information across organizational and domain-specific boundaries. Interactive maps are increasingly used in society in general and crisis management in particular. Use of maps with geo-located tweets is a promising strategy for visualization of events and crisis (Liu and Palen, 2010).

Further, we want to explore how social media can be integrated with existing geographical information systems in use, to support coordination within and across municipalities. Our study of current information systems used in local crisis response shows that all municipalities are using social media like Facebook and Twitter, but mainly for sharing information between local authorities and the local community. Only one of the emergency coordinators reported use of social media during events and crises, where a municipal employee monitored social media during special events and used this information as a resource in addition to other formal sources. Various studies have shown how social media have the capabilities to provide valuable information to emergency and contingency planning (Starbird and Palen, 2013; Starbird and Stamberger, 2010) and thus changing the "information pathways". For example, Starbird and Stamberger (2010) have developed the Tweak the Tweet syntax (TwT) to assist in computational filtering and classification of emergency related information tweeted during an event. Thus, it can be used as a coordination mechanism between formal and informal information and across contexts. In this research we will address the research gap of developing improved support for information dissemination and monitoring that is matched to the needs of emergency managers (NAS, 2013).

Finally, we will explore development of ICT support for shared event monitoring. While CIM is intended to

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serve as the standard system to be used for event logging in Norway, there are important stakeholders in the region that do not use this system (e.g. police, fire department). Also, users of CIM report challenges with providing sufficient training for effective use. In comparison, we find the use of Google Docs for event monitoring as part of the "virtual disaster desk" of Humanity Road to be an interesting example of an intuitive service enabling joint contribution from a distributed team (Starbird and Palen, 2013). In the further work we will analyse how this type of service could be a supplement to the event monitoring in CIM to increase situational awareness and support coordination.

The work on these activities will be conducted in close collaboration with crisis responders, with pilot trials conducted as part of crisis exercises in the region. Through this we aim to contribute to the development of an information infrastructure supporting effective crisis response coordination in the local municipalities.

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