Crisis Management 2.0:
Towards a Systematization of Social Software Use in Crisis Situations

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ABSTRACT

In this paper, the authors propose a systematization of social software use in crisis situations, examining different types of cooperation and challenges. The authors discuss how the organizational actors involved in crisis management (police, fire-fighters, organizations, etc.) and the affected citizens are communicating and can communicate and collaborate through the use of social software. After defining the term 'social software,' the authors outline its use in crisis management. They present two case studies where they have examined the use of social software in 2010: first during the disruption of air travel caused by the eruptions of the volcano Eyjafjallajökull in Iceland and second during the mass panic at the Love Parade music festival in Germany. Based on both previous work and case studies, the authors discuss potentials and weaknesses and propose a classification matrix for different types of cooperation as a step toward a systematization of social software use in crisis situations.

Keywords: Classification, Collaboration, Computer Supported Cooperative Work (CSCW), Crisis Management, Social Media, Social Software, Systematization, Web 2.0

1. INTRODUCTION

Disasters are large events that last for a considerable time, affect large areas and have widespread consequences on people, values and objects (BSI, 2008). In the last decades many crises came up, not only because of changes in climate. There are not just tsunamis, floods, earthquakes or wildfires: technical accidents such as oil leakages, energy breakdowns or crises caused by humans, e.g., spree killings and terror attacks, affect both, organizations and people. The pictures of those accidents can be seen always in old and new media: cities in exceptional circumstances, a large number of injured people and often no functioning infrastructure. Those responsible for crisis management may find it hard to obtain essential information to make reasonable decisions and to help the people affected by the crisis. This can be due to a lack of infrastructures for cooperation between people and organizations. Anyway, people are an authentic source of crisis-information and should be included in the

information infrastructure. Palen and Liu (2007) point out that organizations of formal response may be shaped to "support the new information pathways that will arise". People often use mobile phones and the Internet to inform their families and friends. Using social software applications, such as social networks, blogs, micro-blogs, photo and video communities, a lot of information is published by everyone.

The aim of this paper is to suggest a systematization of the use of social software in crisis situations, deriving different types of cooperation and develop related requirements. Therefore, we first describe major categories of social software (Section 2) and review the related state-of-the-art (Section 3). Furthermore we enhance it with data from our own case studies in Germany, where we observed the social software use at two major events, particular about the relationship of organization and citizen (Section 4). Based on a discussion on both literature and case studies and the identification of both strengths and weaknesses (Section 5) we suggest a systemization of cooperation in social software use for crisis management (Section 6).

2. POTENTIAL OF SOCIAL SOFTWARE IN CRISIS COMMUNICATION

Social Software is a part of Web 2.0. The term 'Web 2.0' is not well defined but describes the innovations of the Internet after the crash of the 'new economy' in 2000 (Alby, 2007). At a conference held by O'Reilly, the competences of the surviving companies of the new economy were summarized under the term 'Web 2.0.' O'Reilly (2005) defined them in seven characteristics which include the usage of the Internet as a platform to provide different services, the participation of users and a collective intelligence, the consideration of the user generated data as capital of an application, the inclusion of the user in the development using new software development models, the usage of services on different terminals and rich user experience. The term 'social software'

describes web-based applications, which support the user's interaction and communication process. In addition to this definition, there are various other considerations. Hippner (2006) defined social software as the possibility to exchange information, manage relationships and communicate in a social context. Besides the exchange of information, Ebersbach et al. (2008) have defined that user-generated content is an essential element of social software. Therefore, the existence of a community is an important pre-condition.

The following characteristics arise from the different definitions and will be used in this paper: Social software encompasses a range of applications from the Internet, which enable different people to contact and interact with each other. A community providing the data is the basis of these applications and they support different activities: the allocation of information, the generation of information, relationship management, communication and self-expression. Different activities are often combined. Based on the definition of these activities, various classes of social software applications can be distinguished (Ebersbach et al., 2008).

Wikis aim at a collaborative accumulation and creation of information and knowledge. They are useful to collect knowledge of a topic based on one's own research. In a crisis, this activity may be done by people who are not seriously affected by the crisis.

Blogs support the publishing of information and self-expression through an individually owned journal. They are not useful as a fast response as they often contain longer personal entries. *Micro-blogging* is an alternative. These applications use allow entries limited to 140 characters, similar to text messages. The most prominent application is *Twitter*. Users can publish messages (tweets) on their site and tag words (#hashtag) within a message. With the help of these tags, certain messages can be found. It is possible to address other users with the '@user' notation. It is also possible to publish tweets by sending text messages using a mobile phone. Due to the tweet's text message-

like structure, tagging and easily finding tweets about specific topics, its huge dissemination with over a 100 million users worldwide and its mobile usability, Twitter is a significant social software for crises.

Social networks were originally used for relationship management, self-expression and communication, but now these applications are more and more incorporating by functionalities related to blogging and the exchange of information. An example for a social networking service that offers good opportunities for crisis communication is *Facebook*. In addition to networking with people, organizations, companies or celebrities are possible. Each profile includes a wall where people can leave messages or where the owner of the profile can post his/her own status messages. The entries can include text, links, photos, videos and other users can add comments. On the wall a dialogue between individuals and organizations is possible. *Facebook* provides a client for various mobile devices making it possible to upload profile information from almost everywhere. People with older devices can receive updates through text messages and in turn update their own pages by sending their own messages via SMS. Lastly, the wide acceptance of *Facebook,* there are about 800 million active users worldwide, makes it the largest online community – one of the most important reasons why we recommend its use in crisis management.

Social sharing enables the user to generate and categorize digital content. Photo and video communities are the most interesting for crisis communication. The most popular are *Flickr* for sharing photos and *YouTube* to share video clips. Both services allow the indexing of uploaded content using self-selected tags describing the content and making a targeted search possible. *Flickr* offers several ways to interact with the website; one option is a website optimized for mobile devices, another is uploading photos via e-mail. *YouTube* offers a mobile version of the page, which supports the recording and uploading of clips by using a mobile phone. *Flickr* also lets users geo-tag pictures that can

then be placed on a map, or be displayed with additional image information using EXIF data.

When a crisis impends, quick reaction is necessary. Therefore, information about the incident is needed. For social software this means that the user has to provide his/her information in real time on the Internet. Not every type of social software is adequate for this. Regarding the potentials of different types of social software, in this paper we will focus on micro-blogs, social networks, social sharing and the provision of content with an eye on classifying social software use in crisis management (Figure 1).

3. LITERATURE REVIEW: USE OF SOCIAL SOFTWARE IN CRISIS MANAGEMENT

Social software has been used in crisis management for at least 10 years: Already after the terrorist attacks of September 11th (2001), wikis, created by citizens, were used to collect information on missing people (Palen & Liu, 2007). In a study on the information search behaviour during the forest fires in southern California in 2007, it was noted that people affected by the fires communicated via mobile phones. Furthermore, they used the Internet to search for information and to trigger any kind of communication, to read blogs, news sites and forums. They made use of photo-sharing services like *Flickr* in order to obtain information (Sutton, Palen, & Shklovski, 2008)

Many published research papers focus on crises in the USA, and many of them on the use of Twitter. The use of *Twitter* was analysed scientifically in the context of various crises such as in the case of technological failures (Sutton, 2010), the flood of the Red River (Starbird, Palen, Hughes, & Vieweg, 2010), an attack on four police officers in Lakewood, Washington (Heverin & Zach, 2010), hurricanes (Hughes & Palen, 2009) and earthquakes (Qu, Huang, Zhang, & Zhang, 2011). The focus of these investigations was on the general examination of all messages that had been twittered dur-

Figure 1. Considered social software in crisis management in this paper
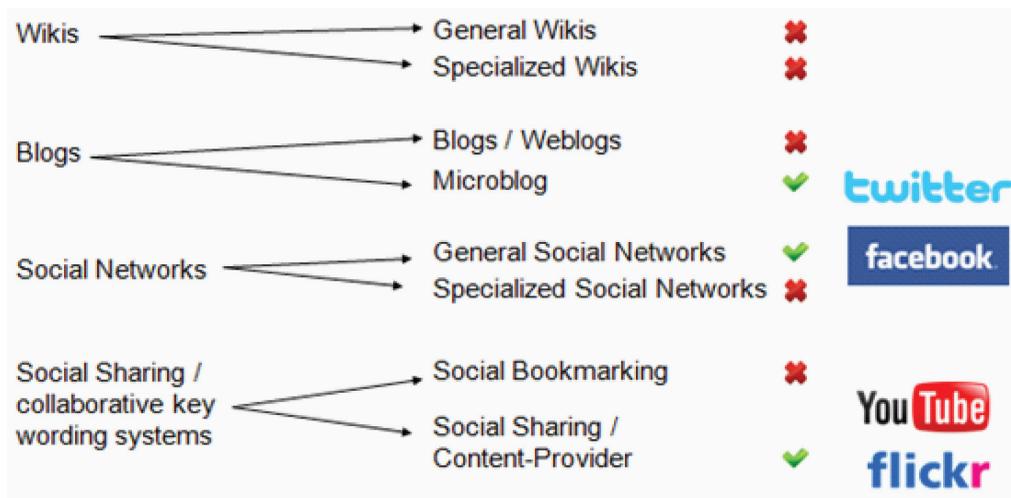
ing the particular crisis. Objects of analysis included the geographical distribution of Twitter users around the trouble spot, their group membership (individual person, organization, journalist, activist, etc.), their daily Twitter activity, the number of tweets per user and the number of responding tweets, retweets and broadcasts. The observers tried to show what distinguishes the Twitter experience in a crisis from everyday Twitter usage (Hughes & Palen, 2009). As for Twitter messages it has been found that twitterers assume the role of the classical media if the news coverage by the media and other organizations is not satisfactory (Sutton, 2010). Within the first hour of an emergency, using Twitter to retrieve information is almost essential. It takes up to 24 hours for mainstream media to catch up to the average level of information quality on the Twitter network (Mills, Chen, & Lee, 2009). Twitter can raise awareness of a crisis, as it is able to reach a large numbers of people all at once. Therefore, the service is often used as a broadcast medium (Hughes & Palen, 2009). False information is prevented from being spread by the collective intelligence of users, who ensure that faulty tweets are corrected. In this context, retweets serve as an evaluation mechanism for important information (Starbird et al., 2010). A study on

the use of a Chinese microblogging platform very similar to Twitter during an earthquake in China in 2010, found that it can not only be used to collect information, but also can be used to coordinate actions, exchange opinions and assist in emotionally processing the disaster (Qu et al., 2011). Twitter is also used by organizations, such as the fire department, to obtain citizen-generated content and also to publish their own information (Latonero & Shklovski, 2011).

A study of the geographical distribution of Twitter users has shown that people, who are not affected or only slightly affected, use Twitter more often than citizens and organizations that are affected much more seriously. However, the information generated by those who are not involved, is of great help to those affected by the crisis or disaster (Sutton, 2010). While looking into the habits of individual Twitter users, it was discovered, that there are so-called 'information brokers' (Hughes & Palen, 2009), who collect information from various valid sources, and pass it on to help victims of the crisis (Sutton et al., 2008; Vieweg, Palen, Liu, Hughes, & Sutton, 2008). In these exceptional situations, the broadcast and brokerage of information plays an important role. They occur much less often in everyday Twitter activities

(Hughes & Palen, 2009). Activities, tasks and domains can be identified as mechanisms of self-organization for digital volunteers in times of crisis (Starbird & Palen, 2011). During a rampage, the decentralized problem-solving behaviour of students was observed: a short time after the beginning of the attack, they used *Facebook* to attempt to identify the victims together and used *Facebook*'s group function for that purpose (Vieweg et al., 2008). An important conclusion can be drawn from this study, which is that the assumption that rumours are spread via social software is wrong. The authors show that the collective intelligence of citizens helped to correctly identify the victims, because users were concerned about reliable sources in this particular situation.

In addition to these studies on user behaviour and the use of social software in crisis situations, other articles propose solutions for including citizen-generated information in crisis management. The program TED - Twitter Earthquake Detector - is based on tweets, and scans for (previously defined) crisis-relevant hashtags (Guy, Earle, Ostrum, Gruchalla, & Horvath, 2010). Relevant tweets are filtered and archived. The application is used during earthquakes to close the gap of about 20 minutes between the first quake and the publication of scientific data. The idea of including citizen-generated information is very helpful but unfortunately it also bears some problems. By focusing specifically on Twitter, the range of opportunities for citizens to help by using social software is not entirely covered. The use of visual information, for example during floods, is also left out by TED.

Vieweg et al. (2010) analysed the structures of twitter messages in order to detect information categories used in tweets to describe aspects of crisis situations. Based on these findings Starbird and Stamberger (2010) proposed the use of a particular hashtag-syntax for tweets during crises. A standardized hashtag-syntax would be machine-readable and could help to collect information that is more relevant. In another study, Latonero and Shklovski (2011) monitored the Twitter-use of a Fire Department to obtain citizen-generated information. Another proposal for the treatment of user-generated data is being provided by Bellucci et al. (2010): their project eStoryS is a social software mash up, that identifies crisis-related photos from the *Flickr* API, and arrange them on a map. A similar function is provided by the TED system, which can display tweets on a map. Goolsby (2010) considers the ad-hoc crisis community Ushahidi, which uses social media as a crisis platform to generate community crisis maps.

Raman et al. (2010) suggests that wiki technology can be used to manage knowledge for emergency response. 'Scipionus' is an example for a crisis-related wiki, which arose during the fight against the effects of Hurricane Katrina. It deploys a visual interface which allows its users to publish and edit information on the Google Map Interface (Palen, Vieweg, Sutton, Liu, & Hughes, 2007). Further examples are Emergency Wiki or Quake Help Wiki (White, Plotnick, Addams-Moring, Turoff, & Hiltz, 2008). Jennex (2010) warns against just adopting social media for crisis response without analysing its impact on the organization; he suggests combining it with a knowledge management strategy.

To summarize, the following lessons can be learned from the present literature: during crises Twitter can take over the (1) *role of the mass media* if it does not fully cover the needs of the receivers. Twitter is then used as a (2) *broadcast medium* to pass on information to the public. Information is not only meant for the victims, but is addressed to all readers and thus can draw attention to the crisis. As a consequence groups of "*digital volunteers*" emerge during a crisis (Starbird & Palen, 2011). Another finding in relation to Twitter is the role of (3) *retweets*. They can be considered relevant information, and thus an evaluation mechanism. The importance of a tweet depends on the number of retweets (Starbird et al., 2010). In relation to the usage of any social software, (4) *brokerage* is more common in crisis situations: Users are identified as *information brokers*, when they gather relevant information, prepare them and make them available to other users (Hughes & Palen, 2009). One last very important conclu-

sion that can be drawn from the literature is the fact that (5) *collective intelligence* prevents the spread of false information (Vieweg et al., 2008). Misleading information is detected and corrected because a large group of people receives the information. This important finding helps to judge the validity of user-generated information.

4. CASE STUDIES: SOCIAL SOFTWARE IN CRISIS MANAGEMENT

Many published research papers focus on crises in the USA. Hence, it is useful to observe the use of social software in Germany. Our focus is to observe the role of the organizations using social software to keep in touch with people affected and these people's perception. Therefore we observed the use of social software in Germany during two crises in 2010, the volcano eruption in Iceland and the mass panic at the Love Parade in Germany.

4.1. Case 1: Use of Social Software during the Flight Cancellations in the Course of the Volcanic Eruption in Iceland in April 2010

In April 2010, the eruption of the volcano Eyjafjallajökull in Iceland caused a huge disruption of air travel across western and northern Europe for a period of six days. Haarhaus (2010) wrote, in a very short article, that some airlines attempted to manage the crisis by offering services to their customers through social software such as Twitter and Facebook, while others failed to inform their customers properly about the development of the crises.

Method: Inspired by this article, we have analysed the activities of the airlines Lufthansa, EasyJet and AirBerlin on their Twitter and Facebook pages. The three airlines were mentioned in Haarhaus' article. For our study, the period between April 15th, 2010 (the eruption was first mentioned) and April 22nd, 2010 (air travel was resumed) was selected. We observed and analysed the activities of Lufthansa, EasyJet and AirBerlin on their Twitter and Facebook pages. To obtain relevant information from Twitter and to search for tweets, we used the search engine Topsy (http://topsy.com), on Facebook we gathered information manually from the Facebook wall. Our explorative study aimed at understanding the field and the motives of the infrastructure providers and citizens. We analysed the data with a focus on the connection between organizations and citizens.

Results: The observation of the Twitter pages showed that all three airlines provided news and constant updates about flight cancellations and the spread of volcanic ash. Most of the tweets provided a link to the news sections of their own websites. Thus, the subscribers were constantly being informed by the companies. Twitter was used very efficiently as a broadcast medium during the crisis by the airlines. Communication with customers was observed on all three channels. Tweets with questions that directly addressed the companies were answered individually. In the channel of EasyJet, questions were either answered immediately or the customers were redirected to EasyJetCare, a special service-channel of EasyJet on Twitter. Although all three companies used Twitter as a broadcast and contact medium for customers, the activities varied. While AirBerlin published 18 tweets in the period from April 15 to 22 and answered only three personal questions, Lufthansa tweeted 69 times in the same period and replied to about 17 personal customer requests. EasyJet showed the largest activity on Twitter: in addition to the broadcasting of news, many personal tweets were answered, mainly because this airline was operating on two Twitter-channels to provide customers with quality service.

On Facebook, AirBerlin posted news on their wall, but comments posted by users were hardly taken into account. This shows that AirBerlin did not consider Facebook as a medium for communication with customers. The users of Facebook recognized this and they regularly answered questions that were left unanswered by AirBerlin on Facebook. EasyJet and Lufthansa also used Facebook as a broadcast medium.

Unlike Air Berlin, these two companies used Facebook to actively communicate with their customers: the supervisors of the profiles answered almost all of the questions posted to their walls, although most were only referred to the service centre.

In summary, taking Twitter and Facebook into consideration as a way of communication within this crisis, shows that many companies use social software as a broadcast medium. Some companies have recognized the potential of those applications and use them to support the communication with customers. From the perspective of their clients, Twitter and Facebook are accepted ways of contacting the companies, although many customers wrote that the first contact happened by phone or mail, afterwards they used social software to get help.

4.2. Case 2: Communication via Social Software during the Love Parade Disaster in Germany on 24th July, 2010

A second case where we analysed the use of social software, was the mass panic that occurred at the Love Parade in July 2010, an electronic dance music festival in Duisburg, Germany, which led to the death of 21 people in the resulting stampede and at least 510 people were injured. Shortly after the incident, many TV reports mentioned that visitors had used social software to warn others about the huge crowd. Pictures and videos taken with mobile phones were offered as first sources, providing insight into the disaster.

Method: Due to these reports, we observed the activities on Twitter, Flickr and YouTube before and after the accident, in order to investigate if participants had been able to deliver information to participating organizations other visitors of the Love Parade in a timely manner via social software. To obtain relevant information and to search for tweets, we used the search engine Topsy (http://topsy.com), for Flickr we used its own search engine and YouTube videos were filtered with Google Video. We concentrated on Twitter messages exchanged from 9 a.m. to 10 p.m. on July 24, 2010, videos uploaded on the same date and photos that were uploaded on July 24th, 2010 before 6 p.m.

Results: The search for tweets provided us 105 results containing the term "#loveparade." This list has to be regarded as incomplete, but our aim was to focus on the tweets, which were tagged with this well-known term. Most of the tweets were posted only in the wake of the disaster. However, some tweets had warned of overcrowding and chaos beforehand. For example, 'sektorkind' tweeted: "*Police says: area is full. No chance of admission. #loveparade 3duisburg*" at 4:47 p.m., about an hour before the mass panic broke out. Helpful tweets were mainly distributed on the news portal 'Der Westen', belonging to the WAZ media group, the third largest newspaper and magazine publisher in Germany, where a news ticker about the Love Parade was created. The news was also reported on Twitter in short intervals, tagged with #loveparade. Before the actual disaster happened, the portal had given information on train delays, the backlog of the crowd and the closure or congestion of the festival venue. The media published some of the tweets that followed the disaster. Entries such as "*visitors of the #loveparade make sure to keep calm. Do not go to the station. It's closed! Pass this info on!*" warned others, trying to avoid further chaos and panic. Information, especially about the number of deaths, the recommended ways to return home and about other security measures was also distributed. It is noticeable that even here some twitterers acted as information brokers and played a major role in providing information to stakeholders. They collected information about the event from different sources and made them available via Twitter.

The search on Flickr showed that only three photos, showing the conditions at the Love Parade, were uploaded before the incident. One photo shows the crowded stairway to the festival site, posted at 5:42 p.m., two pictures from another user, also taken with a mobile phone; show the tunnel to the festival site and people climbing over the embankment of the festival grounds. The images were posted

at 2 p.m. and at 2:24 p.m., respectively. All other images, which were identified as photos uploaded by visitors, were taken with either digital cameras or mobile phones and had been uploaded later in the evening to Flickr, images on Flickr show the time of their posting. Many photos have EXIF (Exchangeable Image File Format, a standard that specifies the formats for images, sound, and ancillary tags used by digital cameras) data, which is displayed next to the photo on Flickr. This data shows both the camera model and the settings with which the photo was taken, and the exact time of the recording and upload.

On the video portal YouTube the upload date is provided, but the exact time of the upload cannot be determined. The Google-search on youtube.com with the exact phrase 'Love Parade 2010,' the tag 'panic' and the date July 24th, 2010 found 73 results. Parts of the results show footage and coverage from television and interviews with eyewitnesses. Some videos are a compilation of images and text, as reminders of the disaster. Many of the results contain mobile phone videos, taken by visitors during the accident, also included are several videos that give an impression of the event before the accident. For example, the tunnel and the staircase are shown at various times before the panic, almost always full of people. Other videos show the huge crowd at the accident site, or paramedics caring for the injured after the panic. The videos are often tagged with the exact time of recording, which is added by the uploader as a comment. If the videos were not tagged, users asked for that meta data in the comments field of the video, leading to the information to be added subsequently. Showing the recording time is now a common practice on YouTube that has evolved as a result of the accident. Users, who asked for such data, can be generally identified as information brokers that collected all relevant videos on YouTube and transferred them to a separate channel of information on the disaster. According to the description of the clips, some of the videos that show the locations before the accident were sent to the authorities responsible for criminal

investigations of the disaster. Information brokers had the same intention, by tagging the clips and collecting the available recordings.

The investigations of the activities on Twitter, Flickr and YouTube following the Love Parade disaster, show that a significantly small amount of information was provided before the disaster. Only few images, tweets and videos warned others of the crowds in advance. The largest part of the information followed after the incident. Photos and videos showing the disaster were uploaded later in the evening or the following day. The information the majority of users provided, was primarily used for the investigation of the incident, but could not act as a warning for other visitors. We observed that a flood of information was posted after the actual disaster. In the case of the Love Parade, the mobile phone network collapsed – therefore, visitors had few chances to even be warned beforehand. In our observation of Twitter and YouTube, we found that users tried to make out or commemorate the victims after the event.

5. DISCUSSION

Strengths: Based on our literature review and our observations we can conclude that services like Facebook, Twitter, Flickr and YouTube are appropriate tools for an exchange of information between citizens and organizations, also in Germany (Table 1). All those applications can be used via mobile applications and not only via computer. The use of SMS is also very important particularly when no Internet is available. Tagging can help to find information. Geotagging can also help, especially when messages or pictures are sent with a mobile phone, because then the exact location of the described situation can be identified. This is important in case of fires, storms, floods or energy breakdowns. Especially when energy breakdowns occur, a mobile phone can provide important information. A Hashtag-Syntax can also help to sort information and link it to issues, groups or individuals (Guy et al., 2010). Retweets can confirm the importance of information (Star-

Table 1. Strengths and weaknesses of detected social software use

Strengths	Weaknesses
• Mobile use, use of SMS • Tagging, GeoTagging • Twitter: Hashtag-Syntax • Twitter: Retweets • Flickr: EXIF-Data • Facebook: contact point	• YouTube: time • Flickr: EXIF-data base on cameras' settings • Twitter: location errors • Facebook: broadcasting vs. communication • No central contacting point • Quantity of information

bird et al., 2010). Flickr has the opportunity to provide EXIF-Data that help to determine date and time of when a picture was taken. Facebook has a large potential, as citizens can contact organizations without calling them, which usually takes a lot of time.

Weaknesses: Besides the potentials, we also observed some weaknesses in current social software applications (Table 1). *YouTube* does not provide information on place or time; users have to add them in a comment, it has to be provided by the user in a comment, when uploading the content. *Flickr* supports the EXIF-Data, but this depends on the device used, and it may provide wrong data. *Twitter* can use the location of a tweet, but only if the message was sent with a mobile phone with a location sensor. If the user twitters from his computer, the location of the user profile is used, but it might not be correct. *Facebook* is the most problematic service: many companies use it for broadcasting, but not as a communication platform. A problem is that the users do use those systems, and then communicate only amongst themselves. While observing an interruption in air traffic, we saw that a large number of people affected, used this method of communication. A problem is often caused by the communication partner, as many organizations and companies use Facebook as medium for broadcasting – while many users interpret it as a communication platform. Another deficit, at this point, is that only few organizations and companies, that need to be contacted in a crisis situation, are registered there. This also indicates a more general problem within crisis communication. There is no official contact person whom citizens can address with their digital information; the only addressee is the general public of Internet users. There, the potential of the citizens as information providers is not fully utilized, because they do not have a central contact point. The opposite occurred in the following case: During the flood in Saxony in 2010, the regional television channel asked its viewers to act as reporters, and to upload images of flood on the television channel's website. People submitted over 1,000 images, which documented the flood in various cities (MDR, 2010). A search for relevant photos on Flickr brought only one page of results, consisting of pictures that users uploaded without being asked. From this observation, we have concluded that a specific motivation of the citizens and a central contact point generate more information than can be obtained through the people's own initiative.

6. TOWARDS A SYSTEMATIZATION OF SOCIAL SOFTWARE USE

In order to develop software for crisis management it is important to take the specifics of the field into account. Due to the large number of people involved systems should be "highly flexible", but "also structured group communication systems" (Turoff, 2002). Furthermore systems should be easy to learn, they should be concise and self-evident and contain a high degree of tailoring and filtering (Turoff, Chumer, van de Walle, & Yao, 2004). Most of the research in that field was done before the emergence of Twitter, Facebook et al., which actually do address many of the requirements described. In addition,

social software services defined a new public articulation space that is particular helpful for establishing communication channels between organization actors and the general public as well as publics of citizens. Along these lines, the establishment of social software services in crisis communication concepts is not so much a question of the availability of new technologies, but of the configuration of existing technologies and services. With regard to software aspects of technology use Jennex (2004) called for organization-wide templates and terminologies, the use multiple communication methods and recommended not to trust in the availability of the Internet.

In the discussion we saw that the potentials of social software are not yet exhausted. On the one hand, we observed that the integration of citizen into crisis management has some potential; on the other hand, social software can also be used for communication among the professionals involved. Based on a distinction between the organizations of crisis management and the public as two groups we suggest a classification matrix for cooperation in crisis situations, depending on the sender or creator of digital content (X-axis) and the recipient or user (Y-axis) (Figure 2). White and Plotnick (2010) created a more complex matrix to identify best practices also taking event size and event phase into consideration. The aim of this matrix is to take a step towards a systematization of social software use in crisis management and to clarify different types of cooperation in order to develop appropriate systems.

6.1. Type 1: From Organizations to the Public: (Classical) Crisis Communication

Based on our results we think that it is important to research the information needs during different phases of a crisis and inform people in advance. With the publication of information to citizens (Vieweg et al., 2008), it is possible to reduce the load other channels have to carry. Furthermore the support of information brokers (Hughes & Palen, 2009) and the recommenda-

tion of crisis tags (Starbird & Stamberger, 2010) are possible. Incorporating social personal media, such as text messages or e-mail, allows further refining of communication strategies. Citizens may define certain triggers (e.g., "power outage will last > 4 hours") where they are automatically notified about critical escalations which may make it possible for them to start measures for their own crisis management (Ley, Pipek, Reuter, & Wiedenhoefer, in press). This would also help remove pressure from the hotlines of infrastructure providers.

6.2. Type 2: From the Public to the Public: Self-Help Communities

Social software supports the creation of self-help communities and creates new opportunities for people to participate in such communities (Palen & Liu, 2007). Those emerging groups may act as virtual or neighbourly help communities (Reuter, Heger, & Pipek, in press). The actual physical presence is no longer necessary in order to coordinate self-help locally. In a study on the use of ICTs in disasters, Shklovski et al. (2008) found a series of self-help activities being carried out with social software. These included the search for reliable information and thus also the confirmation or correction of different information spread by the media. The potential of the paradigmatic turn from perceiving the citizens affected as a passive force that needs to be managed and controlled towards acknowledging them as crisis managers in their own respect is visible in the usage patterns of social software. The articulation of questions, needs and fears meets the will to provide help, assistance and support. Self-help communities can be based on co-location (e.g., neighbourhoods) or specific needs (e.g., baby caretaking, diabetes, treatments that require electric devices), but always require preparation, e.g., by gathering resources (like locally available generators or independent fresh water wells) as well as determining specific needs (e.g., locations of dialysis patients).

Figure 2. Classification matrix for social software use in crisis management

6.3. Type 3: From the Public to Organizations: Integration of Citizen Generated Content

There are different approaches to the analysis of citizen generated content. Besides monitoring based on relevant crisis tags (Bellucci et al., 2010; Guy et al., 2010), which calls for the provision of relevant material (MDR, 2010), its aggregation (Starbird et al., 2010) and archiving for future analysis and training purposes (Reuter, Pipek, & Müller, 2009) may also be helpful. Howe et al. (2011) describe the lessons learned from Exercise 24, which, with over 49,000 participants, tested how social media and crowdsourcing technologies can be implemented. Kavanaugh et al. (2011) analysed the use of social media by government officials in Virginia and identified huge requirements concerning the overwhelming amount of data. Acknowledging the affected citizen as a responsible actor in crisis management raises the potential of benefitting from citizen-generated content, e.g., to illustrate problematic situations through photographs taken with mobile phones. The perceived unreliability of such information is a significant obstacle in exploring such opportunities. This could be alleviated by crowdsourcing strategies to confirm the trustworthiness of information visible on a picture, but also by training 'community scouts' as amateur 'first informers', just as there is training for medical first aid. The publicity of this information would help stimulate similar information postings. Also, according to the principle of the 'wisdom of the crowd', information may become more reliable if it comes from different sources via different media. Tools to select and summarize as well as to access information quality can help improve the practice of professional actors in crisis situations.

6.4. Type 4: From Organizations to Organizations: Inter-Organizational Crisis Management

Social software can help to improve inter-organizational awareness and informal processes. White et al. (2009) examined the potentials of online social networks with emergency management students: Sharing information, communication and networking were the most requested features. They also show that

possible concerns against those systems may be information integrity, user identification, privacy and technology reliability. With regard to the inter-organizational communication between the established organizations we discovered some potential of using social software for shared data maintenance about individuals, as social networks for professionals (e.g., LinkedIn, XING) offer it (Ley et al., 2012). Valuable data types would be contact information, the role/responsibilities a person takes at different escalation states of a crisis, or specific experiences (prior crises) and expertise (additional qualifications or regional/domain knowledge). As with the professional social networks mentioned, these obvious benefits may also result in strengthening informal ties even beyond the organizational groups. This becomes visible in the everyday practice of the organizations. Complemented with representations of formal organizational structures and processes, this infrastructure may become an invaluable source for organizational learning (e.g., by exchanging experiences). Christofzik and Reuter (in press) show that the identification of information composition functions should be taken into consideration when designing those inter-organisational collaborative systems. Anyway any use of groupware – such as social software – might change interpersonal communication, both planned and unplanned (Mark & Wulf, 1999).

7. SUMMARY AND CONCLUSION

In this paper, the aim was to provide a systematization of social software use in crisis situations. The contribution of this paper is (a) to summarize the state-of-the-art in this field, (b) to define further requirements, and (c) to create a classification matrix, which takes into consideration the actual use of social software in crises by citizens and organizations.

Based on a definition of the term social software and a first selection of these services due to their rapid reaction capability, we have defined four classes of social software suitable as tools in crisis communication. We have limited our study to these applications: *Facebook* as a representative of social networks, *Twitter* from the category of micro-blogging services, and *Flickr* and *YouTube* as photo and video sharing sites. A large part of the paper published so far deals with the general use of social software by the citizens in a crisis situation. All communication via the media was considered, but it was not explicitly stated how citizens can be involved to provide information to organization relevant in crisis management. Studies that address this point have tried to offer solutions in the form of programs tailored to these demands. In these texts only one social software service was included in the application design.

In our own descriptive study we investigated the use of social software by people in Germany during two crises. Regarding the case of flight cancellations the study focused more on the question of how citizens tried to communicate with companies and other organizations. Thus, we analysed the Twitter and Facebook pages of airlines during flight cancellations in April 2010, which were caused by the volcano outbreak in Iceland. The investigation yielded the finding that travellers used to contact airlines after the conventional communication channels, such as telephone and e-mail, failed. While the travellers regarded this method of communication as almost self-evident, the airlines used Twitter and Facebook more as a broadcast medium. In the investigation of the Love Parade music festival in Duisburg, Germany, the general provision of information by participants was analysed. We considered information on Twitter, Flickr and YouTube, which referred to the disaster. As a result, we found that people did not provide information only because they had the possibility to do so, but because additional incentive existed: In the aftermath of this incident an information culture developed, available material was collected and conventions for a uniform database (date of the clip, collection of image sets and channels) were developed.

Based on the findings from literature and our own studies, we conclude that certain types of social software have the potential to combine citizens and organizations in crisis management, especially in combination with mobile phones or other location-based media. Our classification matrix for cooperation in crisis management is a first step and distinguishes between different types of cooperation: (1) *crisis communication* – to quickly inform citizens and to communicate with citizens with regard to individual needs, (2) *self-help communities* – to foster emergent groups and neighbourhood aid, (3) *integration of citizen-generated content* – to gather citizen-generated information from various social software services and (4) *inter-organizational crisis management* – to support inter-organizational communities for professionals. Each of the quadrants we defined may require different technologies and technology configurations to reliably work in the event of a crisis, and the biggest challenges may be non-technological, but related to communication strategies and multilateral negotiations of information exchange. Our categorization helps to frame the arenas these interactions take place. It may also be helpful to structure research efforts: As (4) may well connect to IS or CSCW research in other organizational settings, and (2) may well connect to studies and design research with regard to communication and collaboration in communities, the sectors (1) and (3) identify fields of practice, where organizational work settings now interacts with not only a general public, but also the new 'publics' that manifest social network sites, and where new research methods may be needed that cover traditional crisis management work settings as well as the new online communication environments, and integrate analytical and design-oriented research methods. Design case studies (Wulf, Rohde, Pipek, & Stevens, 2011) could be an appropriate research framework to further work on this topic.

Particularly our empirical studies of the use of social software indicate, together with many others (Mark, Agdouri, Palen, & Martin, 2012; Starbird & Palen, 2012), that despite their vul-nerability, social software services have already become an important societal infrastructure that is also used in coping and recovering work after a crisis. Citizens already have started their infrastructuring activities (Pipek & Wulf, 2009) by configuring and using social software to cope with and recover from crises, and it is high time to also look at and support, or motivate, infrastructuring activities in professional crisis management as well.

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