An Action Design Research Approach to Developing Emergency Management Systems

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ABSTRACT

We propose Action Design Research (ADR) as an approach to promote user participation and mutual learning in the design and development of systems for emergency management based on social media technologies. We outline some design challenges related to the dynamic and evolving nature of social media, and emphasize an iterative design process that is strongly oriented toward collaboration and change involving both the researcher and the user community. In particular, we emphasize the transformative power of social media and argue for design approaches that take into account the new dimension of e-participation throughout the design process.

Keywords

Design, user participation, action research, action design research, emergency management, social media

INTRODUCTION

Designing information systems is one of the core areas in the interdisciplinary community of emergency management, emphasizing technological, sociological, and organizational challenges as key issues in developing and maintaining effective disaster communication systems. Moreover, some of the co-founders of the ISCRAM community have called for "a user-centered systemic approach with a major emphasis on user requirements, driving technological developments as a result of lessons learned" (Van de Walle and Turoff 2007, p. 30). An informal review of papers accepted for publication in the ISCRAM conference proceedings implied that about 70% of the papers were based on case studies and less than half of the papers included a formal method section (Franco et al. 2007). The authors of this review called for more methodological rigor and more analytic generalization from multiple case studies to a broader, overarching theory of disaster management (Franco et al. 2008, p. 117). They argue further for not only focusing on technology as the primary variable of interest, but also on the type and scale of the disaster, and the characteristics of the people using or being affected by the technology (Franco et al. 2007). Taking into account the evolving use of social media in emergency management implies increasing need for user involvement and more dynamic design processes. In this paper, we argue for a new approach for designing a social media infrastructure to promote local emergency preparedness and management based on recent methods such as Participatory Design (Hagen and Robertson 2012) and Action Design Research (ADR) (Sein et al. 2011). These methods emphasize design and development as an iterative process of mutual learning and thus enable co-design with community members in the context of their daily lives.

The motivation for this research in progress paper originates from an ongoing research project at the Centre for Integrated Emergency Management (CIEM) at the University of Agder, Norway. The SmartEMIS (Smart Emergency Management Information Systems) project aims to develop information systems for integrated emergency management to promote collaboration and coordination in municipal practice. Based on an initial mapping of local practices as well as review of similar studies, we have recognized the potential of social media to promote situational awareness across agencies as well as across formal and informal emergency management. Thus, we focus on developing a social media dashboard as a visual display of the most important information generated from social media. However, several design-related challenges in this process motivated us to look for design approaches mirroring the evolving nature of social media. Theoretically, we build on previous studies in the field of Crisis Informatics that is broadly defined as the interconnectedness of people, organization and

technology during crisis (Hagar 2010). Of special interest in our study is the relation between users and producers of technologies, the transforming power of social media on emergency management and how it affects interaction in the design process. First, we focus on user involvement in the design process and highlight the blurred boundary between users and producers of information in social media. Second, we discuss some of the challenges of deriving user requirements when use of social media is part of the context. Third, we focus on the driving forces in the design process and the relation between the local context and theories of social media.

DESIGN APPROACHES IN CRISIS INFORMATICS

One of the primary missions of the ISCRAM community is design and development of information systems, and methodological principles have long been emphasized within this community. Turoff et al. have outlined a framework for system design and development and presented general design principles (Turoff et al. 2004). Although we recognize these principles as overall guidelines for the design of emergency management systems, we emphasize the need for methodological approaches that address the dynamic development of information systems with emergency management stakeholders.

To get an impression of methods currently applied in crisis informatics research, we carried out a brief review of the full research papers published at the ISCRAM conference in 2013. A large part of the studies were laboratory experiments, i.e., performed in a controlled and artificial setting. For example, a study carried out by Moon et al. focused on the development of a visualization tool based on Twitter data. The system was developed in an artificial setting and then evaluated by domain experts (Moon et al. 2013). Furthermore, case studies and field studies were also widely used. The study of Stiso et al. was based on a user-centered approach in the development of a large touch screen display that provides a common operational picture for command staff in large multi-agency emergency response efforts (Stiso et al. 2013) This type of study provides a valuable contribution to the design process by highlighting the role of multiple users, from a command & control perspective. Overall, several studies published in the ISCRAM 2013 proceedings deal with design issues, but with different perspectives. We recognize this pluralism in research methods, but call for methods where the user role is more emphasized.

In general, there has been a growing interest in studies of social media. A large part of this research has been descriptive, i.e. it has presented empirically what are the characteristics of these new media environments. The majority of these studies have either emphasized social behavior in social networks, or specifications or prototypes of technological systems. For example, many studies have focused on socio-technical mechanisms in social networks with theoretical contributions to coordination and situational awareness (Stiso et al. 2013) . Other studies have focused on filtering and classifications (Starbird and Palen 2011) as well as analysis and visualization of twitter posts (MacEachren et al. 2011; Terpstra et al. 2012), and thus provided insight into socio-technical capabilities of social media. While acknowledging the importance of this type of studies, we call for more emphasis on design approaches that take into account the new dimension of e-participation throughout the design process.

The emergent and social nature of social technologies in particular, imposes new challenges to traditional design methods. While traditional design methods are characterized by predictability, stability, rationality and control (Lyytinen 1987), social technologies are evolving, emergent, user-generated and contextual (Hagen and Robertson 2012). Accordingly, participation is a key issue for a number of design methods that have been developed to encourage user involvement. The Participatory Design (PD) community in particular has emphasized the role of end users in the co-design of information and communication technologies (ICT). PD is a well-established area of research across many design disciplines, that is also used by researchers within the ISCRAM community. The origin of the PD method derives from the Scandinavian IS research community with a strong emphasis on user involvement as a strategy for increasing workplace democracy (Bjerknes and Bratteteig 1995). Some of the key characteristics of this method are use of iterative design techniques (mock-ups, prototyping), "reflection-in–action", and user-driven innovation (Robertson and Simonsen 2012), thus aiming to reduce the user-producer gap in the design process. Kristensen et al. (2006) used a participatory design approach to reveal opportunities for innovation in order to support coordination between multiple people, disciplines and places in medical emergency response work. Moreover, by conceptualizing the victims as boundary objects, the study also contributed theoretical insights in coordination (Kristensen et al. 2006).

Action research is a similar method that also endeavors user participation as a way to make research more relevant to practice. It is a collaborative, iterative, change-oriented research process aiming to solve practical problems while expanding scientific knowledge (Baskerville and Myers, 2004). Action research has its roots in the work of Kurt Lewin and the sociotechnical design movement, and has since evolved into a class of research approaches such as participatory action research (Baskerville 1999). The dynamic and iterative nature of action research is maybe one of the reasons that this method has also been used in the ISCRAM community. For

example, White et al. used action research to explore how social networking sites can be useful and effective for a large group of collaborating emergency professionals and volunteers. In the iterative design process, a mixed method data collection technique was used as a basis for the development of a prototype (White et al. 2009).

To sum up, there are different approaches for the design of information systems that have overlapping as well as complementary elements. In a multidisciplinary community such as emergency management, there is a need for a comprehensive paradigm that takes into account the heterogeneity of users and producers of information systems. The evolving use of social media in particular, implies new challenges to traditional design principles and the need for a flexible approach. We thus suggest a special form of action research, i.e. Action Design Research (ADR), which facilitates the interaction of design efforts and contextual factors throughout the design process (Sein et al. 2011)

AN ADR APPROACH TO SOCIAL MEDIA RESEARCH IN THE CONTEXT OF LOCAL EMERGENCY MANAGEMENT

Applying ADR provides an opportunity to combine basic principles of traditional Design Research (building and evaluating innovative IT artifacts) (Hevner et al. 2004), with emphasizing participation and cooperative change (Baskerville and Myers 2004). In contrast to traditional design that separates building from evaluating, ADR is characterized as an iterative process that addresses a problem situation encountered in a specific organizational setting by intervening and evaluating (Sein et al. 2011). The notion of information technology in ADR is based on the ensemble view of IT artifacts and involves the interaction of design efforts and contextual factors throughout the design process. Basically, the design process consists of four stages: 1) Problem formulation; 2) Building, Intervention, and Evaluation, 3) Reflection and learning; and 4) Formalization and learning. The next section briefly outlines the various steps in which we highlight issues related to the use of social media.

Formulating research questions is typically based on the identification and conceptualization of research opportunities and may be either practice inspired and/or informed by theories (Sein et al. 2011). Based on a PD approach, users play an active part in the design process that is driven by users' needs. A major challenge though, is that there are different perspectives and interests concerned with defining what the problem is and how it can be solved (Bratteteig 2007). Particularly when it comes to use of social media among formal emergency coordinators, there may be different motivations and needs. Thus, it is not straightforward to identify problems and opportunities from the field of practice. Formulating research efforts may also be informed by theories and/or review of prior research. In applying this approach, there is a danger that the design process is driven by the researcher's intentions and assumptions. We thus highlight the importance of the principle of mutual learning among the different project participants (Sein et al. 2011) and establishing a shared design space among researchers, formal actors in emergency management (fire, health, police, municipalities) as well as first responders and volunteer groups in online communities.

In a shared design space, the researchers bring their knowledge of theory and understanding of technology, while the practitioners bring practical understanding of work practice (ibid.). In addition, the public space also includes social networks and is thus part of the design space. This implies involving online communities in the design process and adds a new dimension to user involvement. However, identifying activities and participants in online communities is not straightforward. The study by Hagen and Robertson presented new opportunities for participation enabled by social technologies and examined how the commitment to participation can be taken up in these environments (Hagen and Robertson 2012). In their study of the use of social technologies as reporting tools illustrated the capacity and tendency for participant to socialize the research and the ability to bridge existing and future practices (ibid. p. 81). An interesting example of user participation is a study by Starbird and Palen (2013). The first author spent more than 16 months as a participant observer within a volunteer organization (Humanity Road) and acted both as a digital volunteer and a researcher of the organization. Through this research, the Tweak the Tweet (TtT) syntax was developed based on self-organized behavior in online communities (Starbird and Stamberger 2010). TtT is a crisis-reporting micro-syntax that encourages users of the Twitter platform to format their event-related tweets in a specific, standardized way and has demonstrated the capability of user-generated tagging and the power of retweeting. In this context, virtual volunteer groups emerged as “translators”, who filtered and restructured information from “the ground” using hashtags and then tweeting it out to their followers (Starbird and Palen 2011). Thus, virtual volunteer groups have the capabilities to act as information brokers across loosely coupled organizational boundaries (Franco et al. 2013).

The next stage in the design process is the building of the IT artifact, intervention in the organization, and evaluation. Sein et al. (2011) distinguish between technological and organizational factors in this part of the process. On the one hand, this distinction points out both technological capabilities as well as organizational

innovations. On the other hand, there may be a tendency to focus either on a techno-centric perspective or a human-centric perspective. However, we argue that this distinction is purely analytical during the design process. For example, social media like Twitter is not just a technology or an objective "thing". It is more like a web or ensemble of equipment, techniques, applications, and people that define the social context (Orlikowski and Iacono, 2001). During the building and intervention phase, it is necessary to open the "black box" of technology as well as social practice as a way to inscribe the various forms of the organizational context into the artifact. Yet, this is not a step by step, sequential process but an iterative process where the ensemble of artifacts is shaped and reshaped by the use context (Sein et al. 2011). Particularly when the design process involves the use of social media, we argue that the technical and social are inextricably related (Orlikowski, 2007). As stated by one of the co-founders of Twitter, Biz Stone, and quoted by Plotnick and White: "It's not about the triumph of technology, it's about the triumph of humanity, it's about what people will do with it" (Plotnick and White 2010, p. ii).

Finally, we emphasize "Reflection and learning" and "Formalization of learning" as important contributions in the design process. These steps recognize that the research process involves reflection and contributions to knowledge as well as formalizing the learning into design principles (Sein et al. 2011).

CONCLUSION AND FURTHER RESEARCH

There are some main features of the ADR approach that we consider highly relevant for designing systems that integrate social media in formal emergency management. Firstly, it takes into consideration the dynamic and emergent nature of socio-technical systems and the interplay between planned design and the context of use. Second, ADR focuses on interaction among researchers, practitioners and end-users throughout the design process. Thirdly, it is strongly oriented toward collaboration and change involving both researchers and subjects. Further research will focus on applying ADR as a basic approach in our efforts to develop a social media dashboard in cooperation with key stakeholders in the local community. Our objective for future activities is twofold. First, we aim to develop design principles that can be generalized to the research and design of social technologies. Second, we emphasize contributions to the knowledge of coordinating mechanisms for interconnecting loosely coupled socio-technical networks in emergency management. In particular, we focus on the relational aspect of socio-technical systems and build on concepts such as boundary objects and boundary spanners (Franco et al., 2013; Levina and Vaast, 2005). Finally, we argue that conceptualization of the IT artifact is important for the scale and scope of user participation. For example, Tilson et al. (2010) have questioned whether it is possible to conceive of individual users without understanding infrastructure relations that define what it means to be a user (Tilson et al. 2010).

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REFERENCES

1. Baskerville, R. L. 1999. Investigating Information Systems with Action Research. *Communication of AIS* **2**(Article 19) 1 – 32.
2. Baskerville, R., and Myers, M. D. 2004. Special Issue on Action Research in Information Systems: Making IS Research relevant to Practice- Foreword. *MIS Quarterly* **28**(3) 329–335.
3. Bjerknes, G., and Bratteteig, T. 1995. User Participation and Democracy : A Discussion of Scandinavian Research on System Development. *Scandinavian Journal of Information Systems* **7**(1) 73–98.
4. Bratteteig, T. 2007. Design Research in Informatics. *Scandinavian Journal of Information Systems* **19**(2) 1 – 10.
5. Franco, Z. E., Zumel, N., and Beutler, L. E. 2007. A Ghost in the System : Integrating Conceptual and Methodology Considerations from the Behavioral Sciences into Disaster Technology Research. *Proceedings of the 4th International Conference on Information Systems for Crisis Response and Management,* 115–124.
6. Franco, Z. E., Zumel, N., Blau, K., Johnson, K. A., and Beutler, L. E. 2008. Causality, covariates and consensus in ISCRAM research: towards a more robust study design in a transdisciplinary community. *International Journal of Emergency Management* **5**(1/2) 100 – 122.
7. Franco, Z., Kuziemsky, C., Ahmed, S., Biedrzycki, P., and Kissack, A. 2013. Using Social Network

Analysis to Explore Issues of Latency , Connectivity , Interoperability & Sustainability in Community Disaster Response. *Proceedings of the 10th International ISCRAM Conference*, 896–900.

8. Hagar, C. 2010. Crisis Informatics, Introduction by guest editor. *Bulletin of the American Society for Information Science and Technology* **36**(5) 10–12.
9. Hagen, P., and Robertson, T. 2012. Social Technologies: The Changing Nature of Participation in Design. *Design Issues* **28**(3) 77–88.
10. Hevner, A. R., March, S. T., Park, J., and Ram, S. 2004. Design Science in Information System Research. *MIS Quarterly* **28**(1) 75–105.
11. Kristensen, M., Kyng, M., and Palen, L. 2006. Participatory Design in Emergency Medical Service : Designing for Future Practice. *CHI 2006* 161–170.
12. Levina, N., and Vaast, E. 2005. The Emergence of Boundary Spanning Competence in Practice: Implications for Implementation and Use of Information Systems. *MIS Quarterly* **29**(2) 335 – 363.
13. Lyytinen, K. 1987. Different Perspectives on Information Systems: Problems and Solutions. *ACM Computing Surveys* **19**(1) 5 – 46.
14. MacEachren, A. M., Jaiswal, A., Robinson, A. C., Pezanowski, S., Savelyev, A., Mitra, P., Zhang, X., and Blanford, J. 2011. SensePlace2: GeoTwitter analytics support for situational awareness. *2011 IEEE Conference on Visual Analytics Science and Technology (VAST)* 181–190.
15. Moon, S. P., Entezari, S., Pappas, A., Liu, Y., Pirzadeh, A., and Pfaff, M. S. 2013. Top Health Trends : An information visualization tool for awareness of local health trends. *Proceedings of the 10th International ISCRAM Conference*, T. Comes, F. Fiedrich, S. Fortier, J. Geldermann, and T. Muller (eds.), 177–187.
16. Orlikowski, W. J. 2007. Sociomaterial Practices: Exploring Technology at Work. *Organization Studies* **28**(9) 1435–1448.
17. Orlikowski, W. J., and Iacono, C. S. 2001. Research Commentary: Desperately Seeking " IT " in IT Research — A Call to Theorizing the IT Artifact. *Information Systems Research* **12**(2) 121–134.
18. Plotnick, L., and White, C. 2010. A Social Media Tsunami : The Approaching Wave. *International Journal of Information Systems for Crisis Response and Management* **2**(1) i – iV.
19. Robertson, T., and Simonsen, J. 2012. Challenges and Opportunities in Contemporary Participatory Design. *Design Issues* **28**(3) 3–9.
20. Sein, M. K., Henfridsson, O., Puraro, S., Rossi, M., and Lindgren, R. 2011. Action Design Research. *MIS Quarterly* **35**(1) 37–56.
21. Starbird, K., and Palen, L. 2011. "Voluntweeters": Self-Organizing by Digital Volunteers in Times of Crisis. *Proceedings of CHI 2011*
22. Starbird, K., and Palen, L. 2013. Working & Sustaining the Virtual " Disaster Desk ." *CSCW 2013*
23. Starbird, K., and Stamberger, J. 2010. Tweak the Tweet : Leveraging Microblogging Proliferation with a Prescriptive Syntax to Support Citizen Reporting. *Proceedings of the 7th international ISCRAM conference* 1–5.
24. Stiso, M. E., Nilsson, E. G., and Skjetne, J. H. 2013. Building a flexible common operational picture to support situation awareness in crisis management. *Proceedings of the 10th International ISCRAM Conference*, 220–229.
25. Terpstra, T., Stronkman, R., Vries, A. de, and Paradies, G. L. 2012. Towards a realtime Twitter analysis during crises for operational crisis management. *Proceedings of Ithe 9th International ISCRAM Conference* 1–9.
26. Tilson, D., Lyytinen, K., and Sorensen, C. 2010. Research Commentary--Digital Infrastructures: The Missing IS Research Agenda. *Information Systems Research* **21**(4) 748–759.
27. Turoff, M., Chumer, M., Walle, B. Van De, and Yao, X. 2004. The Design of a Dynamic Emergency Response Management Information System (DERMIS). *Journal of Information Technology Theory and Application* **5**(4) 1–35.
28. Van de Walle, B., and Turoff, M. 2007. Emergency Responses Information Systems: Emerging Trends and Technologies. *Communications of the ACM* **50**(3) 28–31.
29. White, C., Plotnick, L., Kushma, J., Hiltz, S. R., and Turoff, M. 2009. An online social network for emergency management. *Proceedings of the 6th International ISCRAM Conference*