Inter-organizational Collaboration Structures during Emergency Response: A Case Study

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ABSTRACT

This paper examines the problem of achieving efficient inter-organizational collaboration during emergency response. The authors interviewed 11 representatives from Norwegian emergency agencies and supporting organizations about a hypothetical scenario involving a large-scale chemical incident. The interviews resulted in the identification and categorization of more than 45 actors that would be involved in the response effort, clarification of the individual capabilities and knowledge those actors would possess, and descriptions of how they would interact and communicate with each other. The results illustrate the complexity and necessity of achieving inter-organizational collaboration by showing how capabilities and knowledge are distributed and communicated across different actors, and suggest that such communications are mainly verbal. Based on this, the paper discusses challenges and opportunities for improving inter-organizational collaboration in the future.

Keywords

Emergency management, inter-organizational collaboration, communication, network

INTRODUCTION

A key factor in the successful handling of large-scale emergencies is the effective collaboration between emergency agencies and non-governmental organizations (Granot, 1997). Unfortunately, research and after-action reports have shown that such collaboration is often not achieved. For example, in a study of the relationships that emerged between public, private, and nonprofit organizations following the 9/11 attacks, (Kapucu, 2006) concluded that effective decision making had been hindered by limited coordination and inter-organizational communications. Similarly, the concluding report on the 22 July 2011 terrorist attacks in Norway stated that the emergency agencies were unable to effectively communicate and coordinate their efforts (Gjørv, 2012). The key challenges of multi-agency collaboration have been identified and categorized into three main groups: efficient communication across emergency agencies; establishing and maintaining shared situational awareness; and achieving adequate organizational understanding (Eide, Haugstveit & Halvorsrud, 2012).

Together, these findings calls for an improved understanding of the underlying structures that govern inter-organizational collaboration in today's practice. This paper adds to that understanding by examining the collaborative structures that could appear between organizations that would likely be deployed in response to a hypothetical, large-scale chemical incident in Norway. Specifically, we (1) identify and categorize the actors that would be involved in the response effort; (2) clarify the individual capabilities and knowledge those actors would possess; and (3) examine how (and how much) the actors would interact and communicate with each other. The study was based on a constructed, hypothetical incident scenario, discussed in the next section, and involved 10 in-depth interviews with 11 experienced representatives from the Norwegian emergency agencies and associated organizations likely to participate in the emergency effort. Based on the findings of the study, we discuss the challenges of inter-organizational collaboration, as well as opportunities and recommendations for improving such collaboration in the future. The research reported in this paper is part of BRIDGE[1], a four year collaborative EU project that develops solutions for supporting multi-agency collaboration during emergencies.

[1] http://www.bridgeproject.eu/en

INCIDENT SCENARIO

The incident scenario used to study inter-organizational collaboration structures was based on a large-scale explosion in a Norwegian factory that stores chemical fluids and gases. The incident scenario was developed by members of the research team, and validated by an expert working with safety in the chemical industry. The expert gave valuable feedback that improved the realism of the scenario, and provided general suggestions for improvement. In the process of developing and detailing the scenario, the following requirements were taken into account: complexity (the scenario must be complex enough to involve multiple agencies, organizations, and outside expertise); concreteness (the scenario must include enough details to allow the participants to identify the relevant actors); and realism (the scenario must be realistic).To emphasize the dynamic nature that often characterizes large-scale emergencies, the scenario was divided into three phases. Each phase included additional details about the unfolding events. In the list below we reproduce the descriptions of each phase of the scenario exactly as it was presented to the interviewees. The term "you" is used in the descriptions to direct the text towards the interviewee.

- **Phase 1 - Explosion:** On a Tuesday at 10:00 am you receive information that there has been an explosion at a factory known to store chemical fluids and gases. The factory consists of several separate buildings and storage tanks. Several nearby witnesses have observed smoke, flames, broken windows and loud noise at the factory. Some of the witnesses also report feeling an earthquake-like shaking in buildings. Outside it is 6°C and raining, with wind coming from north at 10 m/s.
- **Phase 2 - Evacuation:** The time is now 10:20 am. The incident site is characterized by chaos, and there are many wounded and traumatized factory employees in the area. Some buildings have collapsed, and other buildings are heavily damaged. The number of people within the area/buildings is not known.
- **Phase 3 - Leakage:** The time is now 10:30 am. There is a high risk of new explosions at the incident site. Additionally, factory employees coming out of the factory have reported that there is a leakage in one of the storage tanks containing ammonium gas.

In addition to the textual descriptions, the scenario was further supplemented with a map of the incident area, and illustrations of the factory showing buildings and infrastructure in the area (see examples in

Figure 1). Intentionally, the descriptions of the three phases of the scenario do not include any references to specific actors that could take part in the response effort, as identification of actors was one of the tasks for the interviewees during the interview.

Figure 1: Map of the incident area and illustration of factory infrastructure

METHOD

To examine the inter-organizational collaboration structures that could be deployed during the emergency response effort for the given incident scenario, 10 semi-structured interviews were conducted in Oslo, Trondheim, Stavanger and Sandnes between the 7th and the 22nd of June 2012. The rationale for choosing semi-structured interviews as a method was that it in addition to following a predefined interview guide gave the interviewers the opportunity of being flexible and providing additional questions related to what the interviewees answered. Some criticism of semi-structured interviews is that one cannot do comparisons between interviews because the data is not standardized across cases (Lewis-Beck, Bryman, & Liao, 2004). However, for the present study, the method of semi-structured interviews was regarded as appropriate because no comparisons

between cases were to be made in the analysis. Further, the method's allowance for follow-up questions was seen as advantageous in relation to gaining more in-depth insight into the complex domain in question.

Interviewees were recruited through the contact network of the BRIDGE project. The interviewees that were asked to participate in the study had to fulfill the underlying prerequisite of having leader experience with handling emergency response efforts in inter-organizational environments, within their respective organization. A total of 11 interviewees took part in the study; 8 representatives from the emergency agencies and 3 from organizations likely to contribute in an emergency response efforts involving chemical spills. One interview included two participants, while nine participants were interviewed separately. All interviewees were men between the ages of 37 and 62 (M = 47.9, SD = 8.5)**,** with a mean work experience from emergency response of 22.5 years (R = 10 – 36, SD = 8.5)**.** The participants from the emergency agencies had leader experience from the following professional roles: Police Operational Leader and Incident Commander, Fire and Rescue Commanders, and Health Commanders. Each of these 8 interviewees had experience from large-scale emergency response efforts (e.g. the collapse of the Alexander L. Kielland platform, high-speed ferry accidents, forest fires, flooding, railway accidents, tunnel fires, industrial chemical spills and explosions) involving high numbers of response personnel and patients. The interviewees from organizations likely to participate in the incident included an Emergency Response Advisor from a municipality and 2 Industrial Safety Teams Leaders. Their experience included coordination of their respective organizations' work-effort during various emergencies (e.g. the 22/7 terror attack at Oslo and Utøya, industrial accidents), and participation in training exercises with the emergency response agencies.

Prior to the interview, participants received an information sheet explaining the purpose of the study, the procedure, and they were informed that interview was going to be based on a scenario portraying an industrial accident. However, the detailed description of the scenario was not disclosed prior to the interview.

During the interviews, the interviewees were presented with the descriptions of the three phases of the incident scenario in a structured manner. To facilitate the interviewees' understanding of the scenario, supplementary material was provided to them in addition to the textual description of each phase; Phase 1: a generic chart of the Norwegian emergency management hierarchy based on the Police Emergency Preparedness System (PBS1[2]), and a geographical map of the incident area; Phase 2: an illustration of the factory site, the exact position of the explosion, and affected buildings in the near vicinity; Phase 3: an updated illustration of the factory site depicting the gas leakage. For each phase, participants were asked to explain which actors they thought likely to take part during the emergency response effort, including themselves, actors from their own agency, and other actors that would provide them with support or critical information. For each identified actor, the interviewees were asked to explain which role, capabilities, knowledge and expertise the actor could contribute with for the given incident. The interviewees were also asked to indicate who the identified actors would communicate with during the emergency response, explain which types of information that would be communicated, and how the communication would be mediated (e.g. radio, telephone). Each interview lasted approximately 1.5 hours.

The interviews were audio-recorded for later analysis. In addition to the interviewer, an assistant was present to help with the data collection, take notes and pose follow-up questions to complete the predefined information templates for each of the actors identified during the interview. The audio-recordings were carefully analyzed after the interview to ensure that all the details revealed during the interviews were included in the templates. Information about an identified actor in the individual templates was merged into a common template in the case of multiple mentions of an actor type. The merged templates were then used for analysis. A cluster analysis was conducted by comparing the actors' nature of participation in the incident to establish a consistent categorization. The purpose of a cluster analysis it to establish a classification of different units (here: actors) into groups, based on their similarities on some variables (Lewis-Beck et al. 2004). To examine the information being exchanged between actors, a content analysis was conducted, systematically sorting out both the information that the different actors would need from - and provide - for other actors (Lewis-Beck et al., 2004). The visualization program Gephi[3] was used to analyze and visualize the pattern of communication among the different actors.

[2] https://www.politi.no/vedlegg/rapport/Vedlegg_1660.pdf

[3] https://gephi.org/

RESULTS

Actors and Capabilities

Altogether, more than 45 actors were identified as plausible contributors to the emergency response effort of the given incident scenario. The list of actors covers public, private, and nonprofit organizations. The cluster analysis of actors resulted in five categories: emergency agencies; supporting organizations; external expert organizations; informants; and other actors. In this section, we provide in-depth descriptions of the identified categories and the most central actors of each category.

Emergency Agencies

The Emergency Agencies category includes governmental agencies that are prepared to handle emergencies. The emergency agencies initiate, coordinate and lead individual parts of the main emergency operation, and are also active during some of the aftermath activities (e.g. additional investigations of an incident). The actors identified for this category include the *Police*, the *Fire and Rescue service*, the *Health service*, the *Joint Rescue Coordination Central* (*JRCC*), and the *Local Rescue Coordination Central* (*LRCC*).

The identified actors hold a wide variety of capabilities and knowledge that are crucial for handling the incident, and operate within different levels of the emergency response hierarchy. The *JRCC* is responsible for the coordination of search and rescue operations at a national level, while the *LRCC* hold the responsibility of coordination at a local strategic level. Specific tasks include keeping a situational overview of different operations at their respective level of responsibility, and handle requisition, allocation, and prioritization of resources between different incidents. The individuals working at the *JRCC* and the *LRCC* usually have experience from the police or from other fields that are central in emergency response work, and therefore hold a variety of knowledge and capabilities depending on individual experience and previous work background.

Within the *police*, the *fire and rescue service*, and the *health service*, several actors from different hierarchical levels were identified. The actors that function at an operational level are typically not present at the incident site, but operate from the emergency agencies' operational centrals and emergency call centrals (110, 112, and 113 for fire, police and health, respectively), coordinating information, receiving emergency calls from the public, contacting liaisons and advisors, and communicating information to the tactical level. Actors operating at the tactical level are working on-site, physically participating in the emergency response effort and performing the on-site work tasks that are relevant for the respective agency they belong to. Specific knowledge and capabilities varies between agencies and work role, and between individuals depending on levels of experience and training. In Norway, the police have the overall responsibility for organizing, leading, and coordinating an emergency operation. Six police actors were identified: *Chief of Staff*, *Operational Staff, Operational Leader*, the *112 Central* (operational level), *Incident Commander* and *police personnel* (tactical level). Some police specific tasks during the given incident would be to capture and arrest potential perpetrators, conduct a registration of all who are involved, notify relatives of victims, set up barriers for easier control of the area, and provide information to the media about the incident. The *fire and rescue service* are in charge of an incident site until the police arrive. Four fire and rescue actors were identified in the study: *Fire and Rescue Operational Staff* and the *110 Central* (operational level), *Fire and Rescue Commander* and *fire and rescue personnel* (tactical level). The *fire and rescue service* is responsible for saving lives, securing areas within their expertise, extinguishing fires, perform technical rescue work, and identify, monitor and handle dangerous substances. The *health service* is responsible for the medical treatment of patients and saving lives. They offer physical and mental treatment for patients, prioritize patients through triage, and provide transportation to the hospital. Four actors from the health service were identified: the *113 Central* (operational level), *Health Commander*, *Health Coordinator*, and *health personnel* (tactical level).

Supporting Organizations

The Supporting Organization category includes all organizations that take an active part in the emergency response effort based on their own internal contingency plans, providing on-site support for the emergency agencies. The supporting organizations identified in the study were: *Forum for Volunteering Organizations* (*FORF*), *The Norwegian People's Aid* (*NPA*), *The Red Cross*, *The Norwegian Civil Defence* (*NCD*), the *Industry*, the *Municipality*, *The Norwegian Coastal Administration* (*NCA*), and *Inter Municipality Committee for Acute Pollution* (*IUA*). Some supporting organizations would in the given scenario participate in the emergency effort based on their obligated areas of responsibility (e.g. *industrial safety team*, *IUA*, *municipality*), while other organizations are humanitarian relief organizations and participation is mainly based on voluntary work (e.g.

FORF, *NPA*, *the Red Cross*).

FORF, *NAP*, *The Red Cross*, and *NCD* all provide on-site assistant to the emergency agencies, holding knowledge about evacuation, search and rescue operations, first aid, psychological support, and human care. In addition, these organizations can contribute with equipment such as vehicles, blankets, tents, food, and heating equipment. The organizations may also include individuals with capabilities and experience with medical care, decontamination, gases, explosion hazards and radioactivity measurements.

Actors from the industry include a variety of groups within the organization, such as the *industrial emergency department*, the *industrial management*, and the *industrial safety team*. They can assist the emergency agencies in the emergency work by providing important information about factory employees and visitors, the factory buildings, chemicals stored in the area, and volume of tank containers. A Norwegian industrial factory such as the one portrayed in the present study's scenario shall according to Norwegian laws have established emergency plans for handling events that threaten life, health, and the environment (Lovdata, 2012).

The *municipality* plays an important role during a crisis, having a general responsibility for its citizens. Different municipalities have to a large degree conducted risk- and vulnerability analyses for the local community, examined possible consequences of potential events, and implement preventative actions (NOU, 2001:31). The municipality can in the given scenario contribute with information about the municipality's infrastructure, population and industries, implement actions to mitigate acute pollution, and provide health and care services and other additional resources if necessary.

NCA and *IUA* have a duty on behalf of the government to maintain preparedness for and respond to major instances of acute pollution. During the response effort, *NCA* and *IUA* could contribute with personnel, expertise, and equipment for preventing and limiting pollution caused by the incident.

External Expert Organizations

The External Expert Organizations category includes organizations that aid the emergency response effort by providing their expert knowledge from their respective fields of expertise. Representatives from these organizations are typically not present at the incident site. The external expert organizations that were identified as contributors for the given scenario were: *Meteorological institutes*, *Nuclear, Biological and Chemical Center* (*NBC*), *Directorate for Civil Protection and Emergency Planning* (*DSB*), *Norwegian Water Resources and Energy Directorate* (*NVE*), *Climate and Pollution Agency* (*KLIF*), *Norwegian Food Safety Authority* (*NFSA*), *Norwegian Radiation Protection Authority* (NRPA), *Petroleum Safety Authority Norway* (*PSAN*), *Poison Information Central* (*PIC*), *Norwegian Defense Research Establishment* (*FFI*), and *Crane services*.

The majority of the external expert organizations identified in the study hold knowledge about pollution, and the impact and handling of a chemical leakage. General information about chemical gases is provided by *NBC*, *DSB*, *PIC*, and *KLIF*. *NBC*, *NFSA*, *PIC*, and *DSB* can assist with information regarding health risks associated with the chemical leakage and recommended treatment of patients, while information about how chemical spills might impact the environment is given by *KLIF*, *NFSA*, *NRPA* and *PSAN*.

During an incident, it will always be important to obtain information about weather conditions and possible changes, as this might affect the emergency response work directly. *Meteorological institutes* and the *NVE* provide the emergency agencies with information about weather and water flow, for the present and for the near future. The *crane services* contribute with expert capabilities in how to perform lifting services during rescue operations. They also have access to equipment for lifting if extra resources are needed, and can assist in the emergency efforts on site.

Informants

The Informants category includes individuals that aid the emergency response effort by providing information based on his/her general knowledge or observations before and during the emergency. The informants are typically present at the incident site, but do not usually participate directly in the emergency response work. The actors identified as informants for the given scenario were mainly *witnesses* (e.g. industry employees and *transporters* that deliver and/or collect dangerous substances from the factory).

Witnesses can sometimes provide crucial information, e.g. regarding the chain of events, the number of wounded people in the area etc. Industry employees may hold information about the infrastructure of the factory, work procedures, and the number of people that might be trapped inside the buildings. *Transporters of dangerous substances* could provide information about the chemical substances that are stored at the factory or in vehicles, and usually has knowledge regarding the risks and challenges associated with these chemicals.

Other Actors

The Other Actors category includes organizations and individuals that aid the emergency response effort by providing support and services within their respective fields of authority. Other actors identified in the study were: *County Governor's Emergency Manager and Advisors* (*CGEM*), *Port Authorities*, *Avinor*, *Telenor*, and the *media*. The *CGEM* hold knowledge about the local society and are trained in collaborative operational staff work with the emergency agencies and representatives from supporting- or external expert organizations. Specific responsibilities are to ensure that all actors in the county have a mutual understanding of their roles and responsibilities, and that predefined plans and procedures are working as expected and are not contradictory.

Avinor are responsible for operating the Norwegian air traffic and airspace. Having access to manned fire engines located at the airports, they could potentially contribute in the emergency response effort if extra resources are needed. In addition, Avinor and local base towers can provide information about present and future weather conditions.

Telenor is Norway's largest supplier of telecommunication and data services. The company holds knowledge about for example network load or possible errors due to high network traffic. Telenor can in a crisis situation, as in the given scenario, provide services for sending out phone-based alerts (e.g. text message, automated information call) to all individuals within the affected area.

The *media* is often present at the scene immediately after an incident has occurred. In general, the *media* captures information about the incident and broadcasts it to the public. The *media* serve as a channel to inform the public about the incident or hazards connected to the incident. If necessary, the *media* can stop the regular broadcast (e.g. TV- or radio show) to communicate important news to the public. In addition, information the *media* captures such as pictures, observations and statements from witnesses can in many cases be of valuable for the emergency agencies, both during and after an incident.

Communication Network

The communication network of the given incident is characterized by a high number of actors. Figure 2 illustrates the communication network and its complexity by representing actors as nodes (circles) in the graph. Each node represents an actor, and is colored according to the associated category. An exception here is actors from the emergency agencies. As they dominate the communication network they are assigned separate colors for clarity, although they belong in the same category. A line connecting two nodes represents a communication path between the two actors represented by the nodes. The *color* of the connecting lines indicates the actors that *initiated* the contact, e.g. a red line connecting the *110 central* to the yellow *NVE* node indicates that the *110 central* initiated some sort of communication towards *NVE*. By comparing the number of connections each actor has with other actors, it becomes clear that some actors are more central in the network than others. This is emphasized by the node diameter, being proportional to the number of communication paths emerging from the node. In this way the size of each node (actor) corresponds to its centrality in the network.

The ten most central actors in the network were (1) the *incident commander* who communicates with 40 actors, (2) the *fire and rescue commander* who communicates with 32 actors; (3) the *110 central* which communicates with 32 actors; the *112 central* which communicates with 30 actors; the *health coordinator* who communicates with 28 actors; the *health commander* who communicates with 26 actors; the *113 central* which communicates with 23 actors; the *industrial safety team leader* who communicates with 19 actors; the *JRCC* which communicates with 19 actors; and finally *NCD* which communicates with 18 actors.

On an overall level, the collected data indicates that the most central actors in the communication network are commanding personnel and emergency centrals from the emergency agencies. Supporting organizations and expert organizations typically have a much smaller role in the communication network. By looking at the colors of the communication paths, it is also clear that the communication with these organizations is initiated by the emergency agencies and in particular by the emergency centrals.

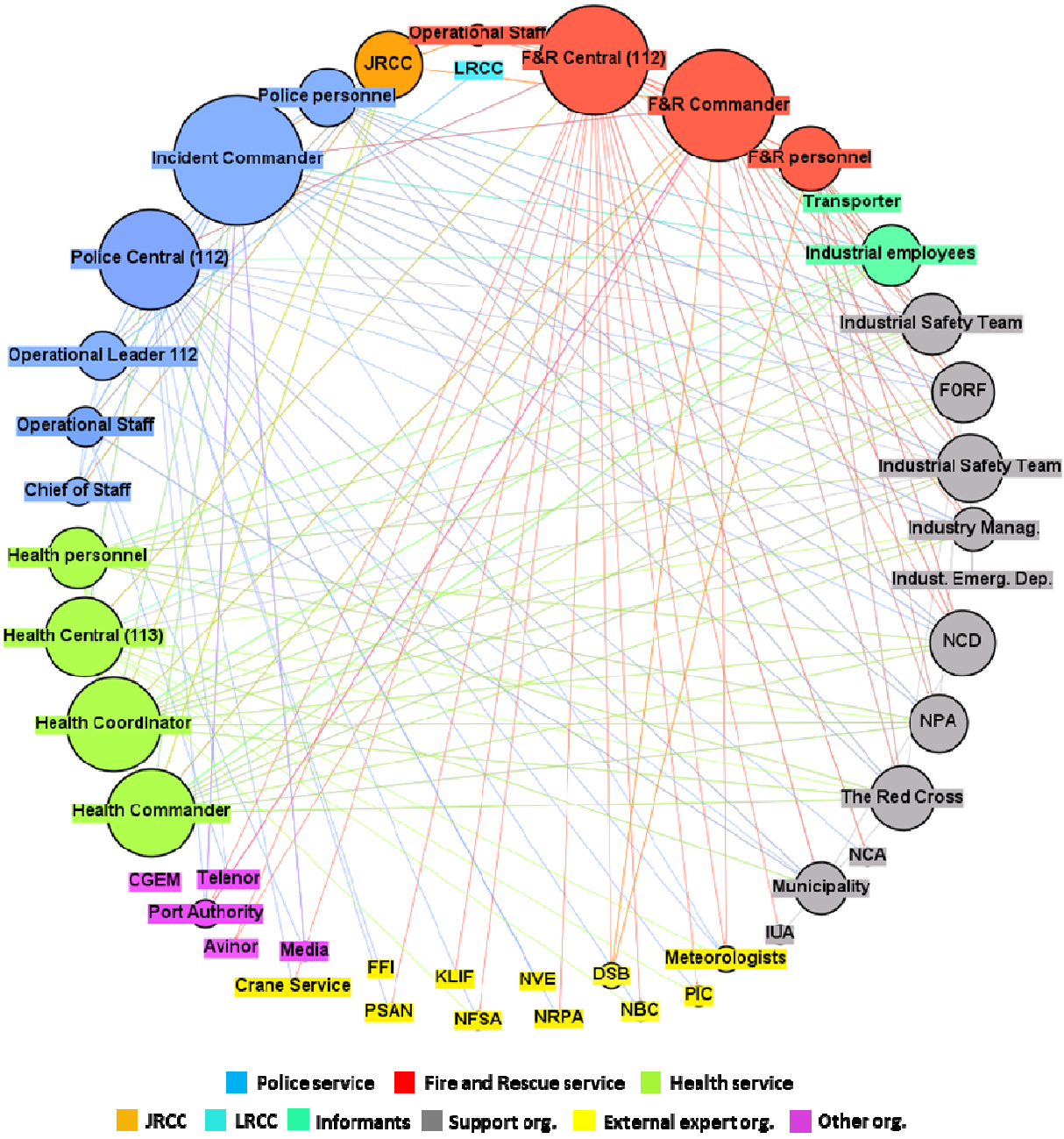

Figure 2: Communication network

Information Exchange

For each reported communication path in Figure 2 the interviewees were asked to explain what kind of information that would be exchanged between the actors. The content analysis reveals several categories of information being exchanged. Figure 3 shows the frequency of information exchange for each information category during the emergency response for the given scenario. The first category, *risks,* covers information about risks connected with the emergency, and specifically health risks associated with specific chemical substances. The most important organizations providing information about risks were *DSB*, *PSAN* and *NFSA*. The second category, *victims*, covers all information about the victims of the incident, and specifically information about the number of wounded, their injuries, and recommended treatments. The third category, *incident*, covers all information about the unwanted incidents that has occurred, including the past, current and future state of the situation. This type of information is typically provided by emergency response personnel and on-site witnesses, and will be gathered in many different formats such as pictures, text, maps, drawings, videos, and audio. The fourth category, *resources,* covers all information about human- and material resources that

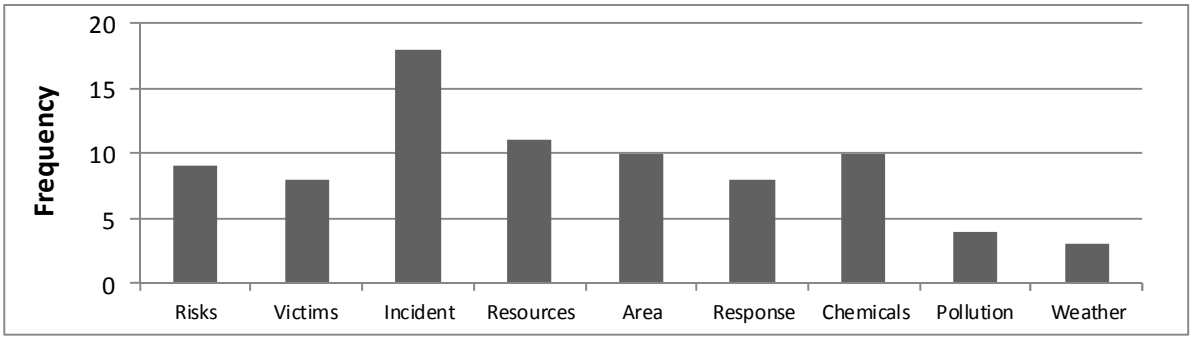

Figure 3: Distribution of information exchange

organizations or individuals can contribute with during the response effort, information about the current status of resources, and requests for additional forces. The fifth category, *areas*, covers information about the terrain and infrastructure in the area affected by the incident, and other local knowledge provided by witnesses, property owners, victims, municipality, and the industry emergency team. The sixth category, *response*, covers all information regarding the planning and coordination of response activities initiated to handle the incident. The seventh category, *chemicals*, covers all information regarding the different chemicals substances (stored at the chemical factory), and how these substances should be handled. The most important organizations providing this information are the *NBC* center and *NCA*. The eighth category, *pollution*, covered information about potential pollution caused by the incident, how such pollution could be minimized and counter-acted, and information about potential consequences. The ninth category, *weather*, covered information about current weather and forecasts for the affected areas, and are typically provided by meteorologists, weather services, *NVE*, or local air base towers. Unsurprisingly, a substantial amount of the total communication activity involves information about the incident itself, and about the resources participating in the response effort.

Communication Means

For each reported communication path in Figure 2 the interviewees were asked to describe *how* the information exchange was mediated. Figure 4 shows the frequency of use for the various communication means during the incident. The reported communication forms includes face-to-face communication, radio, telephone/mobile phone, SMS, crisis management systems, email, alarm systems, fax, and video conference. As the latter three were only mentioned once or twice, they were merged into a single category called *Other*. As seen from Figure 4, speech-based information-exchange through telephone (48%), radio (20%), and face-to-face communication (15%) accounts for more than 80% of the reported communication. The remaining communication was handled using text-based communication means like email, SMS, fax, or more advanced support tools for crisis management and alarming. These numbers illustrate the limited use of IT-based support tools to facilitate communication during emergencies, and the predominant position of verbal communication as the most commonly used communication form. Furthermore, the observation that telephone based information exchange accounts for almost half the communication is somewhat surprising, as one might expect the use of radio to be more prominent. One explanation might be that the majority of the involved organizations are off-site, and not given access to the radio network. Comparatively, communication between the emergency agencies alone is more frequently managed by radio than by telephone, although telephones are widely used in this context.

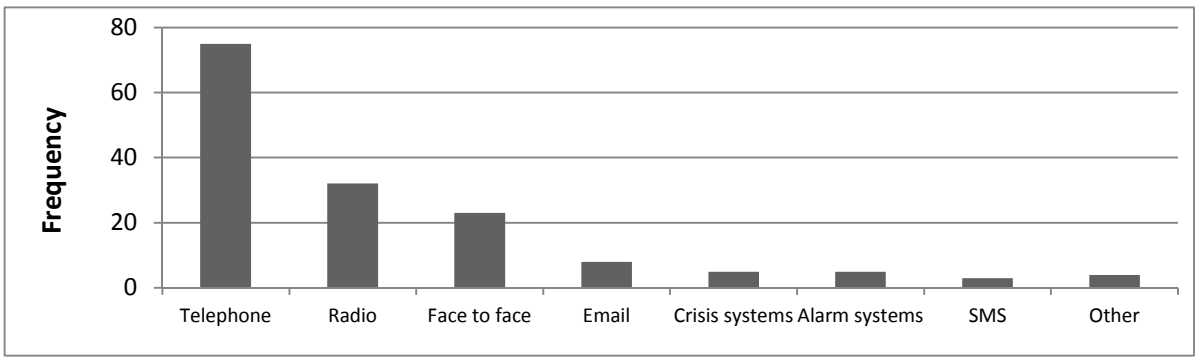

Figure 4: Distribution of communication means

DISCUSSION AND CONCLUSION

In this paper, we have examined the inter-organizational collaboration structures deployed during a hypothetical incident in Norway involving chemical spills. First, the study has provided a categorization of the actors likely to participate in the response effort for the given incident, based on the actors' nature of participation. The network of actors found in the study is characterized by being highly inter-organizational and complex, including public, private, and non-profit organizations. Similar networks have been found in studies and reports examining actual large-scale events (NOU 2012:14, 2012; Kapucu, 2006). In addition, the network is characterized by involvement of several hierarchical levels of the emergency response agencies, where the different levels are depending on collaboration with each other and liaisons from other organizations participating in the emergency effort. During routine operations, hierarchical networks can work efficiently, but can sometimes fail in dynamic emergency situations (Kapucu, 2006). Connectivity and close collaboration across hierarchical levels is essential for such networks to function well during large-scale emergencies, and to ensure that the emergency effort is not hindered by levels of the organization being isolated from each other.

Second, the study has examined the type of information likely to be communicated between actors during an incident. The results of this analysis indicate peaks in the communication pattern, where information about the incident itself and about the resources participating in the response effort is communicated more frequently than other types of information. Similar peaks in the communication pattern have been identified in a study of information support in collaborative command and control work (Trnka, 2006). Adopting a different categorization scheme, Trnka found that the most frequently exchanged information types were "Information about an Incident", "Information about own activity" and "Acknowledgment". In comparison with the information categories adopted in this paper, "Information about and Incident" overlaps with the *incident* category, while the other two categories, "Information about own activity" and "Acknowledgment" falls under the *resources* category. Based on these findings, it can be argued that these types of information are of general importance for large-scale inter-organizational operations, regardless of the type of incident. These findings can guide the development of ICT in the field, by providing awareness of important information needs, for example in connection to management of resources (personnel and equipment), and in relation to situational awareness.

Third, the study has investigated the means used to communicate information during an emergency event. The results show that telephones are the most frequently used means for exchanging information, followed by radio and face-to-face communication. Other studies have reported similar findings, stating telephones (mobile phones in particular) as important communications means (Landgren & Nulden, 2007). In a recent study, the main barriers for efficient communication between emergency agencies were lack of radio capacity; technical problems with the radio network; lack of knowledge in how the radio channels should be used; and lack of a common language and terminology across emergency agencies (Eide et. al., 2012). These results combined with the present findings showing that verbal communication makes up for more than 80% of the overall communication strengthens the belief that new and better communication systems are necessary to improve inter-organizational collaboration in the future. If these systems are designed to support verbal communication, they should also support accountability by making such communication persistent, visible and accessible, as emphasized by (Landgren, 2006), who studied how actions in time-critical work can be made visible.

The fact that all participants had extensive leader experience with inter-organizational collaboration during emergency response efforts suggests that the sample should be sufficient and adequate for addressing the aim of the study. Nevertheless, it is clear that a larger sample size could have resulted in additional information about actors likely to participate in the given incident scenario. The interviewees were situated in densely populated cities in a Norwegian context, which might have affected the results to a certain degree. It is possible that individuals from less populated areas would have identified different actors, for example due to the lack of immediate access to emergency response personnel, experts and/or supporting organizations. Still, it should be emphasized that several of the identified actors are required by Norwegian laws to participate in emergency efforts at a national level, implying a certain level of generalizability to the results.

The identified actors not only reflect a general group of actors that contribute during an emergency situation, but also actors that possess specific capabilities essential for mitigation of the presented scenario. In many cases, the different actors hold knowledge and capabilities similar to those of other organizations, and hence it is likely that some of the identified actors represent redundant services or similar expertise. Undoubtedly, the actors involved in an emergency effort, and the information being exchanged vary depending on the characteristics of the incident, such as its type, magnitude, geographical placement, and setting. On the other hand, the Norwegian emergency response structure can be regarded as a typical example of how a nation's emergency response is structured (Rake, 2008), indicating that the results of the study could apply for similar scenarios in other countries. Studies of emergency response in other countries have also reported similar inter-organizational

structures during emergency response efforts (Kapucu, 2005; Comfort & Kapucu, 2006; Militello et al. 2007).

The present study provides a framework for analysis of the communication network that is formed during an emergency situation across a variety of key actors in different agencies, organizations and expert groups. A critical reflection on the applied methodology is appropriate as this point. The use of scenarios can be advantageous as they provide distance and a neutral attitude (Mietzner & Reger, 2005). However, when inquiring the pattern of communication based on a hypothetical incident it is likely that there is a bias towards "optimal emergency response", deprecating the challenges of collaboration and sub-optimal conditions that are known to exist during real emergencies (Eide et al., 2012). On the other hand, the use of a scenario-based incident enabled inquiries among a larger sample of essential actor roles that are normally represented by one person only. In relation to a real incident, identifying and reaching the individuals representing each node in the communication network for a certain incident would pose challenges to the present study.

A natural extension of the presented work would be to apply the present methodology with different scenarios in order to delineate the generic communication pattern from the scenario-specific issues. In future work it will also be valuable to assess the validity of the present scenario-based inquiry by applying it to a larger sample of actors/roles and identify commonalities among the resulting communication patterns. Work is in progress to investigate real incidents with a corresponding analysis of the inter-organizational collaboration networks.

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