A Volunteer Coordination System Approach for Crisis Committees

Hans Betke
Martin Luther University Halle-Wittenberg
Chair of Information Management
Halle (Saale), Germany
hans.betke@wiwi.uni-halle.de

ABSTRACT

In disaster situations security authorities and organizations have the responsibility and duty to manage the disaster response. These organizations work in elaborated command and control structures with well-trained employees. But in recent events, supported by new technologies like social media and mobile devices, spontaneous volunteers from the local population gained new importance as helpful force in disaster response. The high amount of volunteers bears high potentials to improve the efficiency of several activities through pure manpower. However, these people are not integrated in existing structures and lack a proper qualification. The proper coordination of spontaneous volunteers poses new challenges for disaster authorities. In this paper we introduce the prototype of a novel information system enabling crisis committees to coordinate spontaneous volunteers by semi-automated purposive communication and allocation. The results of first staff exercises are discussed to emphasize potential benefits and open challenges.

Keywords

spontaneous volunteers, coordination system, prototype demonstration

INTRODUCTION

In case of a disaster incident volunteer helpers from the local community have always made their contribution in disaster response by supporting officially responsible security authorities and organizations (SAOs). But currently the way people provide their help is changing in different ways. SAOs in many countries recognize a decreasing willingness of citizens to volunteer in the context of an honorary appointment where they are bound to an established organization (e.g. McLennan et al. 2016, Angermann & Sittermann 2010). On the other hand dissemination of new technologies like social media and mobile devices massively influences the involvement of volunteers. Incidents like the flood catastrophe in middle Europe in 2013 and the hurricane Katrina showed how unaffiliated volunteers using these technologies made important contributions in disaster response. These changes force established SAOs to rethink current methods to activate and integrate unaffiliated volunteers. The novel possibilities for interaction and collaboration open new opportunities to utilize potentials of the civil society and coordinate unaffiliated volunteers to support the goals of responsible SAOs for a more efficient and effective disaster response (Sauer et al. 2014).

In the literature, unaffiliated volunteers, people who are neither through work or honorary appointment bound by a SAO, are separated in two types: digital volunteers and physical volunteers (Whittacker et al., 2015). Former are using information systems directly to gather and distribute information about the current disaster event to support SAOs or share them with the community. A well-known example is the earthquake in Haiti in 2010 where digital volunteers used the crowdsourcing geo-platform Ushahidi to visualize and aggregate the information about the incident they collected and analysed from social media and other communication channels (Morrow et al., 2011).

In contrast to that, physical volunteers offer their workforce and support at the disaster response sides within their range. They use information systems primarily to coordinate their response activities and to get information about help requests and possible response locations where they spontaneously decide to offer their help. In this paper these kind of physical volunteer is called spontaneous unaffiliated on-site volunteer (SUV). In the middle European flood catastrophe of 2013 thousands of SUVs supported official helpers in their work. They communicated and organized their spontaneous activities via social media like Twitter or Facebook without consulting responsible crisis managers. Reports showed the enormous support capacities which could be activated but also revealed that some disaster response sites were nearly overrun by SUVs whereas other sites were in urgent need for additional manpower. SAOs were often overwhelmed by spontaneous converging volunteers and were not able to coordinate the large amount of people especially in critical situations. The self-organization of SUVs is not integrated in established command and control structures of existing SAOs so that the potentials are not directly accessible for crisis managers. Deficits in the volunteer coordination can lead to waste of workforce, decreasing motivation to offer help or even improper and counterproductive actions, necessitating further response efforts or even cause new damages (Barsky et al. 2007).

In this paper we address the problem of coordination of spontaneous unaffiliated on-site volunteers through disaster managers in established security authorities and organizations and especially crisis committees. We focus on the design of a volunteer coordination system (VCS) using modern information technology for a demand-oriented assignment of SUVs to adequate response sites with help of semi-automated communication processes. Thereby we emphasize the applicability of the system for as many people as possible to exploit the highest potential of volunteer workforce. This paper is part of a bigger research project for the development and evaluation of a holistic system taking the needs of different actors into account and aiming at a largely automation of volunteer coordination to allow an effective and efficient employment of SUVs. The research in this project follows the design science research process of Peffers et al. (Peffers et al., 2006). While the problem identification (phase 1) and objectives of a solution (phase 2) (Betke et al., 2017) have already been addressed in former publications, as well as different aspects of the artefact design and development (phase 3) (Lindner et al., 2017; Lindner et al. 2018; Rauchecker & Schryen, 2018) the paper at hand mainly addresses the demonstration (phase 4). The special focus of this paper is the presentation and discussion of a first prototype system. The results of a live test by crisis staff members in a standard training situation give evidence of the possible benefits of the system and describe open challenges. The paper is structured as following: in the next section we will introduce the functional system requirements derived from interviews and literature analysis. Build on that a first simple system prototype consisting of three mayor components is presented. Furthermore we will describe the testing of the prototype and discuss the insights. The paper closes with a summary of the results and a critical outlook in the conclusion.

CHALLLENGES OF VOLUNTEER COORDINATION

The coordination of unaffiliated volunteers is not a new challenge and different aspects of this topic have already been subject of research in recent and current projects like KOKOS or EMERGENT. For a comprehensive overview of respective projects see e.g. Zettl et al. 2017. The research presented in this paper is part of the *KUBAS* project. As mentioned before the project aims at the development of a volunteer coordination system for to improve the employment and management of spontaneous unaffiliated volunteers by official crisis committees. Thereby the project focuses on some special concepts which are researched and developed in own subproject. These concepts are: (1) building of a workflow-based system structure to allow automated, individual communication processes for each volunteer, (2) optimization of matching between volunteer offers and help requests by sophisticated algorithms to allow optimal utilization of volunteer potentials and (3) simulation of SUV behaviour for staff education and system evaluation. The project also pursues additional targets like diversification of communication channels for spontaneous volunteers and open interfaces for integration in existing operational command systems. However, these concepts and aspects are discussed in own papers or part of a system design paper.

In this paper we want to emphasize the requirements directly from the two user groups. Therefore we conducted guided interviews with participants of each user group: 9 members of disaster response authorities with different roles in crisis committees and 19 spontaneous volunteers with experience gained in former disasters. The guided interviews comprised questions about their previous experiences as or with spontaneous volunteers in regard to conducted work, positive experiences and potentials, negative experiences and concerns, integration in command and control chains, communication behaviour as well as individual requirements on a volunteer coordination system from their respective point of view. We used the interview results in combination with existing literature about computer supported cooperated work esp. in disasters (e.g. Ludwig et al. 2017, Meissen et al. 2017, Weigand et al. 2003) and volunteer coordination (e.g. Fernandez et al. 2006, Johansson 2013, Lorenz et al. 2017, Rogstadius et al. 2010, Whittaker et al. 2015) to derive a set of functional requirements in the form of user stories for each user group. Table 1 comprises an overview of the resulting user stories. Whereas the original set of user stories has a 3-level hierarchical structure we decided to just present the second level of requirements for place and clarity reasons. We also cut out user stories addressing the matching algorithm since this discussion is detailed part of other papers. The whole set of user stories was taken as target specification for the development of a new VCS. However, we do not regard these user stories as the final system requirements but just a starting point. They will be enhanced and refined based on an iterative development process considering user feedback and further research efforts.

Table 1. User Stories for a Volunteer Coordination System

Nr	User Story
RV1	As a volunteer I want to be informed about relevant help requests so that I do not have to search for them.
RV2	As a volunteer I want to get detailed information about help request so that I can make a decision to help.
RV3	As a volunteer I want to see my volunteer mission details at any time so that I do not lose any information.
RV4	As a volunteer I want to provide sufficient information about my volunteering offer so that I can get the best help requests.
RV5	As a volunteer I want to group with my friends so that we can work at the same sites.
RV6	As a volunteer I want to change my volunteer offers so that it matches my current circumstances.
RV7	As a volunteer I want to get information if my volunteering offer was recognized to be sure it will be taken into account.
RV8	As a volunteer I want to be able to get offers from more than one request so that I can help at different sites.
RV9	As a volunteer I want to use mobile devices so that I am not bound to a single location.
RV10	As a volunteer I want to use different devices so that I can be sure that I get help request information.
RV11	As a volunteer I want to get information about disaster incidents in my home area so that I can prepare myself.
RV12	As a volunteer I want to share on-site information with disaster authorities so that I can report potentially dangerous incidents.
RV13	As a volunteer I want to get information about the traveling options so that I arrive on site as fast as possible.
RS1	As staff member I want to create and communicate help requests with sufficient information so that I get suitable volunteers.
RS2	As staff member I want to get Information about the status of assigned volunteers so that I can react to capacity problems.
RS3	As staff member I want to have an event history so that I can reproduce every action in the aftermath of the disaster.
RS4	As staff member I want to have detailed information about all running help requests, so that I can overview the situation.
RS5	As staff member I want to use a situation map with volunteer related information so that I always have an overview about the entire situation.
RS6	As staff member I want to register volunteers arriving on site so that I have a better overview of the capacity situation on that site.
RS7	As staff member I want to change the information in help requests so that I can react on a changing situation.
RS8	As staff member I want to to send custom information to individual volunteers or groups so that I can warn them in critical situations.
RS9	As staff member I want to get address information about volunteers so that I can associate compensation claims in the aftermath.

VOLUNTEER COORDINATION SYSTEM PROTOTYPE

The following chapter is part of the demonstration phase (phase 4) in the design science process of the research project (Peffers et al., 2006). It will give an insight into an early prototype system and show which feature meets the user stories. Although until now not all user stories and requirements could be addressed, the first iterations of the design and development process succeeded in a functional prototype system consisting of three major components: the Task Manager as interface for crisis committee members, the Volunteer App as interface for SUVs and the VCS server.

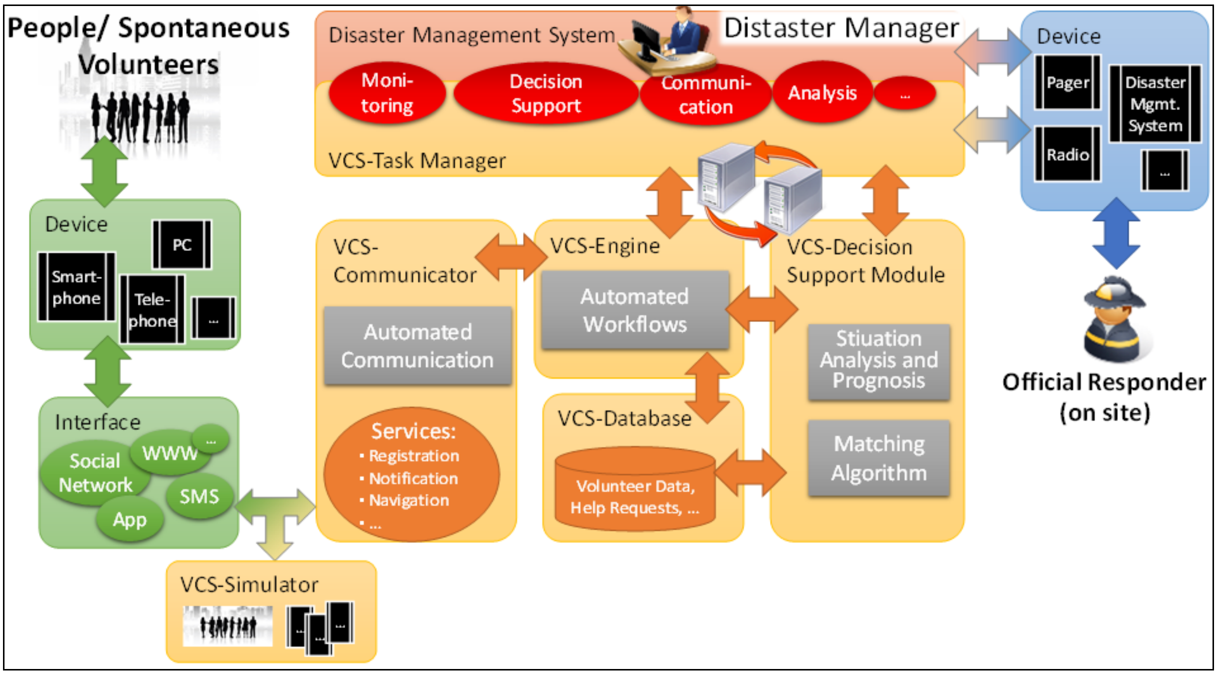

Figure 1. VCS General Architecture

The VCS server comprises five modules which interact with each other for a purposive processing of the information from Task Manager and Volunteer app (see figure 1). The main engine of the VCS is a workflow management system whereby we more precisely decided to use the Camunda BPM Workflow Engine due to its high flexibility and open architecture (for a comparison of current open source workflow engines see Bischoff & van Dinther 2016). The workflow engine is the main hub for all in- and outgoing information and manages the interaction of all further system components. The engine also controls the individual communication workflows for each volunteer. The second basic module is the Database where all information about volunteer offers, help requests and volunteer user data is stored. We decided to use PostgreSQL as it offers all necessary functionality and is often discussed as the best open source database system. Another key server component is the decision support module whose task is to constantly analyse the situation on volunteer offers and help requests to determine matches and provide information about which SUV should be alarmed for open help requests. For a detailed discussion of this module and presentation of the underlying algorithms see Rauchecker & Schryen, 2018. The fourth server module is the Communication Manager, which can be seen as a wrapper that converts the in- and outputs from and to the volunteers regarding on their preferred communication device. It is currently very simple since there is no other Interface than to the Volunteer App, whereby an integration of SMS, speech dialog systems and social media using an intelligent, purposeful chat bot and further communication interfaces is currently in development. Also part of the current research project but not a server component is the VCS-Simulator. It uses a multi agent approach to simulate the behaviour of an adjustable amount of SUVs who interact with the VCS in the same way and via the same interfaces as a human SUV would. The simulator is used for evaluation purposes as well as to support staff education and exercises providing a large number of SUVs. For more information about the simulation see Lindner et al., 2017 and Lindner et al., 2018. The last server module to be mentioned is the Web Server running the Task Manager which is currently an Apache HTTP Server. Alternatively the VCS server also provides an interface for existing disaster management systems. Using this interface, it is possible to integrate the VCS functionality in a familiar system for easier use and advantages like a shared event diary. The server features are crucial to address almost every user story but especially the basic requirements like **RV1**, **RV8**, **RV10**, **RS2**, **RS3.**

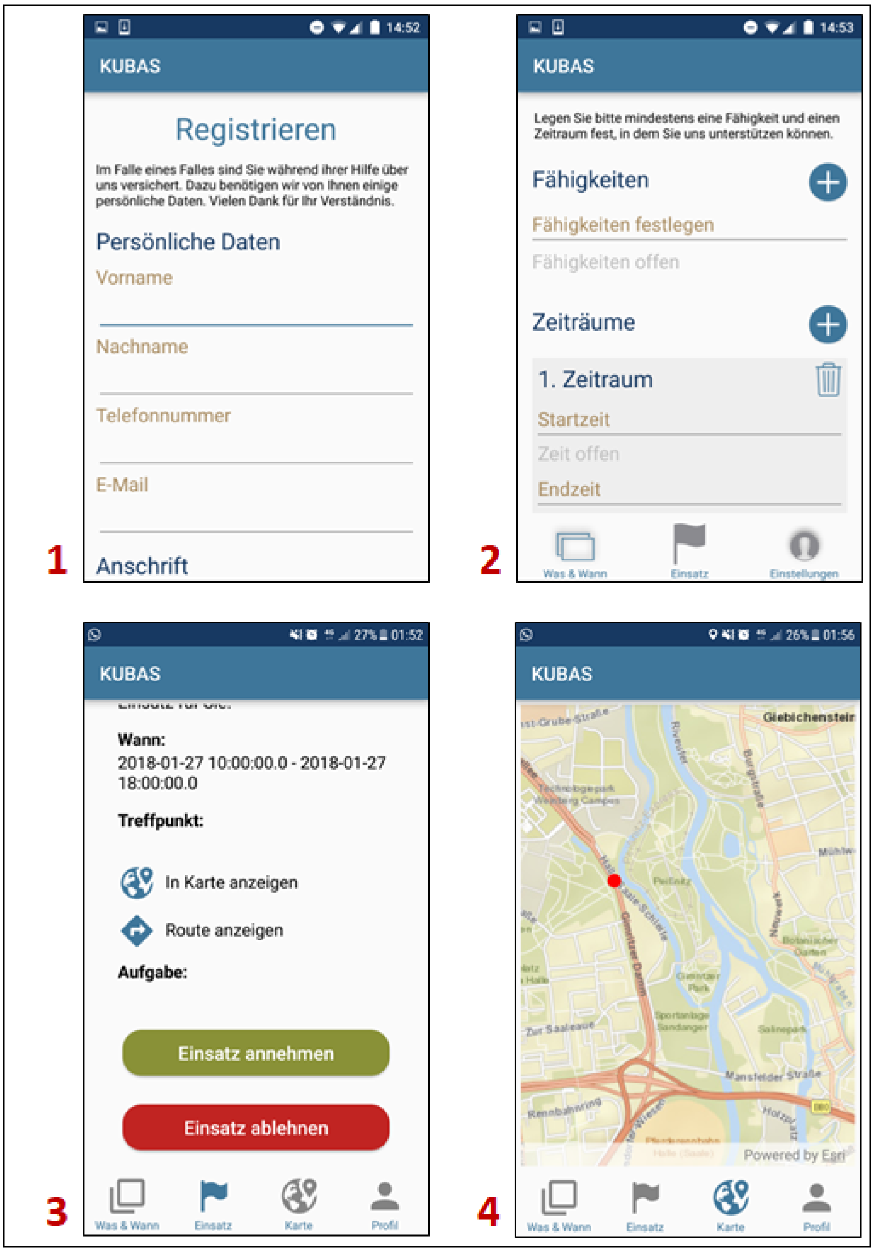

Figure 2. Volunteer App - Different Screenshots

The Volunteer App shown in figure 2 is the first implemented communication channel and was chosen because it allows the most comprehensive interaction with the VCS in the simplest way and provides the best flexibility for users (**RV9**). In the current version volunteers can already use all core features of the system. They can register (figure 2 – Screenshot 1) with the system by just setting a nickname and password or additional submission of some personal data for an easier processing of possible insurance cases (**RS9**). When logged in, the user has the possibility to offer their volunteer work (**RV4**, figure2 – Screenshot 2) by specification of capabilities (hard work, medium work, light work, information delivery, transport, care), available working time and current location, whereas the letter can be automatically stated via GPS tracking or otherwise is set to the home address of the user. The existing offer of a user is overwritten when he resubmits new information (**RV5**). Users get a short acknowledgement if the offer was successfully received (**RV7**). The app also provides an automatic alarm, to inform the user about an incoming mission request. This request can be accepted or rejected after notification of the general mission information (**RV1**, **RV2**, figure 2 – Screenshot 3). If the mission is accepted, the user is routed to the mission meeting point (**RV13**) and, with help of geo-fencing, automatically registered as on-site if he allows GPS tracking (**RS6**, figure 2 – Screenshot 4). The user can always change to a detail view of his accepted missions (**RV3**).

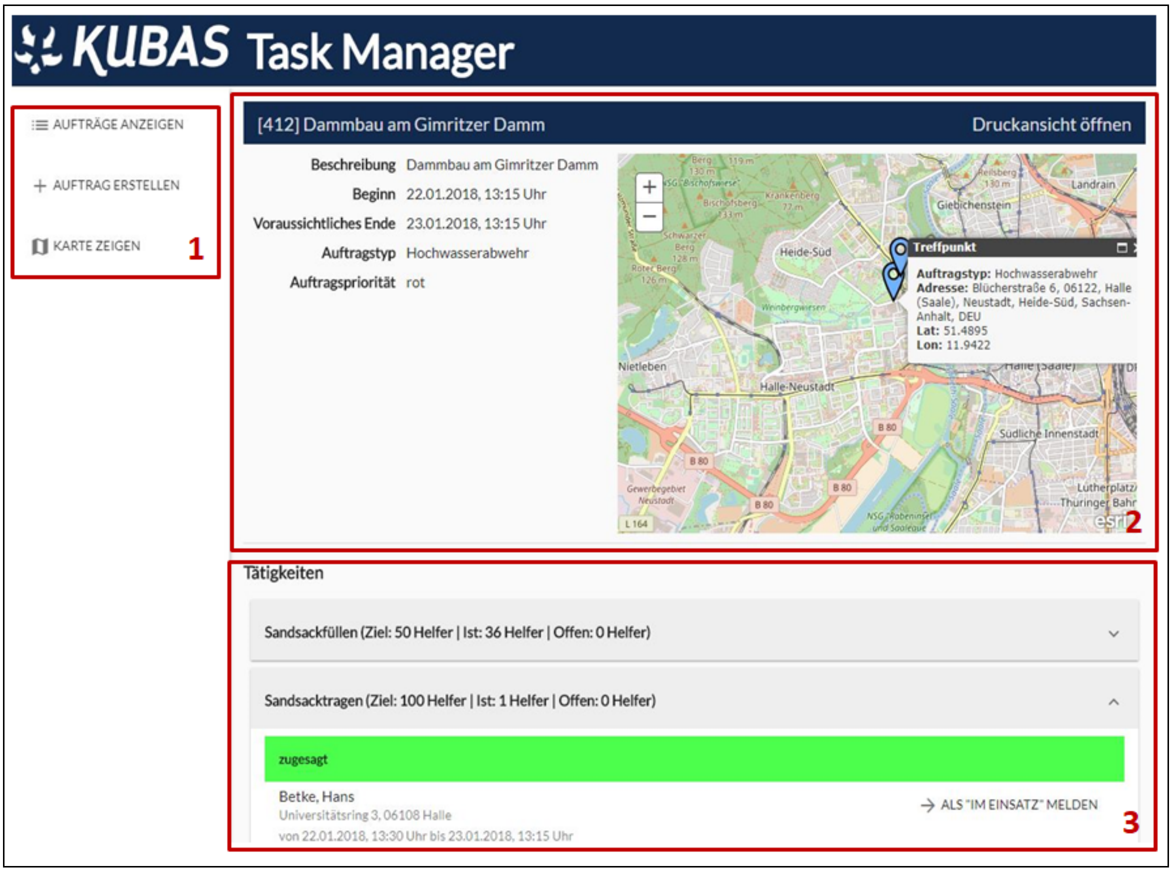

Figure 3. Task Manager Detail View – Screenshot

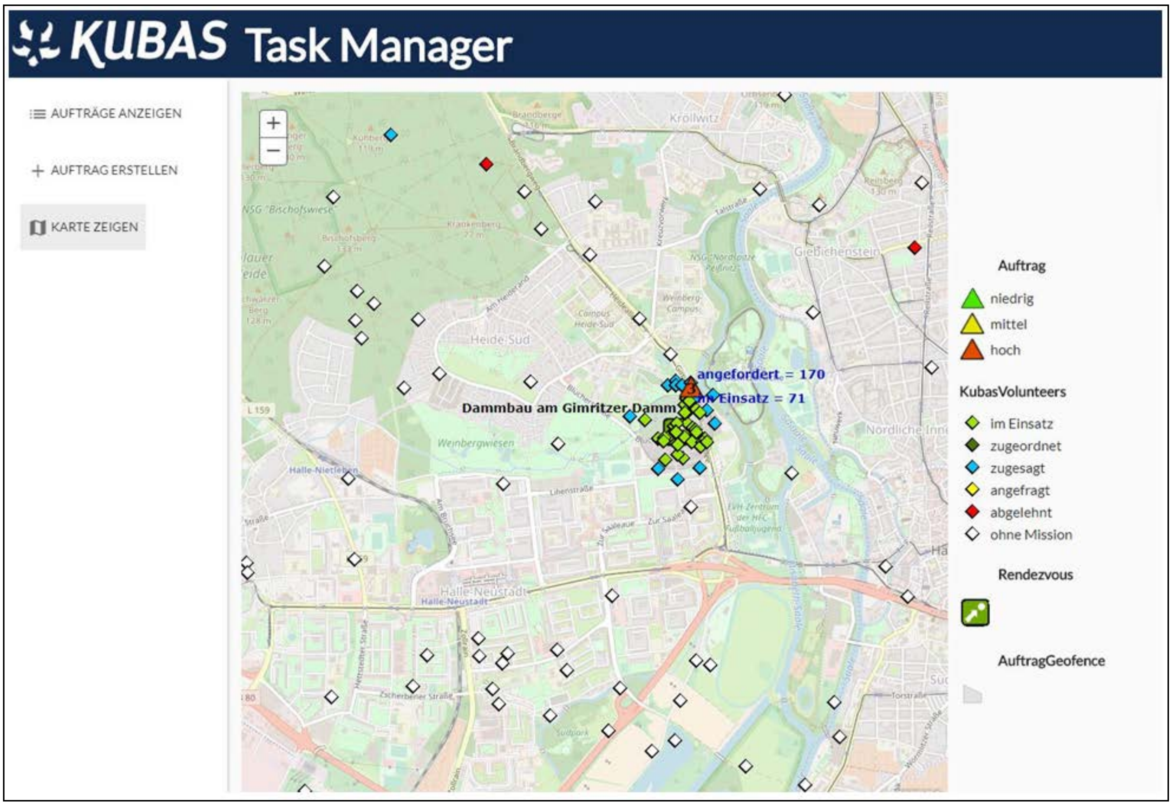

Figure 4. Task Manager Map View - Screenshot

The Task Manger is the dedicated, browser-based user interface for crisis committee members or disaster managers which can be used if there are no existing operational command systems with integration of the VCS.

Similar to the app, the Task Manager is not complete but already supports the basic features to allow a volunteer coordination through creation and monitoring of tasks as well as a map overview (figure 3 – box 1). To create a volunteer task, users must set start and end time, priority, description, the activities to be executed, demand of volunteers for each activity, the task location and an optional meeting point (**RS1**). The Task Manager also provides a detail view for every created task (**RS4**, figure 3 – box 2) and information about the status of all assigned volunteers (**RS2**, figure 3 – box 3). A feature for the on-site commander in chief is the possibility to mark volunteers as “present” in the system, generate attendance lists or add on-site volunteers which have not yet been registered in the system (**RS6**). The last big feature is the map view where all tasks and optionally also all volunteers are displayed with their respective status and some basic information (**RS5**, figure 4).

The VCS prototype currently focuses on providing the basic functionality of the system which could be achieved with the presented version. Although a huge amount of user stories is already considered, especially those about custom information exchange (**RV11**, **RV12**, **RS 8**) or with sophisticated detail challenges (**RV5**) demanding further specification could not yet be implemented. However, the prototype demonstrates that the development of a VCS as demanded by the user stories is technically possible.

ACCESSIBILITY OF THE VCS

The VCS and its components are designed to incorporate a large number of volunteers with different abilities, skills and motivations. In order to achieve that, simplicity and variety were important requirements for the system development. However, main goal of the system is the coordination of spontaneous volunteers to support on-site response. While every volunteer offer is always welcome this purpose nevertheless restricts the targeted user group on volunteer side to people being able to provide this kind of support. The following discussion describes the most important key features of the system addressing the universal design principles as stated in Story, 1998.

The system supports a variety of different communication channels like smartphone app, telephone, SMS and some social networks. While this variety should also provide a fall-back mode, if the internet is not available it is first of an offer to all volunteers to use their preferred or maybe only usable communication device. In this way we can involve volunteers with different abilities like illiterates, who can use the telephone or mute people, who can use one of the text-based communication channels. Furthermore, the final system provides open-source interfaces for each of the supported communication channels, allowing users to develop own solutions for user interaction. If e.g. the standard smartphone app may not provide a sufficient usability for some kind of disabilities it is possible to write an own app using the features of the system.

Another point is the minimalized and simplified user interaction. In the simplest case, telephone-based registration, the user has to enter just 4 information (refusal of personal data survey, preferred volunteer time, capabilities and location) to submit the volunteer offer followed by telephone call with a yes/no question when he/she was assigned to a mission. The system also tries to automatically find necessary information in the registration process, so that the user do not has to think about it. For example the location can be automatically submitted from the GPS feature of a smartphone, if this device is used. Another example is the unique identifier of each volunteer, which is automatically either his telephone number or social media account nickname. The system also has a high tolerance to incorrect entries while entering location or residence since every entry is automatically checked against a post office database of all existing addresses so that it can be corrected before saving or demand a second entry. Information regarding volunteer time and capabilities will be surveyed via multiple choice queries to prevent misunderstandings.

The volunteer capabilities are kept very simple to exclude as few people as possible. Every volunteer can chose at least one up to all of the following capabilities: hard physical work, medium physical work, easy physical work, paper work, care, information retrieval. These capabilities were defined in multiple workshops with disaster managers trying break down all imaginable volunteer tasks to a simple set of required competences. In the system database each of the capabilities is bound to a predefined but extendable set of different volunteer tasks for different situations. When creating a volunteer mission the disaster managers choose one or more of these tasks and can add further mission details. The volunteers matched by the decision support module will get this information and still can decide if they are able to do this work or decline the mission. This processing allows an easy registration of the volunteer offer without forcing the volunteers to think about dozens of possible tasks whereby they still can decide if they are suitable for the specific mission.

STAFF EXERCISES

In this state of development, the system is far from being complete but already suitable to test the main concepts of the projects and collect feedback for further iterations of the development process. Hence, up to now, the system has already been tested at one large and three small staff exercises of the crisis committee of a large city (population > 200.000) in Germany. The designated users (n=3) were experienced staff members with responsibilities in different subject areas (supply and logistics, communication and public relations, chief of staff). Users on volunteer side were mostly simulated by a multi agent simulation developed in the project to imitate the behaviour of SUVs in large-scale disasters for exercise and evaluation purposes (Lindner et al., 2017, Lindner et al., 2018). A small amount of volunteer users was played by project members and members of the local fire department by using the Volunteer App.

Hereinafter we give a short summary of the feedback without mentioning every detail statement and feature suggestion of the participants. A substantial evaluation of the mature system based on field exercises with real volunteers and a novel coordination-performance measurement method will be subject of a following completed research paper. The overall feedback in all previous exercises was positive whereby staff users emphasized different aspects depending on their professional background. The supply and logistics expert was especially pleased to know the number of volunteers at each task site as it would facilitate the planning of necessary supplies and concrete information about present volunteers will save a lot of work in the processing of possible insurance and compensation claims. The communication expert positively mentioned the direct and short communication channel to volunteers as well as the automatically selection and limitation of the target audience in contrast to the usually used mass media. He also stated, that the acceptance of the system by volunteers must be analysed. The chief of staff highlighted an improved situation overview due to the task and volunteer map and the detailed information on occupancy rates of each task. The creation and communication of precise tasks would allow him to make better use of the volunteer potentials as he can employ them sophisticated and more goal oriented. He also mentioned the importance to evaluate the reliability of the system information. All participants positively mentioned the ease of use of the Task Manager as well as the Volunteer App and stated this as a critical requirement for the application of the system. However, no consistent position could be derived regarding the information that should be communicated using the app. While some people wanted the app to share more information on the disaster and their respective task with the volunteers others did not share this opinion because more information could bring volunteers to draw the wrong conclusions and behave undesirable e.g. by independent actions which could harm themselves. This issue was recognized and will be analysed in further research. In summary, first feedback underlined the assumption, that the system can improve coordination of SUVs by crisis committees whereby some research still has to be done.

CONCLUSION

Inquiries of disaster events of the recent past led to the presumption that the potentials of SUVs could be better utilized by responsible crisis committees if modern information technology and respective methods are applied. In this paper we derived requirements for a volunteer coordination system by analysing the literature and interviewing staff members as well as former spontaneous volunteers. In consideration of the resulting user stories we developed and presented the first prototype of a volunteer coordination system aiming for bringing volunteer offers and official help requests together. Although not all requirements were taken into account in this early version the general concepts of the VCS could be brought to a practical application. First user feedback from staff exercises was overall positive giving first indication for the usefulness of the approach. The development of a more comprehensive and mature system seems possible and desirable by potential users.

However, the research in the project and the development of the VCS is not completed and many open challenges persist. An important concept of the project is the diversification of communication channels, but up to now just the smartphone app could be implemented. Further communication channels like SMS, speech dialog system and social media apps need to be integrated to reach a wider range of spontaneous volunteers and improve resilience by using different communication infrastructure. Also the communication workflow is currently concentrated on the essentials with just four general functions (registration, offer creation, mission request, mission tracking) although further features like grouping or carpooling are desired by volunteers. Other crucial system components like the optimizer for allocation of volunteers and the multi agent are also constantly enhanced and refined. The results of the respective research efforts can be found in other papers (Rauchecker & Schryen, 2018, Lindner et al., 2018). The last substantial prototype enhancement worth mentioning is the integration of the system into existing operational command systems to create a consistent user interface and a better integration of volunteers into existing command and control structures. To reach this, the project team is currently enhancing the standardized, disaster specific XML-interface “XKatastrophenhilfe” to allow the easy exchange of information for coordinating spontaneous volunteers. The operational command system DISMA, whose usage is obligatory by disaster response agencies in different German federal states, will be the first system to use the VCS functionalities, providing a prototype in February 2018. The final step prior to a comprehensive evaluation is the development of a measurement method for the coordination performance. Performance indicators need to be defined to make a comparison between situations with and without usage of the VCS. The last phase of the project and the design science process is the evaluation which will be conducted in three large scale exercises with a huge number of volunteers and further small staff exercises.

We do not assume the VCS to completely replace current coordination practices or render the engagement of crisis committees in social networks and mass media redundant in order to coordinate spontaneous volunteers. Although the system can provide considerable benefits and is easy to use, some people will prefer to use their familiar communication and information platforms which in turn have features that are out of scope of the VCS. However, the approach has the potential to make a notable contribution in improving the efficiency and effectiveness of coordinating SUVs. If the evaluation proves this thesis it would be interesting to analyse the potentials of the system in other parts of the worlds with different conditions in infrastructure or disaster challenges. A current idea is to make use of the system in third world countries like Ethiopia, where SMS is an important communication channel. For example in a drought catastrophe the roles in the system could be changed so that crisis committees of NGOs and government state their support offerings whereas citizens communicate their support requests and the system informs about the nearest supply stations. The approach may be part of a solution for different disaster specific problems and previous achievements encourage further research efforts in this area.

ACKNOWLEDGMENTS

This paper is part of the KUBAS project (https://kubas.uni-halle.de) sponsored by the German Federal Ministry of Education and Research. The development of the system is a result of the cooperation of colleagues from the Martin Luther University Halle-Wittenberg (Chair of Information Management), University of Regensburg, ESRI Germany GmbH and the city of Halle (Saale).

REFERENCES

Angermann, A. and Sittermann, B. (2010) Volunteering in the Member States of the European Union: Evaluation and Summary of Current Studies, *Working paper no. 5 of the Observatory for Sociopolitical Developments in Europe*, Frankfurt am Main, Germany.

Barsky, L. E., Trainor, J. E., Torres, M. R. and Aguirre, B. (2007) Managing volunteers: FEMA's Urban Search and Rescue programme and interactions with unaffiliated responders in disaster response, *Disasters*, 31, 4, 495-507.

Bischoff, B. and van Dinther, C. (2016) Workflow management systems-an analysis of current open source products, *Digital Enterprise Computing*, Springer, 147-160.

Betke, H., Lindner, S., Sackmann, S. and Gerstmann, S. (2017) Informationssysteme im Katastrophenmanagement – Entwurf eines Koordinationssystems für ungebundene Helfer, in: Maximilian Eibl, Martin Gaedke (ed.): *INFORMATIK 2017, Lecture Notes in Informatics (LNI)*, 1283-1296, Gesellschaft für Informatik, Bonn, Germany.

Fernandez, L., Barbera, J. and Van Dorp, J. (2006) Strategies for managing volunteers during incident response: A systems approach, *Homeland Security Affairs*, 2, 3.

Johansson, Roine (2013) Professional emergency responders and unorganized volunteers: incident sites as meeting places, *Risk and Crisis Research Centre Working Paper Series*, 2013, 2, 1-12.

Lindner, S., Betke, H. and Sackmann, S. (2017) Attributes for Simulating Spontaneous On-site Volunteers, *Proceedings of the 14th ISCRAM Conference*, 846-856, Albi, France.

Lindner, S., Kühnel, S., Betke, H. and Sackmann, S. (2018) Simulating Spontaneous Volunteers – A Conceptual Model, *Proceedings of the 15th ISCRAM Conference*, Rochester, USA.

D. F., Schulze, K., & Voss, M. (2017) Emerging citizen responses to disasters in Germany, Disaster myths as an impediment for a collaboration of unaffiliated responders and professional rescue forces, *Journal of Contingencies and Crisis Management*.

Ludwig, T., Kotthaus, C., Reuter, C., Dongen, S. Van, Pipek, V., van Dongen, S. and Pipek, V. (2017) Situated crowdsourcing during disasters: Managing the tasks of spontaneous volunteers through public displays, *International Journal on Human-Computer Studies (IJHCS)*, 102(C), 103–121.

McLennan, B., Whittaker, J. and Handmer, J. (2016) The changing landscape of disaster volunteering: opportunities, responses and gaps in Australia, *Natural Hazards*, 84, 3, 2031-2048.

Meissen, U., Fuchs-Kittowski, F., Jendreck, M., Hardt, M., Pfennigschmidt, S. and Voisard, A. (2017) A general system architecture and design for the coordination of volunteers for agile disaster response, *Proceedings of the 14th ISCRAM Conference*, 890-900, Albi, France.

Morrow, N., Mock, N., Papendieck, A. and Kocmich, N. (2011) Independent evaluation of the Ushahidi Haiti project, *Development Information Systems International, 8*, 2011.

Peffers, K., Tuunanen, T., Gengler, C. E., Rossi, M., Hui, W., Virtanen, V. and Bragge, J. (2006) The design science research process: a model for producing and presenting information systems research, *Proceedings of the first international DESRIST 2006*, 83-106.

Rauchecker G. and Schryen, G. (2018) Decision Support for the Optimal Coordination of Spontaneous Volunteers in Disaster Relief, *Proceedings of the 15th ISCRAM Conference*, Rochester, USA.

Rogstadius, J., Teixeira, C., Karapanos, E., & Kostakos, V. (2013) An introduction for system developers to volunteer roles in crisis response and recovery, *Proceedings of the 10th International ISCRAM Conference,* 874-883, Baden-Baden, Germany.

Sauer, L. M., Catlett, C., Tosatto, R. and Kirsch, T. D. (2014) The utility of and risks associated with the use of spontaneous volunteers in disaster response: a survey, *Disaster medicine and public health preparedness*, 8, 1, 65-69.

Story, M. F. (1998) Maximizing usability: the principles of universal design, *Assistive technology*, 10, 1, 4-12.

Weigand, H., Van Der Poll, F. and De Moor, A. (2003) Coordination through communication, *Proceedings of the 8th International Working Conference on the Language-Action Perspective on Communication Modelling (LAP 2003)*, 107-126.

Whittaker, J., McLennan, B. and Handmer, J. (2015) A review of informal volunteerism in emergencies and disasters: definition, opportunities and challenges, *International Journal of Disaster Risk Reduction*, 13, 2015, 358–368.

Zettl, V., Ludwig, T., Kotthaus, C. and Skudelny, S. (2017) Embedding unaffiliated volunteers in crisis management systems: Deploying and supporting the concept of intermediary organizations, *Proceedings of the 14th International ISCRAM Conference*, 421 – 431, Alby, France.