Identifying Requirements for a Social Media-based Emergency Management System

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***Abstract*—Social media tools provide public safety organizations with a new communication channel for the management of crises and emergencies. While existing studies have mainly focused on exploring how authorities use social media tools, citizens role in producing information for emergency management has not been studied adequately. The research problem of this study is: How social media tools support emergency management from a citizens perspective? The main contribution of this paper is to identify requirements for social media -based emergency management systems. Data on requirements were collected during an a emergency management exercise in Finland. Results indicate that citizens consider authorities presence in social media valuable and reassuring during emergency situations.**

Keywords*—*Emergency; social media; public safety.

I. INTRODUCTION

Social media has rapidly become one of the daily used communication channels. At the same time citizens are more and more equipped with mobile technologies that enable them to be constantly interactive in online social media networks, anytime and almost anyplace. This online behavior is also present in emergencies, where an emerging trend of growing citizens participation through social media can be seen. Both citizens involved in and outside the emergency provide and seek information with implications for both the informal and the formal response effort.

Social media therefore provides opportunities for engaging citizens in response activities both by pushing information to the public and by pulling information from those involved in the emergency, enabling online exchange of information through conversation and interaction [1]. Public Safety Organizations have recently started to discuss how this citizen provided resource could be best utilized in emergency response. Large scale natural disasters, such as earthquakes trigger the need for more agile and scalable emergency communication channels [2].

Public authorities in emergency management domain in Finland include: police, rescue services, municipalities and emergency response centre. In this study, we call these organizations Public Safety Organizations (PSOs). Public Safety Organizations in Finland now face the demand on being present online and there is also (more or less so) shared understanding in the field of emergency response that public authorities should be there where the citizens are, including social media [3], [4]. All of the 22 regional rescue departments in Finland have at least a Facebook account, some use also Twitter. Municipalities play an important communication-related role in Finnish emergency management model.

The usage of social media is, however, still taking its first steps. Communications in social media is mainly dissemination of safety information for citizens, and utilization of the information provided by citizens during crisis and emergencies, such as silent signals, first-hand reports, (geotagged) photos and video, or interactive communication between citizens and public safety organizations, is still meagre. Research on the use of social media in the field of emergency management in U.S. and UK have provided similar findings [5], [6], [7].

Studies on the theme show that one of the key barriers for the adoption of social media tools for emergency management is the lack of related policies and guidelines [8]. These studies have focused mainly on the adoption of social media enabled communication from the point of view of public authorities, focusing less on guidelines for citizens on the use of social media in emergencies and crises.

Additionally, there are studies that have explored social media tools in information sharing of disasters [9], [10] and how social media has been used in disaster management life cycle: prevention, preparedness, response, and recovery [11]. Carter [12] has studied how social media has been used in storm situations in US. Some of the studies have focused on challenges of using social media [13]. As a new mode of communication, its adoption shall likely cause change resistance among emergency management employees.

This study is related to EU Framework Programme funded research projects iSAR+ and SOTERIA that aim at producing recommendations to leverage the use of online and mobile social media in crises and emergency response efforts. In this paper, we focus on a citizen's viewpoint of emergency management. The study reports findings from a user showcase on social media in emergency management. The purpose of the showcase was to study the effectiveness of the interactive communication between the citizens and PSOs in crisis situations through three scenarios: hazardous material accident, aviation accident and a summer storm. These scenarios provided a fruitful playground for studying the bidirectional communication between the citizens and Public Protection and Disaster Relief organizations (PPDRs) in social media as well as testing the social media data analytics platform.

The remainder of the paper is organized as follows. In Sec-

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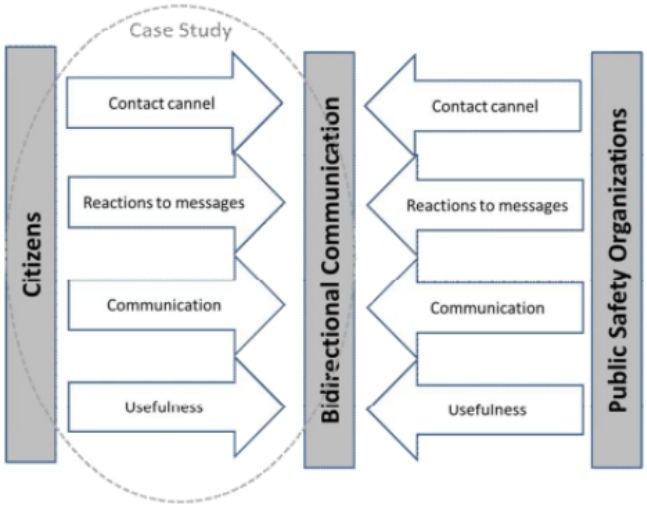

Fig. 1. The context of the study

tion 2, the research method and settings of this are described. In Section 3, the results of the study are presented. Section 4 includes analysis of results. Conclusions are given in Section 5.

II. Research Problem & Methodology

The case study research method was used to explore social media-based emergency management from a citizens perspective. Yin [14] defines a case study as an empirical inquiry that investigates a contemporary phenomenon within its real life context using multiple sources of evidence. The showcase was conducted in controlled environment in order to avoid misunderstanding and panic in social media. The closed environment also enabled protecting participants privacy and anonymity.

A. Research environment

The Finnish user showcase (on social media in emergency management) was organized along with Emergency Services Colleges Crises and Large Scale Emergencies exercise (Krisu exercise). This exercise is carried out twice a year and it is a part of studies of Rescue Activities Management of the graduating course of fire sub-officers and fire officer students.

The aim of the Krisu exercise is to practice management of crises and large scale emergency situations in which several public authorities take part, and in which rescue services is the authority responsible for the overall management of the situation. Several public safety authorities took part in the showcase. In the showcase, the settings of Krisu exercise were utilized bringing new tools for the players to support communication and crisis management. The context of the study is presented in Figure 1.

Showcase description: The showcase consisted of three simulated scenarios: Hazardous material accident in Finland nearby Finnish Russian border area, where a tank wagon of a freight train containing ammonium was leaking at the rail yard. The second scenario was an aviation accident in Helsinki-Vantaa airport: Airbus 320's landing fell short 200 meters

Fig. 2. A photo of an emergency situation tweeted by a citizen

before runway. The third scenario was a storm, during which few hundred tasks were reported to the emergency number 112, one of them a traffic accident with two cars and a tank truck. During a storm scenario a detection of an emergency without a call to 112 was also tested: lightning / damaged power started a fire in a building.

Facilities: The showcase was organized in two different locations: Command and Control Center positioned in facilities of Emergency Services College. Citizen players were located in Korvaharju training ground that is a 36-hectare wide area with over 100 training and testing facilities for fire fighters.

B. Data collection and analysis

Data collection was carried out during the showcase in February 2015. The following data collection sources were utilized: documentation (showcase reports from previous showcases, showcase plan), archival records (iSAR project survey for citizens, tweets sent by citizens during a showcase), participative observation (participation in organizing the showcase, observation reports by citizen players), interviews and coffee table discussions (collecting information during the showcase from citizen players), direct observation (observation of Twitter feed and citizens action), physical artefacts (airplane, train, tank truck simulators (for rescue services training purposes), and feedback survey (directly after showcase and another after showcase).

A within case analysis technique was used in this study [15]. The technique focuses on exploring the case as a standalone entity. The showcase was also part of validation of results. In the analysis, we utilized a pattern matching analysis technique that focuses on comparing empirically based patterns with predicted patterns. Predicted patterns (categories) were created based on previous studies on emergency management and evaluation reports of the previous showcase. Categories focused on citizens viewpoint in management of emergencies. Finally, for each category, we aimed to establish subcategories that described the findings.

Settings: The study has been conducted as a part of EU Seventh Framework projects SOTERIA (Online and Mobile Communications for Emergencies) and iSAR+ (Online and Mobile Communications for Crisis Response and Search and Rescue). Pictures and data were collected from the showcase of February 2015 in training area (see Figure 2).

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TABLE I. FINDINGS OF THE STUDY (SOCIAL MEDIA AS A CONTACT CHANNEL)

Id	Citizens' comments	Subcategory
1.1	If I had an urgent need, I would primarily call 112. But, of course, the more communication channels the PSOs use, the more useful it would be in emergencies.	Social media as an add-on channel
1.2	Through social media, one can receive much more information on emergency situation, compared to phone calls.	Rich information source
1.3	It should go in this way also in real life! Immediate response to the tagged tweet.	Fast response
1.4	Contacting the PSOs via social media felt a bit difficult and unclear.	Challenges in contact
1.5	I sent a tweet with a picture and location data (GPS). The response came within a minute as a private message .	Private message as a contact channel
1.6	PSOs could send their contact details as a private message (a direct phone number).	Private message as a contact channel
1.7	I wonder why I cannot use SoMe as a contact channel at the moment.	Social media as an add-on channel

iSAR+ project aimed at research and development of set of guidelines that enable citizens using new mobile and online technologies to actively participate in the response effort, through the bidirectional provision, dissemination, sharing and retrieval of information essential for critical Public Protection and Disaster Relief (PPDR) intervention, in search and rescue, and medical assistance. On-line and Mobile Communications for Emergencies (SOTERIA) project will result to developing recommendations, to provide guidelines and courses of action for Public Safety Organizations and citizens on how social media tools are best utilized to benefit both citizens and public authorities in emergencies. The participants consisted of Finnish end-user community, such as national PPDRs entities (Rescue Services, Police, municipalities), and citizen players.

III. RESULTS

Results from the case study are presented according to the following categories: 1) Social media as a contact channel, 2) Reaction of citizens to authorities messages and other citizens messages (reliable and reassuring), 3) Communication (message content, reaction time, information clarity, right timing, unambiguity), and 4) Usefulness of social media tools.

Social media as a contact channel. Table I shows the main findings related to social media as a contact channel.

Citizens addressed the role of social media as an additional, value-adding communication channel and emphasized the diversity of social media channel in relation to the traditional contact channel, phone. Citizen players were not trained or told to use private Twitter messages during the exercise. However, several citizen players used this for private communication with authorities.

TABLE II. FINDINGS OF THE STUDY (REACTION OF CITIZENS)

Id	Citizens' comments	Subcategory
2.1	There was a large number of unnecessary tweets and thus, I started to think whether emergency contacts can be easily identified among junk tweets.	Identification of essential information
2.2	Yes. Decreases speculations. In real situations I would read messages but would only trust messages from PSOs.	Trust
2.3	Social media could surely be used also in real situations but mining the accurate information from the false and unnecessary information is relatively hard.	Identification of essential information
2.4	The citizens tweeted various information and I really could not connect with authorities. However, the announcements from the PSOs felt reassuring .	Authorities presence in social media
2.5	The PSOs were actively present in Twitter, and they published some information this was good.	Authorities presence in social media

Citizens comments also showed the perception of social media as a bidirectional communication channel by nature. Contact with the PSOs was expected. Nevertheless, even when a personal contact with PSOs did not occur, the presence of PSOs and their messages in social media was found important. Regarding PSOs viewpoint, we observed during the study that authorities proceed carefully in their social media initiatives. This might be due to unfamiliarity of social media use in PSO communication. Additionally, the persons who deal with emergencies are not communication specialists.

Reaction of citizens to the messages of authorities and other citizens. Table II shows the main findings related to citizens reactions to communication of authorities and other citizens during the showcase. Some of the authorities messages included too generic language. For example, if they refer to a press release, it would be nice to get the webpage where it appears. (IN) Bi-directional communication through social media is surely useful for public authorities.

Citizens' reactions related to social media usage by PSOs was positive. Information provided by the public authorities through social media was considered trustworthy. In this study, the impact of the PSO communication to the citizen behavior was not explored, but the trust in PSO messages indicates that e.g. giving instructions or codes of conduct in social media would lead to preferred action. Citizens reported that PSOs participation in social media discussions was active but also highlighted that information was inconsistent between different data sources.

Communication. Table III shows our findings related to communication between PSOs and citizens.

Our findings emphasized the importance of social media literacy skills (skills required in reading social media feeds and understanding common terminology used in tweets and updates). Capturing essential information) from the flow of tweets (some were true, some spam and some misleading)

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TABLE III. FINDINGS OF THE STUDY (COMMUNICATION)

Id	Citizens' comments	Subcategory
3.1	It would be useful to advise people to avoid accident area as early as possible	Proactive communication
3.2	I think interactive communication between citizens and PPDRs is useful as long as the tweets from PPDRs are clear, open and fast enough.	Quality of communication
3.3	It was good that authorities reported only the essential information such as number of injured persons	Quality of communication
3.4	Does the tank truck have warning signs of Hazardous material? If yes what kind of signs?	Emergency details
3.5	I sent a tweet with a picture and location data (GPS). Now, authorities were well aware and the response came within a minute as a private message	Private message as a contact channel
3.6	PSOs could send their contact details as a private message (a direct phone number)	Private message as a contact channel
3.7	I wonder why I cannot use SoMe as a contact channel at the moment.	Social media as an add-on channel

TABLE IV. FINDINGS OF THE STUDY (USEFULNESS OF TOOLS)

Id	Findings	Subcategory
4.1	It would be good if the PSOs used these tools in real situations.	Need for improvement
4.2	The closed Twitter environment worked almost perfectly.	Retweeting
4.3	The main idea of hashtags was not clear to everybody	Hashtags
4.4	This system would work in real situations! I would use it and I would know who to inform. Might create spam.	Spam filtering
4.5	I received a good understanding of train accident only based on following Twitter feeds.	Progress of emergency handling

was seen to require skills on media literacy (for social media), especially when considering the reliability of the information provided on social networks.

PSO communication should be timely, fast and active. Some citizen players considered authorities response too slow in the exercise. Authorities explained that response takes time due to validation of information provided by citizens. In most cases the validation requires a field visit. One solution could be that authorities first message is that the situation is under investigation or some generic information.

Citizens would also have liked the PSOs to define hashtags for the ongoing situations. During the showcase, citizens communication involved tweets, private messages, video content, and images related to emergency situation. Authorities considered this information useful because it provided details of accident scene such as number and type of cars, color of smoke and warning signs in a tank truck.

Usefulness of social media tools for emergency management. During the showcase, the following tools were used by PSOs: the iSAR+ alerting services (My Public Alerts), iSAR+ fusion centre services (social media monitoring, SMM crawler, text analysis tool), and iSAR+ portal software. A closed Twitter-based platform was used to manage communication between citizens and PSOs. Three citizen players used Permiloc application that enabled locating the citizen and receiving real-time messages. (e.g., evacuation commands, progress notifications on emergency situations) from PSOs. The showcase scenarios included the following data:

- Real time messages (e.g., tweets, photos and video streams of the events, tweets with geolocation data) generated by the players.
- Photos from real emergency situations provided by Emergency Services College.
- Updates created based on previous, real life communications during emergencies
- Rumours and trolls produced intentionally by the citizen players.

Table IV describes the findings concerning how useful citizens considered social media tools in emergency management.

IV. ANALYSIS

According to our findings, social media is a very promising communication channel for emergency situations. However, emergency services field needs guidelines and policies to establish and maintain these channels. Social media might be used as an additional channel to provide richer information on accident scenes than a phone-based channel. We observed that Twitter-based social media tool was easy and fast to use from a citizens perspective, even with no previous experience.

The research problem of this study was: How social media tools support emergency management from a citizens perspective? As main contribution of the paper, we showed the citizens' perspective to the social media-based emergency management. The following **requirements for social media -based emergency management systems** can be derived from our results:

Fast response to citizens' social media updates and messages. Citizens require immediate and almost real time response to their messages in social media. During the showcase, we observed that citizens would require some kind of response on emergency event from authorities in early phase. Authorities' perspective seems to be to first validate the event before commenting anything. (Findings 1.2, 1.3)

Support for public and private messages. In addition to public communication (tweets), some of the citizens tested direct communication with PSOs and this type of tailored communication was considered very useful and effective. We

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observed that before a citizen is able to send a direct message to PSOs, he/she has to be a follower of the PSO role. From a citizen's perspective, opening an emergency chat channel from a hyperlink could be perhaps simpler way to open a direct communication. (Findings 1.4, 1.6, 3.5, 3.6)

Hashtags. Hashtags enable tagging and linking tweets on the same subject together. Some citizen players suggested that social media based emergency system could recommend citizens which hashtags should be used during the emergency situation. We also observed that the role of hashtags remained unclear for some citizens. (Finding 4.3)

Effective and reliable location based services. During the showcase, location based alerting systems (citizen players were using a mobile application) were tested. We observed that in some cases, inside the main building (of training area) the location-based alerting system did not work reliably because the mobile device and application lost the GPS signal.

Sharing information in periodic intervals scheduling. There were several citizen players that were asked (according to a script) to request information from PSOs during the showcase. Often, citizens ask simple questions related to who they should take contact with or where to get medical treatment. A certain number of these questions could be avoided by scheduling functions of social media tools. For example, a tool could be set to automatically post contact details of a hospital every 15 minutes. (Findings 2.1, 2.4)

Validation and analysis of emergency events. Especially, management of trolls provides social media tools with challenges. Image and video analysis tools should be used to check whether images and videos are real and have been taken from a correct place. Validation and analysis should be conducted not only reactively, but also proactively, for example scanning guns from images and analysing landslides from satellite images. During our showcase, some citizen players complained about slow response of PSOs. However, there were also citizens that had received immediate response to their tweets. (Findings 2.4, 2.5)

Educating citizens on what type of information is needed from accidents. The social media -based emergency management system should inform citizens what type of information is most useful for PSOs. For example, in hazardous material accidents, images on warning signs of container trucks and the colour of smoke help PSOs to identify what type of chemical the container is leaking. (Findings 3.4, 3.5)

The showcase results showed that social media enables new kind of citizen engagement in emergencies and crises. Disseminating information, providing eye-witness accounts, sending and receiving alert messages, exchanging experiences of the emergency response and searching and publishing information related to the event were conducted during a showcase in a closed social media platform. We observed that social media platform established strong real-time collaboration mechanisms that led to improved situational awareness of emergency situations.

Social media has been successfully used in several natural disasters to connect people and inform authorities of the scope of disasters/emergency situations. Our findings are congruent with previous studies that emergency management organizations still lack consensus on how the social media can be utilized in sharing emergency-related information. Negative impacts of social media use could be partly overcome by educating the citizens how they should or can act in social media channels. Our results showed that citizens would be willing to help if they knew what type of information authorities need in managing emergencies. Our study also addressed the role of rumor (troll) management. More effective data analytics capabilities of emergency management systems might speed up the validation of emergencies and lead to faster identification and more accurate response to trolls.

As implications for theory, our study contributes to emergency management theory by focusing on citizens viewpoint and exploring how they consider the use of social media as a contact channel and means of communications. Our main categories (social media as a contact channel, reaction of citizens to authorities and other citizens messages, communication, and usefulness of tools) and identified subcategories can be used by future social media case studies on emergency management.

As implications for practice, we validated the social media based emergency management approach with three accident scenarios and collected information on the limitations of social media tools and user experiences.

V. Conclusion

This study aimed to answer the research problem: How social media tools support emergency management from a citizens perspective? The main findings showed that the social media-based platform used in the study was easy to use and enabled the PSOs to find the most essential information from the information sent by citizens in social media. According to the showcase observations, using social media tools enhances the situational awareness of PSOs by providing information (photos, videos and tweets from emergency sites) directly from the citizens involved in the crisis.

However, some of the feedbacks collected from citizens indicated that implementation of these kind of new practices requires time. Using common hashtags in updates about the ongoing situations would have been useful; in this exercise, the citizen players thought that the PSOs could have recommended some hashtags. Citizen participants were worried that the important updates of the PSO might not be noticed among the flood of tweets. Spam and unreliable information was seen as a disadvantage of using social media during crisis situations.

Following social media and in this case the flow of tweets of which some are true, some spam and some trolls requires skills on media literacy, especially when considering the reliability of the information provided on social networks. During the scenarios demonstrated there was genuine need of official information, as it there would be in real life situations.

Pictures were found useful information, also from the point of view that they are helpful for foreigners who do not know the language used in the tweets. Although social media tools are actively used among involved citizens, our observations and interviews showed that utilizing them in bidirectional emergency management situations is relatively new.Feedback from the showcase and the earlier survey indicated that citizens

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trust authorities. This is not obvious in other countries. The citizens considered the presence of PSOs in social media and the bidirectional communication valuable and reassuring during and after a crisis. Our results indicate that social media could be an additional communication channel between public safety organizations and citizens.

This case study contains certain limitations. First, data were collected during a relatively short time period (2 days incl. a showcase and a feedback workshop). However, we managed to get a rich set of material for the analysis through using six sources of evidence recommended by Yin. Second, we used a single case design in this study. We agree that this causes difculties in generalizing results. However, case studies should not aim at generalization but extending the theory. Third, regarding the construct validity, most of the players were relatively young (students) that use social media more actively on their free time than elderly people. Finally, the fact that the showcase was a simulated exercise certainly affects the results.

Further research will continue in Soteria project. Barents Rescue Exercise 2015 will be a starting point for campaigns of experimentations, where the role and impact of social media and related tools will be tried, experimented, analyzed, tested and evaluated in real and realistic simulated environments. This will be instrumental to the production of recommendations on the understanding of the impact and role of social media in emergencies and efficient and effective ways to incorporate mobile technology and social media into emergency response efforts.

Further research efforts could focus on exploring the options how social media based emergency platforms should be organized and provided as a viable business model. Rescue services could apply service management approach for managing social media based emergency services.

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