Communication Problems in Crisis Response

Jonas Lundberg
Linköpings Universitet
Jonas.lundberg@itn.liu.se

Mikael Asplund
Linköpings Universitet
mikael.asplund@liu.se

ABSTRACT

This paper describes five problem areas of communication that occur during crisis response. These areas are communication infrastructure, situation awareness, individual and organizational common ground, form and content of messages, and communication paths through organizations. Five focus groups with Swedish field personnel from national and international crises were performed. The main contribution of this article is a hypothesis, based on the outcomes of the focus groups, about the relation between communication problems and how they interact with crisis response work.

Keywords

Communication, situation awareness, common ground, disaster information systems.

INTRODUCTION

Effective communication in crises is hard to achieve. In this paper we discuss the relation between five problem areas that degrade communication. The five areas affect communication between actors, who organize themselves in new or non-routine ways to meet the demands of a crisis. The actors is thus largely form an unfamiliar organization with unfamiliar actors, facing a new unfamiliar situation. Partially, it can resemble a centralized command-and-control situation, and partially a situation where independent and interdependent actors coordinate work towards shared goals (Comfort, 1994). Both command-and-control and coordination demands effective communication. Taking a step in the right direction, substantial research efforts have been directed at restoring damaged communication infrastructures that sometimes disrupts communication in crisis situations (Bowman, Graham Jr and Gantt, 2007; Kanchanasut, Tunpan, Awal, Das, Wongsaardsakul and Tsuchimoto, 2007; Patricelli , Beakley , Carnevale, Tarabochia and von Lubitz, 2009; Abi-Zeid and Doyon, 2003). However, as the current study highlights, communication is often experienced as ineffective despite a largely functional technical communication infrastructure. Four additional, interacting problem areas have been identified, namely situation awareness, organizational communication paths, common ground, and form and content of messages. We present a hypothesis of how they interact with each other, mainly through the variable of workload. The hypothesis has implications for the introduction of technologies meant to fix communication problems. It is grounded in qualitative focus groups with personnel who, with a few exceptions, have been working in the field during crises. They mainly had experience from three crises, of which two were major international crises, and one was a smaller national emergency. The three crises were the Asian Tsunami of 2004, the Israel-Lebanon crisis of 2006, and the Bodträskfors forest fire of 2006, which was the largest fire in Sweden in modern times. The commonality between these crises where that they required coordination of multiple actors over a large geographic area. During the Tsunami crisis, Swedish response personnel had to coordinate activity between several organizations, including organized volunteers, between staff in Sweden and on-site personnel. The Swedish (non-military) response to the Israel-Lebanon crisis, was an effort that involved staff in Sweden and field staff in four countries. The forest fire in the north of Sweden which raged for four weeks required the formation of a network of actors, including organized volunteers who participated in our focus groups.

Problem areas

We will now outline the communication areas discussed in the focus groups, which can potentially be problem areas if they are not properly addressed as part of the disaster communication environment.

> **Reviewing Statement**: This full paper has been fully double-blind peer reviewed for clarity, elevance, significance, validity and originality.

Communication infrastructure

The communication infrastructure might be damaged or overloaded during disasters, with the additional problem of radio systems of different actors not talking to each other (Comfort, 1995). Numerous papers describe technologies to restore the communication infrastructure through mobile communication units (Bowman et al., 2007; Kanchanasut et al., 2007; Patricelli et al., 2009) or through ad-hoc networks using mobile phones without sim cards (Asplund, de Lanerolle, Fei, Gautam, Morelli, Nadjm-Tehrani and Nykvist, 2010) to meet needs after disasters such as hurricanes (Banipal, 2006).

Communication paths

Telecommunication equipment that functions, in the sense that messages can be transmitted, is a prerequisite, but is not sufficient to reach the right people at the right time. That has not only been discussed in these focus groups, but also in focus groups discussing medical emergencies (Reddy, Paul, Abraham, McNeese, DeFlitch and Yen, 2009). Like in the small and large-scale emergencies discussed here, it has been shown that mobile phones are at present important for smaller-scale emergencies (that could escalate). The exchange of mobile phone numbers can be an important activity, and it has been proposed that other channels could also be integrated in the phone, rather than adding other devices (Landgren and Nulden, 2007). Previous research has also emphasized that emergent groups can be expected to take part in emergency response (Drabek and McEntire, 2002). They can also emerge from within existing groups (Scanlon, 1999). It has been proposed to design systems that dynamically visualize and keep track of the current organizational structure, of people registered in the system, and of their interactions (Oomes, 2004).

Situation Awareness

Situation awareness is one of the most important factors for a successful crisis response operation. As described by Endsley (1988), situation awareness refers to perception and understanding of situation elements, and projection of their possible status and activities at least in the near future. Lack of situation awareness will not only cause direct problems in logistics and resource management, it will also make communication between different actors and organizations less effective. A key problem to achieve situation awareness in crisis response is to both be able to quickly connect data resources from different actors while maintaining security of information that should not be shared. Some basic services needed for collaboration are for instance weather, logistics, video telecommunication (Phillips Jr, Ting and Demurjian, 2002). Collaboration tools could for instance allow people to share and annotate maps showing critical resources such as locations of shelters (Graves, 2004). For instance, map support has been shown to improve effectiveness for specific tasks in search-and rescue (Abi-Zeid and Doyon, 2003).

Common ground

In addition to technical and organizational layers of communication, there is a social layer. People who know each other can talk more effectively and briefly, on the one hand, but people who know but dislike each other may on the other hand choose not to talk to each other at all (Johansson and Hollnagel, 2007).

Form and content of messages

People engaged in different tasks needs information in different forms, a need which technology could support by providing different presentation formats (Reddy et al., 2009).

DATA COLLECTION AND ANALYSIS

Data was collected during five focus groups to elicit views, and contrasting views, on emergency response. Focus groups 1-3 were conducted with Swedish response personnel experienced in international missions. Two recent missions, in response to the Israel-Lebanon crisis of 2006 and the Asian Tsunami of 2004, were dominating cases, that the participants had experiences from. The aims of the two international missions were to support Swedish citizens. Focus groups 4-5 were, in contrast, with organized volunteers from a recent large

forest fire in 2006, in Bodträskfors in the north of Sweden. Similarly to the international crises, the actors needed to organize themselves in non-routine ways. The effort of the organized volunteer effort in the Bodträskfors fire aimed at supporting the fire fighting effort through taking care of surrounding tasks.

The invitation criteria for participants in focus groups 1-3 was experience in international missions, and in focus groups 4-5 most had experience of a large forest fire. Of those who were invited, we included those who had the possibility to attend to the focus groups. The participants in focus groups 1-3 had different initial roles in the missions: logistics, medical care, management, and informing. The participants in focus groups 4-5 also had different roles: manning road blocks, logistics (in particular food supplies), informing and helping with evacuation of the area, supporting management with a situation log.

The themes in focus groups 1-3 were: Assignment of staff to functions, establishing the staff and information paths, information exchange, and long-term knowledge transfer. Three themes in focus groups 4-5 focused on communication and dependence on communication technologies: On time, space, and situation awareness. There were three additional themes in focus groups 4-5: General experiences of the event, information security, and reactions to a technology demonstration. The central theme reported in this article is communication during emergency response.

These focus groups had both group interview and group discussion parts. As described by Boddy (2005), focus group interviews are highly moderated with little interaction between participants, who use for instance forms to fill in responses from the facilitator. In contrast, focus group discussions are based on discussion between participants.

For each theme in the focus groups, the participants were given a number of questions to think about and write down keywords about for a few minutes. They then told the other people about their view on the theme, in a round-robin fashion. After the group interview, the people were free to discuss the themes that they themselves found most important with each other for some time, before going to the next theme. The focus groups differed in character. Some were more focused on the group interview parts, with less discussion, whereas other focus groups tended to start discussions already during the group interviews. The focus group facilitator made sure everyone got the opportunity to talk now and then.

Each focus group was transcribed. Each utterance was assigned a number, a tentative subject, and stored in a database where utterances could be retrieved in chronological order or based on subject. Thus, each utterance could always be reviewed in the context of the surrounding conversation. Utterances covering several subjects were split, or given two tentative labels. Utterances covering one topic, that were intertwined in episodes between several respondents and which would be confusing viewed as fragments, were analyzed as a single unit.

As the focus group summary was written, utterances with similar subjects were grouped together, re-read, and summarized as sentences in the summary. Utterances relating to communication problems from all part of the focus groups were included in the analysis. During the analysis, the four communication problem themes presented below emerged.

Supporting utterances were marked in the text, so that they could be retrieved from the database for review at any time. The markings have been simplified here to a dyad (e.g. L1, informant L from focus group 1). When people basically agreed, this is shown by several dyads after a sentence. Often, individuals gave unique details and perspectives. The reader can thus see during what or which focus groups a topic were discussed – as well as look up other topics from the same individual. The results section is at large written as a thick description, common in qualitative research, to allow the reader to evaluate the evidence for the conclusions based on the data.

RESULTS

Table 1 describes four areas of communication problems that emerged from our analysis of the focus groups. Only minor problems were mentioned regarding the fifth area, communication infrastructure. The table also includes solutions suggested by the focus group participants, which further clarify the problems.

As shown in the first area in Table 1, basic issues such as communication about goals were sometimes seen as lacking, as well as communication about tasks. Reinforcements arriving as a surprise are a particular issue, since it indicates that the organization becomes even more confused. That's potentially increasing the problems in area two, of communication paths. The main problem was that information got "stuck", partly due to informal communication paths. A lack of practice in crisis response was a problem that the participants' thought

contributed. But high workload appeared to be an important problem too. High workload was also the main problem in the next area, form and content of messages. The form of communication was experienced as time consuming (increasing workload) as well as ineffective (people did not know what other's really needed to know), and a lack of content increased workload during hand-over of roles. The situation was made worse by a lack of common ground regarding basic concepts, potentially increasing the risk of erroneous decisions resulting in misdirected work (waste of resources, potentially higher workload on relevant tasks).

Problem areas	Communication problems	Suggested solutions
Situation awareness	Problems with communicating long and short term goals, functions, capacity, and resources. Uncertainty and worry resulted from reinforcements arriving as a surprise. Communication problems with dynamic information that's central to the task at hand.	
Communication paths	Problems finding the right person to contact. Information gets "stuck". Overloaded staff and unclear information paths were important problems. Informal communication paths helped some and hindered others. Lack of practice in informing others about own activities stopped information.	
Form and content of communication	Time consuming and ineffective forms of communication. Time-consuming hand-over of roles if documentation is lacking. High workload prevents time-consuming ways of documenting. Unclear what information other actors need	A common form for communication of central genres such as situation reports, both verbal and textual, could be helpful
Common ground	Different opinions and ideas about basic concepts, such as "sector" and "good road". Risk of misunderstandings causing erroneous decisions. General understanding of field by staff at home important to understand the field workers. Different communication styles in different organizations. Staff rotation affects communication since it takes time for people to get to know each other.	A book of definitions of basic concepts was suggested in the focus groups.

Table 1. Summary of communication problems and suggested solutions from focus groups

The following sections presents results regarding each area in Table 1: Situation awareness, communication paths, form and content of communication, and common ground.

Situation awareness

Situation awareness was discussed in all five focus groups. Regarding communication to achieve situation awareness, in the international missions, communication of goals and resources was seen as critical, including changes in resources or goals [P3, N2, F2, A2], as well as what has been done, what will be done, and basic tasks [P3, J3, A3]. As an example of a task-related communication goal for the organized volunteer group response at the Bodträskfors forest fire, there were instructions about who to let through roadblocks, information which was unfortunately unclear [U4]. This problem recurred yet again later on, when an important visitor arrived and the roadblocks were put up again. [U4]. In addition to practical task-related needs it felt good to be informed. As one informant pointed out, it felt important to know whether the fire was under control (even thought they weren't directly involved in putting it out) [E5].

Workload management can be affected by situation awareness. That Swedish teams lack endurance could be improved by keeping track of goals for the short run [E2]. Also, information about capacity is important for work divided into sectors, since some sectors might have overcapacity that other sectors need [E2]. Confused situation awareness also created communication problems. One problem making communication difficult, as one informant reported, the four staffs in Sweden in the Lebanon operation had different views on what the situation was like, resulting in different policies for sending out staff [J3].

It's worth noting that not all informants in the international missions thought that the communication problems were important or would occur again. One informant thought that the organizations had already learned their lesson and that the problems that had occurred in the Lebanon operation were therefore a unique occurrence that will not repeat itself [P1]. Another informant had not experienced any problems with communication [T1]. On the contrary, in hindsight, communication and coordination are always lacking when reviewing previous operations, one informant thought [J3].

Reinforcements arriving as a surprise

Reinforcements arriving as a surprise were a particular communication and situation awareness problem in the international missions (discussed in focus groups 1-3), since it can contribute to unclear communication paths. There were mixed experiences of reinforcements being expected or arriving as a surprise. As some respondents thought, when other Swedes appear, apparently out of the blue, then that created a sense of uncertainty and a sense of not knowing who is on the site. It was particularly uncomfortable in management positions [A2, F2]. As one informant experienced, when new staff unexpectedly arrived and the orders for the staff on site to stay or go home at the same time changed, that caused some worry [V3]. It should be pointed out that in both international missions, some informants thought it was clear who was on the site [T3, A3, P3]. Regarding the Thailand mission an uncertain factor was what staff, and how many would appear [T3, A3]. One informant from the Cyprus staff in the Lebanon mission thought that the uncertain factor were how many people that would need rescuing [P3]. Another respondent thought that poor coordination between reports by different organizations staffs in Sweden resulted in medical staff appearing in Cyprus that no one else knew of [J3].

As an informant reflected, also in other kinds of operations like UN operations, other units and countries appear on the scene without warning [E2]. Also in the search and rescue teams in earthquake rescue operations, unexpected teams were encountered, one informant had experienced [A3].

The informant who had not experienced communication problems was also unsurprised by reinforcements [T1].

Communication paths

In all focus groups, communication paths were discussed. Unclear communication paths can degrade situation awareness. As experienced by people in the international missions, there is a risk that information will "get stuck" in the organization and not be passed on to people who might need it [P1, F2, F2]. A factor contributing to the disorganized communication was lack of feedback on the current formal organization, so that people did not quite know where to report [A2, F2, I2, E2, J2]. People tend to contact whoever they think has the best information, bypassing the local staff, especially when the formal communication paths are not clear [T3]. Another factor might be that one erroneously thinks that one has informed someone about something, resulting in the illusion that information "gets stuck" [T1]. Information flow also suffered from people unused to disaster work, who report nothing, and ask no questions [A3]. It's moreover important to understand what other people need to know, to be able to communicate [A3, P3]. In the Thailand mission, staff in Phuket was overloaded and unable to respond to the Crabi team.

In the Lebanon operation, there was no official and well-known information structure with information collection points and responsible for disseminating information to different places. The situation, as experienced by some of the focus group participants, was not optimal. For instance, as one informant reported, officials called from different places, seemingly unaware about each other [T1]. It was not entirely clear, when several organizations were collaborating, whether to report to the own staff in Sweden, or to the staff at the site [I2, F2]. This resulted in many different bosses for the operation even though the plan was to have one organization in charge [I2, A2]. One informant through that there might not even have been a common organizational structure agreed upon at senior management levels [I2]. One informant reported having thought that information sent to the staff in Cyprus would be distributed to everyone; something that another informant agreed was not the case [P1, A1].

There were several ideas about how to prevent information to get stuck. Responsibilities for communication must be clear [N2], especially a responsibility to report back [A2] or passing information on [L1]. At the very

minimum, people should get in touch, even if they are unsure whether they have anything to share [P3]. One suggestion was the staff at home could be more active in asking for information [T3]. Social networks are also important, since it's easier to contact someone you know [A1]. The networks need to be built in each mission, something that goes faster if people already know each other [L1]. Training is needed to get the social networks [P1]. On a larger scale, organizations need to become more similar [T1], and on a smaller scale it is important to have regular information sessions so that people know when to expect the next update [L1 T1 P1, I2]. On the individual level, there is also an own responsibility to search information [N2] as well as attitudes towards the mission. People need to want the operation at large to succeed, to want to share information that other people need [A2].

The problems in the Lebanon and Thailand missions were reflected on a smaller scale, in the response of the Bodträskfors forest fire, where a response group of organized volunteers were responsible for manning roadblocks and logistics for food. The organization was unclear, it was hard to find out whom to contact, one informant thought [U4]. No note with phone number had been handed out. [U4]. However, there was a note with phone numbers that was constantly updated at one of the staff positions [R5, S5, M5, E5]. Also, in the small scale Bodträskfors response situation, a some members of the organized volunteers mentioned that they often kept communication informal, within their group [A4 U4], and that talking to people resulted in a good view of the situation [S5].

Common ground

Common ground was an issue that was discussed in focus groups 1 and 3. Different frames of reference can result in widely different interpretations of the same situation, that is, unclear situation awareness. For instance, one respondent recalled that two people had described the same road in contradictory ways. One individual described the condition as poor, comparing the road to normal city roads. The other individual described the condition as excellent, comparing to poor African roads [P1]. Also, people sometimes have different views on basic concepts, such as "a sector" [P3]. A book defining basic concepts was suggested to help maintaining common ground.

Another factor seen as important for communication was that the staff in Sweden should be experienced field workers, so that they could understand problems from the field [A3]. One observation was that people who know each other might need only one word to communicate [T1]. Staff rotation is thus important, since it takes time for people to get to know each other and establish common ground for communication [V3]. Also, different organizations have different or styles of communication [P3, J3].

Form and content of communication

Form and content of communication was discussed in all five focus groups. The ability to inform, to feed the processes needed to achieve situation awareness, was seen by the informants as suffering from high workload. As some informants had experienced, there had been few written reports home in the first days [P3]. Verbal reports had instead been done using telephone [V3, J3]. If you have too chose between taking care of 800 refugees at the quay and writing reports, then you take care of the refugees [J3]. Also, during high workload, meeting notes would be disorganized, providing poor material for the staff attempting to inform [N2]. But meeting notes that are actually made should be made available [L1]. Organization culture also affected what was written down. Some organizations have an oral culture whereas others are used to writing things down [P1].

It was suggested that it would be better to report through phone [T3] or by sending an audio file [J3] than to spend hours writing a report. The respondents also noted that just entering information into the computer is not the same thing as making it accessible since there might be a lack of computers for people to use to access it [L1 P1 A1].

Further emphasizing the effects of workload, it was noted that exhausted teams do not have the capacity to listen to situation updates [A3, J3, T3]. When people are tired, then they need very short and clear messages [J3, E2]. With too little documentation, handing over a function to new staff takes longer, since the person must go side-by-side for a longer time [I2].

There were suggestions about how to improve communication. One suggestion to improve communication was to use a template for reports, so that one does not have to start out with an empty sheet [A3]. The reports should follow a structure, maybe supported by a checklist [P1], as a point of departure for improvisation [A3]. Also for verbal communication, there should be a known structure, which makes things easier when using for instance bad phone lines [L1]. There should be a known basic pattern for describing situations, e.g. the object and situation, it's background, and it's future including plans for own acts [P1]. The reports should be common for

all organizations, rather than each organization making their own report [L1]. That could also result in reports that are easier to compare and make it easier to find important information [J3]. These suggestions further emphasize the need for communication support to reduce workload demands from informing others.

In the Bodträskfors response mission, one of the organized volunteer informants thought that there had been no information meetings giving the big picture, and no fixed times for communication [U4]. Others thought, on the contrary, that one could get a view of the picture from others, after being on post [I5 R5 S5 E5] or during shift hand-over [S5, I5]. Some thought that contradictory views regarding situation awareness were due to people who were temporary from other locations and who were involved rarely got a worse view of the situation [S5 M5 R5 E5]. The head of the organized volunteers thought that there was a good view on the situation. As a coincidence, one of the volunteers had got hold of a good map of the area, that the head of the response (as a whole, not just the volunteers) did briefings at, which gave them a good view of the situation [I5, E5 R5 S5]. Another informal information channel available to some were that they talked to helicopter pilots when they were eating [E5 R5 S5].

DISCUSSION

This study has presented four problem areas that occurred in crisis communication, in addition to problems with communication infrastructure (Table 1). The problems occurred despite the fact that the infrastructure for communication was largely functional in the missions discussed during the focus groups. The study has also verified and strengthened previous research on communication in crisis response, in that some critical areas of communication recurrently cause problems for response teams. It is telling how some of the same problems that occurred in the larger Lebanon and Thailand crises also occurred on a much smaller scale in the Bodträskfors forest fire response, in particular unclear communication paths. Also, surprising appearances of personnel were not unique form the Lebanon and Thailand missions, but some participants had experienced it also in previous missions they had been involved in. The recurrence of these problems suggests the problems are both important to solve, and non-trivial to solve.

A hypothesis, based on the outcomes of the focus groups, and including the classic problem of infrastructure, of how problem areas influence each other is illustrated in Figure 1. Technical infrastructure obviously is a prerequisite for communication. However, despite largely functional telecommunication, there were problems achieving situation awareness (Table 1). Using the infrastructure, communication paths are needed to know who to contact, to mediate situation awareness – which is also needed to know about communication paths. The communication problems were thus at least partly due to unclear communication paths, being unable to know whom to contact, during high workload. The form and contents of messages (e.g., lack of templates for writing reports) increased the problem of high workload. The communication problems are thus related to each other, with workload being generated through forms of communication, and making the problem with communication paths worse. Communication goals and common ground were also related. Incorrect decisions due to lack of common ground regarding terminology, can lead to high workload from incorrect decisions, as well as degraded situation awareness.
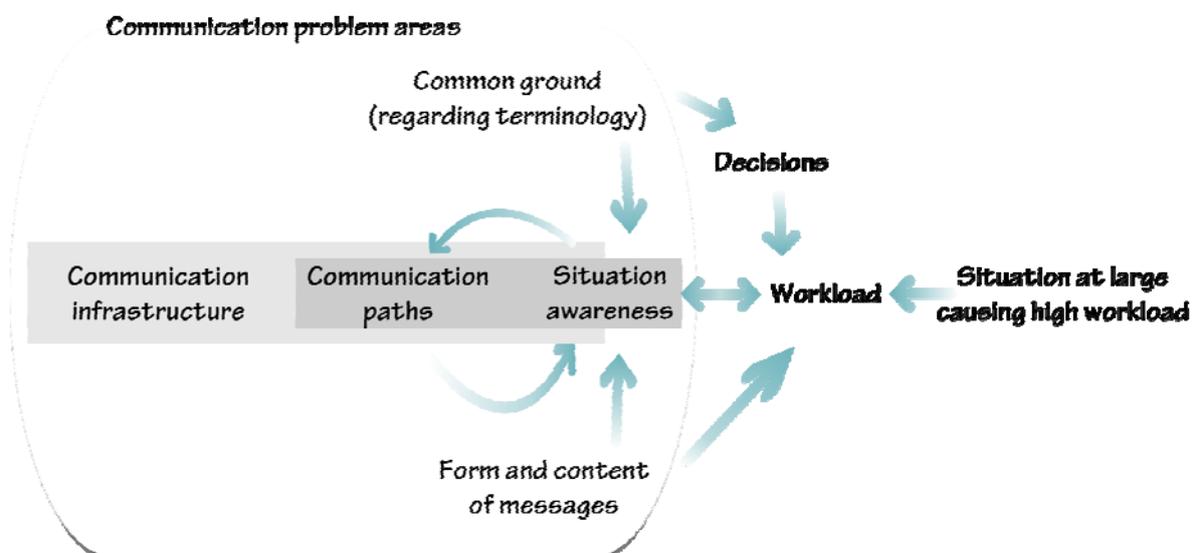
Figure 1. Hypothesis about how areas of communication problems influence each other

Communication problems and technical solutions are here summarized in five areas (Table 2). Of those, the first three have received considerable attention in the previous work cited here. This study has confirmed previous research in that two areas are critical, causing problems, in emergency response (areas two and three, Table 1). It also points at two additional areas that could be of importance (areas four and five, Table 1).

Problem areas	Communication problems	Technical solutions
Technical infrastructure	*Damaged physical communication network or systems that do not work together (Banipal, 2006; Comfort, 1995)*	*Mobile communcations units (Bowman et al., 2007; Kanchanasut et al., 2007; Patricelli et al., 2009)* *Ad-hoc networks using mobile phones without sim cards (Asplund et al., 2010)*
Situation awareness	Problems with communicating long and short term goals, functions, capacity, and resources. Uncertainty and worry resulted from reinforcements arriving as a surprise. Communication problems with dynamic information that's central to the task at hand (also Reddy et al., 2009).	*Basic services needed for collaboration (e.g. weather, logistics, video telecommunication) (Phillips Jr et al., 2002). Integrating services in mobile phones (Landgren and Nulden, 2007).* *Collaboration tools for particular tasks (Abi-Zeid and Doyon, 2003; Graves, 2004).*
Communication paths	Problems finding the right person to contact. Information gets "stuck". Overloaded staff and unclear information paths were important problems. Informal communication paths helped some and hindered others. Lack of practice in informing others about own activities stopped information. *Problems could potentially increase by the formation of emergent groups outside (Drabek and McEntire, 2002) and within (Scanlon, 1999) existing groups.*	*Dynamic visualization of the current organizational structure, and interactions (Oomes, 2004).*
Form and content of messages	Time consuming and ineffective forms of communication. Time-consuming hand-over of roles if documentation is lacking. High workload prevents time-consuming ways of documenting.	A common form for communication of central genres such as situation reports, both verbal and textual, could be supported by technologies.
Negotiation of common ground in communication	Different opinions and ideas about basic concepts, such as "sector" and "good road". Risk of misunderstandings causing erroneous decisions.	Technologies supporting definitions of basic concepts.

Table 2. Problems versus technical solutions needed in integrated disaster communication systems. (Problems and solutions from focus groups, and (in italics) from previous research.)

The literature also proposes different technical solutions that relate to some of the problems (Table 2). Of the

suggestions from the focus groups, the idea to have a book of definitions of basic concepts (Table 1) can be generalized to "technologies" for basic concepts (Table 2). This research suggests that it would be beneficial to solve all five of the problem areas to achieve effective crisis communication. Naturally, these problems cannot be tackled with technology alone, but also requires organizational changes, training of personnel and so on.

CONCLUSION

This research has presented a hypothesis of how five problem areas in crisis communication interact with each other and with workload arising from crisis work (Figure 1). The four problem areas identified here, in addition to the previously well-researched problem of communication infrastructure, were situation awareness, communication paths, form and content of messages, and common ground (Table 1). Technical solutions have been proposed to solve some of them (Table 2). This research indicates that it would be beneficial to solve all of them, and that the solution must not present higher workload demands than current work practices. Further research is needed to evaluate the hypothesis during exercises or field studies of crisis work.

ACKNOWLEDGMENTS

REFERENCES

1. Abi-Zeid, I. and Doyon, B. (2003) Using a geographic decision support system to plan search and rescue operations, *International Journal of Emergency Management,* 1**,** 346-362.

2. Asplund, M., de Lanerolle, T., Fei, C., Gautam, P., Morelli, R., Nadjm-Tehrani, S. and Nykvist, G. (2010) Wireless Ad Hoc Dissemination for Search and Rescue, *Proceedings of the 7th International ISCRAM Conference*, Seattle, WA.

3. Banipal, K. (2006) Strategic approach to disaster management: lessons learned from Hurricane Katrina, *Disaster Prevention and Management,* 15**,** 484-494.

4. Boddy, C. (2005) A rose by any other name may smell as sweet but "group discussion" is not another name for a "focus group" nor should it be, *Qualitative Market Research: An International Journal,* 8**,** 248-255.

5. Bowman, M., Graham Jr, J. and Gantt, J. (2007) Robust and affordable mobile communications for emergency management, *International Journal of Emergency Management,* 4**,** 649-669.

6. Comfort, L. (1994) Self organization in complex systems, *Journal of Public Administration Research and Theory,* 4**,** 393-410.

7. Comfort, L. (1995) Self organization in disaster response: the great Hanshin, Japan earthquake of January 17, 1995.

8. Drabek, T. E. and McEntire, D. A. (2002) Emergent Phenomena and Multiorganizational Coordination in Disasters: Lessons from the Research Literature, *International Journal of Mass Emergencies and Disasters* 20**,** 197-224.

9. Endsley, M. R. (1988) Situation awareness global assessment technique (SAGAT), In *Proceedings of the National Aerospace and Electronics Conference (NAECON)*, Vol. 3 IEEE, Dayton, OH pp. 789-795.

10. Graves, R. (2004) Key Technologies for Emergency Response, *Proceedings of the first International ISCRAM Conference*, Bruxelas, Bélgica.

11. Johansson, B. and Hollnagel, E. (2007) Pre-requisites for large scale coordination, *Cognition, Technology & Work,* 9**,** 5-13.

12. Kanchanasut, K., Tunpan, A., Awal, M., Das, D., Wongsaardsakul, T. and Tsuchimoto, Y. (2007) DUMBONET: a multimedia communication system for collaborative emergency response operations in disaster-affected areas, *International Journal of Emergency Management,* 4**,** 670-681.

13. Landgren, J. and Nulden, U. (2007) A study of emergency response work: patterns of mobile phone interaction, *Proceedings of the SIGCHI conference on Human Factors in computing systems*.

14. Oomes, A. (2004) Organization awareness in crisis management, *Proceedings of the first International ISCRAM Conference*, Bruxelas, Bélgica.

15. Patricelli , F., Beakley , J. E., Carnevale, A., Tarabochia, M. and von Lubitz, D. K. J. E. (2009) Disaster management and mitigation: the telecommunications infrastructure, *Disasters,* 33**,** 23−37.

16. Phillips Jr, C., Ting, T. and Demurjian, S. (2002) Information sharing and security in dynamic coalitions, *Proceedings of the seventh ACM symposium on Access control models and technologies*.

17. Reddy, M. C., Paul, S. A., Abraham, J., McNeese, M., DeFlitch, C. and Yen, J. (2009) Challenges to effective crisis management: Using information and communication technologies to coordinate emergency medical services and emergency department teams, *International Journal of Medical Informatics,* 78**,** 259-269.

18. Scanlon, J. (1999) Emergent Groups in Established Frameworks: Ottawa Carleton's Response to the 1998 Ice Disaster, *Journal of Contingencies and Crisis Management,* 7**,** 30-37.