Retrieving and Exchanging of Information in Inter-Organizational Crisis Management

Benedikt Ley, Volkmar Pipek, Tim Siebigteroth, Torben Wiedenhoefer

Institute for Information Systems, University of Siegen

{benedikt.ley; volkmar.pipek; tim.siebigteroth; torben.wiedenhoefer}@uni-siegen.de

ABSTRACT

Information is the most valuable resource for coping and recovery work in crisis management. It is the foundation for coordination, collaboration and decision-making. However, several challenges face information retrieval, evaluation and exchange processes in inter-organizational crisis management. On the one hand, due to the dynamic nature of crisis situations, information demands are hardly predictable and change in the course of time. Moreover, inter-organizational issues like terminology issues, policy constrains or even the lack of awareness about information available are influencing factors and need to be considered in designing appropriate ICT. In this paper we report from an empirical study, where we had a closer look on information retrieval and exchange practices in scenarios of medium to large power outages in Germany on an inter-organizational level. Derived from these results, we were able to present a reference implementation of an inter-organizational information repository (IOIR) and report our findings from a related evaluation.

Keywords

Information retrieval, information exchange, inter-organizational collaboration, Information Technology, Ethnography

INTRODUCTION

Information retrieval and exchange processes are fundamental tasks for decision-making and collaboration in crisis management. To have all relevant information right on time and in its expected quality, for making decisions, taking actions or even for sharing information with others, is a key task for stakeholders in emergency management. Therefore, to ensure the quality of information, emergency response organizations, such as the firefighters and the police, spent much effort to make coping and recovery work more calculable and predictable, which leads to predefined response plans, communication routines and organizational instructions. However, large incidents (e.g. Thunderstorm Kyrill (Germany, 2007), Hurricane Kathrina (New Orleans, 2005), Hurricane Sandy (US West Coast, 2012)) are hardly predictable. The number of influencing factors (e.g. weather conditions, number of people affected or type of emergency), as well as structural dependencies (e.g. electricity, roads and railways or fuel resources) makes it almost impossible to plan all crisis management activities and information demands in advance. But still, many situations require spontaneous ad-hoc decisions and short-term (re-)planning with unexpected information demands. This is also because crisis management systems cannot provide their full support in these situations, since laws and regulations prescribe and therefor restrict their design and information portfolio to pre-planned scenarios. Furthermore, existing information exchange processes and negotiation practices, intra- and inter-organizational, are too inflexible in order to meet these dynamical circumstances.

In this contribution, we want to address the question: *How to support information retrieval and exchange processes in an inter-organizational setting?* The paper is structured as follows: After presenting and discussing relevant literature we introduce the research question and research field. We will then present the methodology of our empirical study and will focus on information retrieval and exchange practices we have found in emergency management. Afterwards, we summarize the main challenges and will describe the concept and implementation of an inter-organizational information repository. We will end by presenting results from an evaluation and with a conclusion.

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BACKGROUND

Information is a crucial factor in emergency management and plays an essential role for effective and efficient inter-organizational coordination of coping and recovery work (Gonzalez & Bharosa, 2009). In this chapter, we will outline most common research work according to information retrieval, the importance of information in the context of decision-making, information exchanging practices, as well as handling uncertainties about information quality.

Information Retrieving and Decision-making Processes in Crisis Management

Before actors are able to make decisions, lots of relevant information on the current situation is needed (Javed, Norris, & Johnston, 2012). For this purpose, actors need to consider context information to overcome the opacity of crisis situations (Marino, Nascimento, & Borges, 2012). Context information could be, for instance, the location of victims or rescue forces, the demand on resources of rescue forces or even the psychological condition of the victims (Way & Yuan, 2012) and comes from several sources e.g. citizens (Palen & Liu, 2007) or from other organizations (Coppola, 2006). Some of them can be collected in advance, like resource information or geographical information of hospitals from existing databases. However, due to the dynamical nature of crisis situations (Ley, Pipek, Reuter, & Wiedenhoefer, 2012a), most of the relevant context information will just be available over course of the time and is often inaccurate, invalid, and incomplete, when decision-makers received them (Walle & Turoff, 2008). But there are several other issues that are a challenge for information retrieval and decision-making processes, three of them we want point out here. Emergency response activities usually involve several teams from different organizations. Usually, each organization has their own established terminology, emergency procedures or organizational structures, which makes it hard for emergency responders from one organization to collaborate or to share information with actors from another organization (Iannella, Robinson, & Rinta-Koski, 2007). Furthermore, respond teams have to make many decisions under time pressure (Shamoug, Juric, & Paurobally, 2012) or under unpredictable conditions (Ley, Pipek, Reuter, & Wiedenhoefer, 2012b) to accomplish their goals. Even more, due to the fact that citizen generated content from social media platforms, plays more and more a significant role for situation assessment, especially in the early part of an incident, emergency responders have to face the risk of information overload (Schulz & Probst, 2012). These circumstances make it hard to fulfill the decision-making process (constructing a proper picture of the current situation → evaluate potential course of actions → selecting an appropriate action (Drury et al., 2012)) properly in order to address the situation or to share information with others. Dealing with this problem, Diniz, Borges, Gomes, & Canos (2005) have found out that besides context information, the personal and organizational expertise of decision-makers are essential for decision-making in these situations. Furthermore, Fisher & Kingma (2001) mentioned that previous knowledge from earlier related events can help decision-makers to retrieve and evaluate available information or plan further actions in consideration of uncertain information.

Handling Uncertainties about Information Quality in Crisis Management

While we have discovered challenges in information retrieval and decision-making processes during crisis situations in current literature, in the previous section, we will now have a closer look on current research about information quality and handling information uncertainties. This is especially relevant for our research, because Gräfe (2005) pointed out that information quality is the perceived dimension of information suitability for effective and efficient decision-making or information sharing. Due to this, information quality has been in the focus of numerous researchers (Eppler, 2006; Krcmar, 2005), but is slightly discussed in the field of crisis management (Bharosa, Janssen, Rao, & Lee, 2008; Fisher & Kingma, 2001; Friberg, Prödel, & Koch, 2011). Fisher & Kingma (2001) for instance, reveal that a decision, which based on low quality information, leads most likely to a low quality decisions. Hence, the demand for high quality information increases therefore by the rising impact of the results of actions (Friberg et al., 2011) and providing appropriate information to all relevant stakeholders is consequently a key challenge in crisis management (Riedel & Chaves, 2012). However, handling crisis situations means acting under time constraints, which in turn leads to a pressure to act (Moehrle, 2012). Friberg et al. (2011) defined criteria on information quality, but under these conditions, retrieving all relevant information and in its expected quality level to facilitate fast and effective decision-making is still a challenge (Shamoug et al., 2012). This is especially true, because the dynamical nature of crisis situation results in ever-changing and unpredictable information demands and information sources (Longstaff & Yang, 2008). Furthermore, not all needed information from the scene is usually available at the beginning of a crisis situation. Additional information will be available in the course of time (Gabdulkhakova & König-Ries, 2011). At the same time, already received information could be out of date or even revised (Comes & Schultmann, 2012). In that case, decision-makers need to be aware of newer information and need to reconsider action taken and

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conducted strategies (Bharosa et al., 2008). To sum this up, like Friberg et al. (2011) pointed out: Information needs to be *accurate*, *concise*, *believable*, *complete*, *clear*, *valid*, *objective*, *redundant* and *up-to-date*. But this is accompanied by the crisis characteristics of information uncertainties, time-pressure and communication infrastructure vulnerability (Wex, Freiburg, Schryen, & Neumann, 2012). Hence, Palen, Vieweg, & Anderson (2010) revealed that information uncertainties cannot be avoided, but providing *accurate*, *objective* and *reliable* context information can help to assess available information in the way to use them for decision-making properly (Friberg, Prödel, & Koch, 2010).

RESEARCH QUESTION

In this paper our objective is to examine information retrieval and exchange practices on an inter-organizational level. In comparison to prior research, which focuses on practices within organizations, we want to answer the question: *How to support information retrieval and exchange processes in an inter-organizational setting?* Our contribution is to derive requirements for potential IT-support of information handling for crisis collaboration. In order to extend the theory-led considerations, we had to understand local and inter-organizational collaboration, situation assessment and decision-making practices of the agents. Therefore we conducted an empirical study in Germany exploring current coping and recovery practices and the role of information in crisis management of all relevant stakeholders involved in a crisis scenario of medium to large power outages.

RESEARCH FIELD

The findings and concepts in this paper are derived from a study focusing on collaboration, situation assessment and decision-making practices during coping and recovery work at emergency response agencies in Germany. The study was conducted in two regions of North Rhine-Westphalia (NRW) in Germany. Siegen-Wittgenstein (KSW) is a densely wooded, hilly county, whereas Rhein-Erft-Kreis (REK) consists of 10 growing communes in the west of Cologne. In both regions we focus on several persons and organizations affected: *Infrastructure suppliers* (e.g. power supplier), *public strategic administration* (e.g. crisis management, county administration), *public operative administration* (e.g. police, fire department) and *citizens*.

Before we describe our methodologies and present our findings in the next sections, we will have quick look on two interesting aspects regarding police and firefighter forces in both counties. Firstly, related to the organization of fire and rescue forces: REK provides professional fire and rescue brigades, whereas KSW firefighters are mostly members of voluntary fire departments. Here, just members of the control center have salaried positions. Secondly, firefighter receive their orders from the field via incident commands who are positioned on site while police forces in the field receive their commands from the operations management at the control center.

INFORMATION RETRIEVAL AND EXCHANGE PROCESSES IN PRACTICES

To understand current practices in information retrieval, evaluation and exchange, we conducted interviews and group discussions with participants from the mentioned organizations. For this study we analyzed the data concerning phenomena and challenges in inter-organizational information management.

Methodology

The basis for the data analysis were the results of various empirical works in the application field. The studies were embedded in a cooperatively (together with actors from police, firefighters, county administration and an electricity provider) developed scenario framework existing of a windstorm with many incidents and energy breakdowns. The purpose of the scenario was to be able to quickly create a common understanding of a crisis situation and context in our interviews and helped increase their validity and comparability. We conducted 5 inter-organizational group discussions (table 1), each lasted about 4 hours. The aim of the group discussions was to understand communication practice of inter-organizational crisis management. Furthermore, we conducted 22 individual interviews with actors from the participating organizations (table 2). The interviews lasted between 1 and 2 hours each and followed a guideline. The interviews were separated into three parts. The first part focused on the participants' role, qualification, tasks and work steps under normal conditions. The second part covered the participants' tasks during crisis situations and was based on the developed scenario framework. The third part covered applied information and communication systems and perceived problems with these tools. Group discussions and interviews were audio recorded and transcribed for subsequent data analysis.

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No	County	Topic	Participants
W1	-	Challenges in practice, Visit of Control Center	Energy Network Operator (ENO)
W2	KSW	Challenges in practice, Visit of Control Center	County Administration Police Fire Department
W3	KSW	Challenges in practice, Visit of Control Center	Department Head: Public Safety Head of Civil Protection Head of Police Control Center Deputy Head of Control Center District Fire Chief
W4	KSW	Analysis of User Interactions and Communication Flows	Head of Police Control Center, Head of Staff Coordination, Deputy Head of Control Center, Local Head of Federal Agency of Technical Relief (THW), Local Head German Red Cross
W5	REK	Analysis of User Interactions and Communication Flows	Head Regulatory Authority, District Fire Chief, Red Cross: Disaster Management, Red Cross: Communications, Members of other aid agencies.

Table 1. Group Discussions

No	County	Organization	Role
I1	KSW	Administration	Regulatory Authority
I2	KSW	Police	Head of Control Centre
I3	KSW	Police	Head of Section
I4	KSW	Police	Patrol Duty
I5	KSW	Fire Department	District Fire Chief
I6	KSW	Fire Department	Deputy Head of Control Center
I7	KSW	Fire Department	Workmanship
I24	KSW	Fire Department	Head of Control Center
I8	REK	Administration	Office Civil Protection
I9	REK	Fire Department	Chief Officer / Chief of Fire Dept.
I10	REK	Fire Department	Operation Controllers
I11	REK	Fire Department	Clerical Grade Watch Department
I12	REK	Fire Department	Control Center Dispatcher
I13	REK	Fire Department	Head of Control Center
I14	REK	Police	Member of the Permanent Staff
I15	REK	Police	Head of Control Center
I16	REK	Police	Head of Group
I18	-	ENO	Higher Area, High Voltage
I19	-	ENO	Operation Engineer, High Voltage
I20	-	ENO	Operation Technician, Low Voltage
I21	-	ENO	Dispatcher, Low Voltage
I22	-	ENO	Workmanship Technical Incidents

Table 2. Interviews

Results: Data Analysis

The interviews and group discussions clearly illustrate that information is decision-relevant and highly important for a precise situation assessment. Thus, information retrieval and exchange play a significant role in crisis management work. The following categories are derived from the empirical data and give an insight into current information management in inter-organizational crisis management.

Information Retrieval Practices

Information retrieval usually begins with an incoming emergency call or warning message (e.g. severe weather alert). To keep track of the occurrences and to prepare for an incident or a crisis, decision makers have to collect supplementary information from various sources *"You need as much information as possible."* (I24). Some of the information to fulfil the work tasks in operations management is provided by "official" information systems or files. In major catastrophic events or in case of weather alerts these internal information resources are enriched by many external, informal information resources, which are necessary in various situations. Therefore, actors sometimes use about "*40 windows which have to be observed*" for different applications and websites to have an overview of the current state and to handle the situation appropriately (I5). This external information includes webcams, water levels, weather forecast, wind directions, storm warnings and traffic service. Much of that information is provided on different websites – but not in a compulsory "official" application with the result that actors have to search them by themselves. *"It turned out that the […] Internet [is] faster than our officers on site. […] The information has admittedly to be evaluated but they were very, very useful concerning the quality. I was impressed by the mass, the speed and the usefulness."* (I15). However, the use of social network content (e.g. Twitter) involves the risk that it does not always reflect reality (I14) and contains *"lots of trash"* (I2).

On site actors are instructed to *"[…] collect and communicate any information that is locally graspable and available […]"* (I7). This ensures that information gathering happens immediately after the staff have arrived at the place of action. In reverse, on site actors also depend on an optimal overview of the situation. Above all they get continuously informed by the control center, were any information runs together, gets aggregated and redistributed, by radio or phone. In addition to that they often make use of their private smartphones (authorities do not provide smartphones) to get additional information: *"Some of the colleagues have an Internet connection on their smartphone that is often useful, for example to get an aerial image from the locality via Google Maps to check other information."* (I4).

Retrieving information from other organizations is a major challenge. Especially between authorities and companies (e.g. energy network operators or transport services) there is often a lack of information.

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Organizations do not necessarily inform proactively about further development, but they have to be asked directly: "*The other actors have a different perception because – they concentrate on their problems and not on providing information*" (I15). In the case of infrastructure operations sometimes provide information with missing details such as the amount of affected households (I10): "*What has broken down, how much of the energy network is out of work and how many people are affected?*" Many organizations provide their information by email or phone, which is another source of information that needs to be handled.

Information Quality

One of the major challenges when retrieving information about a certain context is the validation regarding the quality of information. Especially information from the Internet needs to be evaluated carefully and it is often difficult to assess its correctness, truthfulness and relevance (I15). The same applies to other citizen generated content as there is no common "*level of consciousness*" (I15) and citizens cannot decide, which information is needed by the authorities and organizations (I2). Especially during crisis situations with many affected citizens this often leads to information floods which are difficult to manage.

Official information like severe weather alerts also contains uncertainties and has to be evaluated carefully. Those warnings are often published too frequently and in many cases no critical weather conditions occur (I2). For this reason, additional information resources (e.g. weather conditions outside the building or webcams that are focused against the wind direction) are used to obtain a better overview of the situation (I24). The more information sources are available the more serious is a specific information in case of a high degree of similarity (I15).

Information Aggregation

There are first approaches for a common aggregation of information resources on an organizational level. For example, the intranet of the police offers relevant hyperlinks to external sources like weather service, traffic news or a statewide overview of the situation (I3). However, there is neither an integration with the control station system nor the possibility to structure this information to personal concerns or to add additional resources. Besides that, every organization has to maintain data that is not available via a website, but needs to be available during specific incidents (e.g. address-books, building plans, resources, map data, construction zones, road closures, emergency plans for companies with hazard potential). This information is gathered either within the control station system or as physical files. In either cases, there is no cross-organizational data administration so that most of the acquisition work is done redundant.

Digital and non-digital maps are an important type of information aggregation and visualization. They are of central importance for all actors to plan and to deal with major catastrophic events. Emergencies always have a geographic reference, therefore the operations management and the crisis management group gather related information on maps. Besides the utilization of technical supported maps, actors also use different non-digital maps: "*We always have to work redundantly to prevent chaos during technical breakdowns. We have to be able to proceed anytime*" (I9). In addition, the representation of the resources and their availability are only maintained on non-digital maps (I15). But this always depends on the given incident and how likely a breakdown is.

Information Exchange

Liaison officers play an important role in cross-organizational information exchange. They are located at the other organization, on site or as a member of the crisis team, and immediately communicate every information that comes to him to their own organization. "*He transports any essential and possibly incident relevant information that are fundamentally relevant for the success of the operation.*" (I16). Besides the communication via liaison officers, there are predefined rules for transfer of specific information to another organization based on defined responsibilities and notification procedures: "*If we [the police] get a call and it is stated that a person got hit by a falling tree, this is firstly not our area of authority, but we have the information. So it is our duty to respond and call the fire department [in Germany responsible for accident ambulance] and coincidently sending out our own officers.*" (I15). In practice the exchange of information often suffers from the fact that liaisons cannot be reached: "*Phone numbers, responsibilities or something else has changed. [...] Because we don't check every contact information every quarter of a year if they are still up to date. This gets apparent when someone is trying to call the number some day if it is still up to date.*" (I2)

In the context of information exchange, terminological differences play a decisive role. Depending on the individual structures and practices of the respective organizations, different terms are used which can cause several communicational issues: "*There is a person with a cut finger and an employee from THW [agency for*

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technical relief] reports this injury – This nearly sounded like a fatality!" Due to the different focuses of the organizations, it is difficult to expedite a terminological assimilation. *"Even if the police are talking to the fire department, there is a big deviation in the terminology and consequently terms are perceived differently."* (W2) Terminological differences with other organizations, especially in the private sector, can be even bigger. An example describes a misunderstanding about the number of people injured after a fire in a factory where 19 casualties were reported: *"People injured in the perception of the factory management, consist of 19 people who were only triaged by doctors but weren't necessarily injured."* Actually, in the understanding of the rescuers there were only *"two people whose health was affected."* (W2).

CHALLENGES IN INTER-ORGANIZATIONAL INFORMATION RETRIEVAL AND EXCHANGE

As we have seen in related work and in our empirical study, information retrieval and exchange practices are influenced by several factors, which makes it hard for actors to proceed effectively and efficiently in decision-making, situation assessment, and inter-organizational collaboration. Before we present the requirements and design implications to facilitate inter-organizational information sharing and collaboration, we will now have a short summarization of the main challenges, we have identified.

1. *No Situation is equal to another*
   Each crisis situation is different and hard to predict and calculable. Information demands vary to each incident and change in the course of time.
2. *Various information types and sources need to be consulted*
   For proper situation assessment various information from different types like Internet websites, contact lists, notes, positioning information, etc. and from various sources like different organizations, in-field officers or databases is needed.
3. *Missing awareness about information available*
   Inter-organizational crisis management lacks instruments, which distribute meta-information about suitable and available information. This is especially challenging for actors in the field, who need to be aware about relevant information from the incident site, as well as to be able to communicate them appropriately to related addressees.
4. *Missing awareness about information demands*
   Current crisis management practices lack order to articulate information demands in order to share information with other organizations proactively.
5. *Dealing with information uncertainties*
   The quality of information has to be evaluated carefully to prove its reliability and to avoid making wrong decisions. Additional information and experience are necessary to validate and assess incoming information sufficiently.
6. *Terminology issues*
   Different symbols or different technical terms, for instance, make it difficult to share information and knowledge between organizations, especially when they originate from other domains.
7. *Out-dated and redundant data*
   Maintenance of data, e.g. contact details or information about external resources, is only intermittently done and leads to outdated and wrong records. As a result, important information may possibly not be available in case of emergency. Besides that, data administration is done redundantly by multiple organizations, as databases are not shared cross-organizational.
8. *Accessibility/Policy issues*
   Obtaining external, non-public information (e.g. degree of power supply) through official channels can be extremely time-consuming. That is why there is a demand for negotiation processes for exchanging information needs associated with necessary access agreements.

SUPPORTING INTER-ORGANIZATIONAL INFORMATION RETRIEVAL AND EXCHANGE PRACTICES

Facing these challenges, we have conceptualized and implemented an inter-organizational information repository (IOIR). It provides a centralized repository, where inter-organizational information resources can be referenced in. Users are able to search for existing information resources, add and share new information and are able to insert selected resources into an existing crisis management application. In our case, into an inter-organizational situation assessment map that is embedded into a social media platform accessible to all relevant emergency respondents. This platform aims at supporting inter-organizational cooperation and learning. Only actors of civil security can use the platform. Since the platform went online almost a year ago, about 250 actors have become a member. First we will present the features of IOIR and we will describe a Participatory Design (PD) Workshop that we have conducted in advance.

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Participatory Design Workshop

As a first design step we conducted a PD workshop with three executives from the fire department and the police (see table 3). The aim of the workshop was to develop and discuss first concepts and ideas for the design of IOIR. We have chosen this method to be able to benefit from the participants' contextual experience and to include it into the design process (Schuler & Namioka, 1993).
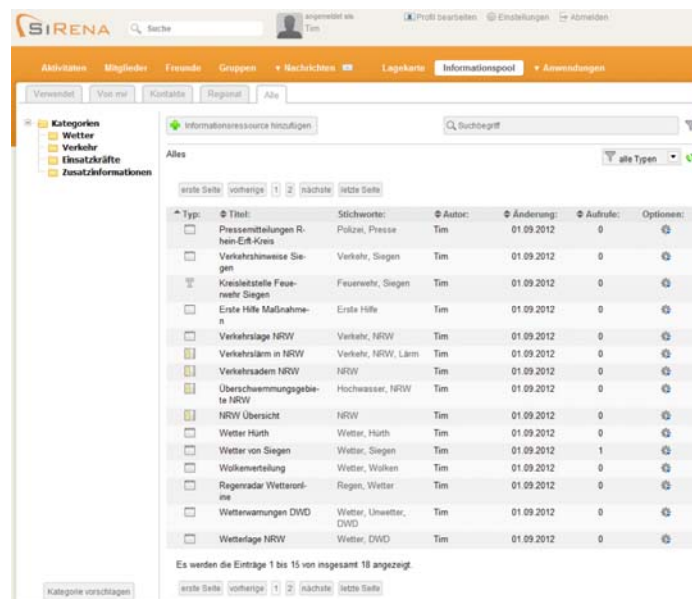
The system should be designed as an extension for an already known social network web application, so we prepared paper mock-ups of the basic system design and common UI elements. These snippets thought to help us and the participants to better visualize the upcoming ideas and concepts by placing the UI elements on the paper screen (Ehn & Kyng, 1991). The workshop was audiovisually recorded and lasted 3.5 hours. We organized the results into three categories: accessibility of information resources, adding and sharing, and information retrieving.

No	County	Organization	Role
P1	KSW	Fire Department	Deputy Head of Control
P2	KSW	Police	Head of Control Center
P3	REK	Police	Head of Control Center

Table 3. Participatory Design Workshop

SUPPORTING ACCESSIBILITY OF VARIOUS INFORMATION RESOURCES

As we have seen in our prior findings and during the PD workshop, actors need to have various sources of information in order to assess the current situation or to collaborate with others. This could be for instance weather information, such as storm warnings or river stages, emergency plans of buildings, roadblocks or electricity breakdown information. This information is usually provided in different forms like on websites, on notes, via telephone or email, etc. and – the fact that this information is often not necessarily available at their own organization – from different organizations. IOIR facilitates the accessibility of information resources from different types and sources. Users are able to access all the information that is available to the user. This can be websites, documents (.doc, .pdf), notes, map based web services (WMS, KML) (see Figure 1). After selecting a favored information resource, users can see meta-data about the resource, which we identified as relevant during the PD workshop: title, description text, category, author, type, tags, date, times used, comments and regional reference. Regional reference indicates in what area the recourse is related to e.g. a specific location, such as a building plan or weather information for a specific area. In case of notes, websites and documents, the user is able to open them directly within the information repository. However, in the case of a map based web services, the information resource will be included into an inter-organizational situation assessment map, after selecting it and the user is then able see it on the map as place marks or an additional layer. By providing a single and centralized repository we want to address awareness issues available information, as well.

Figure 1. Inter-organizational Information Repository (IOIR)

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Supporting adding and sharing of information resources

One special feature of IOIR is that end-users are able to add new information resources by themselves and make them accessible for other colleagues or organizations. By clicking "Adding Information Resource", users can add a title, a description (by using a WYSIWYG-Editor), tags and can than choose if the user will add a website, a document, or a reference to a map based web service. Related to the selection, specific input fields will be visible. When using map services, users only need to paste the source URL in the input field and the system will check if the service is available or not. Finally, an optional regional reference can be defined. By using a map tool, users can select the location to which the information resource is related to. This could be a place mark or a specific area. Date and author will be included automatically. All entries are still editable afterwards.

Supporting information retrieving

Availability of relevant information during a crisis is very important in making the right decisions. It is necessary to have access to this information in time and a quick estimate about its quality and relevance. The centralized capturing and organization of information resources in IOIR is an approach for a simplified access to previously distributed information. However, the amount of acquired available information resources from a large number of users from multiple organizations can still hamper with the discovering of required information. Which weather forecast service is the best for my demands? What are relevant emergency plans or building plans for a specific operation? Besides the centralized accessibility of information resources, it is therefore important to support users in finding the right resources from the repository concerning the users' specific situation. One solution IOIR provides is that the users can file and reorganize any resources they access regularly in a personal repository to simplify subsequent retrieving. More difficult is the initial discovering of information resources. Here we have an advantage from the characteristics of the underlying social network platform. On the one hand, we use the users' profile and networking information to provide pre-filtered information resources (e.g. relevant services resources for the users location or organization) and enrich them with details about their usage within the users network resp. organization (Who else uses this information resource?). On the other hand, IOIR is able to filter resources by their geographical reference. This is interesting because most operations are geographically bounded and so is the need for information. The procedure in IOIR is that the user selects a relevant section on a map and the system returns any information resources that are geographically linked to this selection.

EVALUATION

In order to proof the IOIR concept and implementation, we conducted a first formative evaluation with all three participants from PD workshop (see table 3). The aim of the evaluation was to get first insights to the usability according to DIN EN ISO 9241 Part 11, as well as to reveal issues related to collaboration and information sharing in the inter-organizational setting. For this, we accomplished a usage test with a scenario-based walkthrough including "thinking aloud", in each participant's working environment. The inter-organizational situation assessment map was used as the initial point for the user tasks. Afterwards, we used a semi-structured interview to gain a deeper understanding about usability and inter-organizational issues. Each test was recorded on video, audiotape and screen recorder and lasted about one hour.

Results

Due to the fact that the situation map, which is strongly related to IOIR, has not been used in a real work setting at that time and IOIR contained only example information resources, we are aware of the limitation of the evaluation. However, the tests already gave us good indications regarding the general usefulness of the system, as well as interface issues and usefulness and challenges according to inter-organizational information sharing and collaboration. All participants emphasized the value of being able to access, to save and to share various information easily with others. *"Here we have the chance, that if someone finds out something, adds it into the repository and then everyone can benefit from it"* (E2). Except for minor interface and terminology issues, all participants pointed out that the system is easy to use and did not complain about missing functionalities in this test setting. Asked, if they were willing to share information with others, E1 and E3 explained that they would share their own information with other organizations, when they think the information is relevant in coping with a specific situation. *"During a specific situation, we would share our information with other organizations, in case they can help in this situation and helps to handle it"* (E3). E2 reveled that in this case he would share everything, because he does not know the information demands of other organizations *"I'm generous in this case, because we usually don't know, who needs what information at what time"* (E2). In the role of an information consumer, E1 mentioned: *"I would take everything from others int consideration, what I believe is relevant for us."* (E1).

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So, all participants highlighted the benefits of the systems, but made clear that important issues, such as data privacy and access right management, could not be answered yet and needed to be evaluated in the real working context.

CONCLUSION

In crisis management, information is an important factor when making the right decisions and consequently for the success of the whole operation. Gathering up relevant information is a time consuming process and is made difficult by missing access permissions, unreachable liaisons or missing data on information quality. In our study we analyzed inter-organizational crisis management practices between police, firefighters, public administration and electricity network operators in two different counties in Germany, and pointed out several challenges in retrieving and sharing information on an inter-organizational level. We conducted a Participatory Design workshop with participants from the fire department and the police and discussed first concepts to address these challenges. Subsequently, we developed IOIR, an inter-organizational information repository to support accessibility, adding, sharing and retrieving of information resources. In a first user test we were able to show that IOIR seems to be a promising approach for inter-organizational information management in crisis management, but this has to be qualified yet due to the limitation of the controlled evaluation study. As a next step we are going to make IOIR available to a restricted user group from various organizations, to get an impression of the application under real world conditions.

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