

## 2nd Workshop on Mobile Resilience

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## 2nd Workshop on Mobile Resilience: Designing Mobile Interactive Systems for Crisis Response

Kaufhold, Marc-André; reuter, Christian; Comes, M.; Mirbabaie, Milad; Stieglitz, Stefan

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# 2<sup>nd</sup> Workshop on Mobile Resilience: Designing Mobile Interactive Systems for Crisis Response

Marc-André Kaufhold  
Technical University of Darmstadt,  
Science and Technology for Peace and  
Security (PEASEC)  
Darmstadt, Germany  
kaufhold@peasec.tu-darmstadt.de

Christian Reuter  
Technical University of Darmstadt,  
Science and Technology for Peace and  
Security (PEASEC)  
Darmstadt, Germany  
reuter@peasec.tu-darmstadt.de

Tina Comes  
Technical University Delft,  
Engineering Systems and Services  
(ESS)  
Delft, Netherlands  
t.comes@tudelft.nl

Milad Mirbabaie  
Paderborn University, Management  
Information Systems (Digital Society)  
Paderborn, Germany  
milad.mirbabaie@uni-paderborn.de

Stefan Stieglitz  
University of Duisburg-Essen, Digital  
Communication and Transformation  
(digicat)  
Duisburg, Germany  
stefan.stieglitz@uni-due.de

## ABSTRACT

Information and communication technologies (ICT), including artificial intelligence, internet of things, and mobile applications, can be utilized to tackle important societal challenges, such as the ongoing COVID-19 pandemic. While they may increase societal resilience, their design, functionality, and underlying infrastructures must be resilient against disruptions caused by anthropogenic, natural and hybrid crises, emergencies, and threats. In order to research challenges, designs, and potentials of interactive technologies, the second iteration of the workshop investigates the space of mobile technologies and resilient systems for crisis response, including the application domains of cyber threat and pandemic response.

## CCS CONCEPTS

• **Human-centered computing** → *Empirical studies in ubiquitous and mobile computing; Mobile devices.*

## KEYWORDS

Mobile Resilience, Interactive Systems, Crisis Informatics, Cyber Incident Response, Social Media Analytics

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## 1 BACKGROUND

The digitalization by information and communication technologies (ICT), including recent innovations based on artificial intelligence, internet of things, mobile applications, or social media, exert an increasing influence on contemporary and future societies. Thus, the terms of smart cities and smart rural areas were coined to leverage digital innovation in urban and rural areas [9, 17]. Besides everyday use, ICT can be used to enhance societal response to anthropogenic (e.g., bombings, cyberattacks), natural (e.g., earthquakes, floods, hurricanes), or hybrid disasters [10, 16, 18], which is currently demonstrated by the deployment of contact tracing apps during the COVID-19 pandemic [1]. However, others challenges arise from this:

- How can the functioning of societal and related ICT be secured in anthropogenic, natural, or hybrid extreme situations, crises, and catastrophes [15, 22]?
- In light of an increasing exposure of digital infrastructures, how can we increase preparedness and response capabilities against cyber threats [6]?
- How can big crisis or social data be prepared for a meaningful analysis by authorities and organizations, also mitigating the issues of information overload and low information quality [13, 21]?
- How can the availability, integrity, reliability, and resilience of critical infrastructures in digitally interconnected areas be improved in the future [2, 5]?

These are only some questions that society needs to address to increase its *resilience* [4]. In this context, resilience can be understood as “the ability of a [socio-technical] system to cope with perturbations such as crisis and shocks while preserving its functions” [8]. While *resilient systems* have been described by the characteristics of absorption, recovering, adaptation, or transformation [3], research characterized *(mobile) technologies for resilience* by the properties of accessibility, diversity, evolvability, and usability, amongst others [14]. At the same time, the research field of crisis informatics [19] increasingly investigates the potentials and limitations of artificial intelligence [11], social media [20], and mobile technologies

such as crisis and warning apps [7], which constitute a relatively new public service for citizens and are specifically designed for the dissemination of disaster-related information and communication between authorities, organizations, and citizens [12]. However, another emerging challenge lies in fighting “infodemics”, i.e., the dissemination of misinformation in pandemics [23]. Furthermore, if critical communication or energy infrastructures fail, for instance, the distribution of recommendations and warning messages is challenged and requires alternative infrastructures [2].

## 2 GOALS

In this workshop, we want to explore the overlapping space that both *mobile interactive technologies* and *resilient systems* yield as fields of research. Specifically, in the second iteration of the workshop it is of interest to us how to integrate mobile applications into cyber incident and pandemic response. Thus, we seek to produce empirical findings related to design opportunities for resilient mobile and interactive systems. Furthermore, we aim at working out the state of research in the fields of mobile interactive technologies and resilient systems. Lastly, avenues for further research and the potentials of both fields are in the scope of this workshop. Key topics of the workshop include but are not limited to:

- Case studies, surveys, use cases and theories on mobile, social and, technological resilience, including application domains such as crisis response, cyber threats, infodemics, or pandemics
- Algorithms and systems for user-centered analysis of big crisis data, including cyber situational awareness, open source intelligence, social media analytics, credibility and relevance assessment, or social sensors
- Concepts and technologies for contact tracing in pandemics or stakeholder collaboration, including authorities, computer emergency response teams, rescue organizations, and citizens
- Human and technical factors in decentralized infrastructures, edge computing, and wide area networks for crisis management and response
- Innovative analysis, (interaction) design and, evaluation of resilient mobile or social (crisis) information systems
- Functionality, robustness, usability and user experience of resilient technologies such as mobile crisis and warning apps or wearables
- Best practices, methods, and strategies for the development and deployment of resilient (mobile) technologies in diverse application domains

## 3 CONTRIBUTIONS

The submissions for the workshop address some of the open issues mentioned above. Researchers from fields such as human-computer interaction, cyber security, crisis informatics, emergency communication, mobile information systems, and digitalization of human agglomerations were invited to submit abstracts or short papers for presentation and discussion at the workshop. The following contributions have been accepted for presentation:

The first contribution “*Optimal Rescue Sequences Under Time Pressure Induced by Degrading Health States*” by Rabeaeh Kiaghadi

and Martin Fränzle examines the use of robots to rescue several patients exposed to possible fatal incidents under time pressure. In this approach, a time-variant survival function is allocated to each patient which illustrates the decreasing probability of them surviving over time, whether being rescued or self-healed. The desired task for the agent, which has been defined as a dynamic travelling salesman problem (TSP), is to maximize the expected number of rescued alive patients considering time as its primary budget resource. The algorithm consists of a modified genetic algorithm with a heuristic cost function that considers all changes at each step of the robot’s path and replans when it is necessary. Similar to actual search and rescue missions, the severity of patients’ condition is categorized into different groups of high, medium, low, and lost.

The second contribution “*A Concept for Creating Mobile Games for Enhanced Disaster Preparedness in Cooperation With Local Communities*” by Michael Klafft, Ivana Harari, Agnieszka Dudzinska-Jarmolinska, Ricardo Antonio Gacitua Bustos, and Solhanlle Bonilla Duarte presents a concept on how to use local knowledge and user-generated content from previous disasters in order to create mobile games that support disaster risk awareness and disaster preparedness. The concept involves students or pupils from the area at risk who will not only create the games but also act as multipliers and disseminate the games and disaster knowledge locally, thus increasing the resilience of the local population. The approach is currently being tested as part of a mobile computing class at Universidad Nacional de La Plata in Argentina. During game design, a particular focus is placed on accessibility issues, thus ensuring that the designed games are suitable for a wide-ranging audience.

The third contribution “*Deploying Mobile-based Disaster Relief Systems Trained on Social Media Data*” by Thomas Chen outlines the limitations of existing machine learning datasets for damage assessment based on satellite imagery or social media data. As for datasets sourced from social media, a notable recent development is the Incidents Dataset from Google Images, which is comprised of images of damage incidents largely resulting from natural disasters. The baseline model that the author employed was tested on data from Twitter und Flickr. Instead of utilizing satellite-based remote sensing, this data sourced from on the ground presents new opportunities. However, given that the dataset is a very recent development, there have not been enough subsequent studies based on it to determine its efficacy compared to satellite imagery pipelines.

The fourth contribution “*Towards Strategies and Technologies for Actor-Specific Communication of Cyber Threat Warnings*” by Marc-André Kaufhold, Ali Sercan Basyurt, Marc Stöttinger, Stefan Stieglitz, and Christian Reuter presents both qualitative and quantitative empirical findings on the use of traditional, mobile, and social media for crisis communication. While previous research focused on the use of mobile devices during natural hazards, this contribution also discusses challenges for communicating anthropogenic hazards, especially cyber threats and their potential impact on critical and sociocultural infrastructures. Finally, it presents a mobile app established in Germany for communicating natural and anthropogenic hazards, also describing strategic and technological potentials to increase citizens’ prevention and response capabilities against cyber threats, which is subject of research within the CYWARN project.

## 4 PROGRAM COMMITTEE

The interdisciplinary workshop on mobile resilience was organized by the following people:

*Marc-André Kaufhold* is a postdoc at the Chair of Science and Technology for Peace and Security (PEASEC) in the Department of Computer Science at the Technical University of Darmstadt, Germany. He is project manager in CYWARN (2020–2023, BMBF), researcher at the ATHENE mission SecUrban, and associated member of the LOEWE centre emergenCITY. His research focuses on the user-centred design and evaluation of mobile apps and social media in the context of crisis and security research, comprising more than 70 scientific articles in the fields of Crisis Informatics, Human-Computer Interaction, and Information Systems.

*Christian Reuter* is Professor at Technical University of Darmstadt, Germany. His chair Science and Technology for Peace and Security (PEASEC) in the Department of Computer Science with secondary appointment in the Department of History and Social Sciences combines computer science with peace and security research. On the intersection of the disciplines (A) Human-Computer Interaction, (B) Cyber Security and Privacy, and (C) Peace and Conflict Studies he and his team specifically address (1) Crisis Informatics and Information Warfare, (2) Usable Safety, Security and Privacy, and (3) Technical Peace Research.

*Tina Comes* is Associate Professor at the faculty of Technology, Policy and Management at Delft University, the Netherlands and Full Professor in Decision-Making & Digitalisation at the University of Maastricht, the Netherlands. Tina also serves as Scientific Director of the 4TU Center on Resilience Engineering and is a member in the Norwegian Academy of Technological Sciences. Her research focuses on the collaborative and informational aspects of resilient societies. Tina investigates the role of information in urgent and ill-defined problems to design better sensemaking and decision support systems, which are applied in areas such as critical infrastructures, supply chain risk, and humanitarian logistics.

*Milad Mirbabaie* is Assistant Professor for Management Information Systems at Paderborn University, Germany. He has published in reputable journals such as Journal of Information Technology, Internet Research, Information Systems Frontiers, International Journal of Information Management, and International Journal of Human Computer Interaction. His work focuses on the use of digital technologies in the digital society. His application domains are crisis management, digital work, and digital health. In 2017, one of his articles was awarded with the Claudio Ciborra Award at the European Conference on Information Systems for the most innovative research article.

*Stefan Stieglitz* is a Professor and head of the research group for Digital Communication and Transformation (digicat) at the University of Duisburg-Essen, Germany. In his research, he investigates how to make use of social media data. Moreover, he analyzes user behaviour and technology adoption of collaborative information systems in organizational contexts. He is director and founder of the Competence Center Connected Organization. His work has been published in reputable journals such as the Journal of Management Information Systems, European Journal of Information Systems, Journal of Information Technology, and Business & Information Systems Engineering.

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## REFERENCES

- [1] Nadeem Ahmed, Regio A. Michelin, Wanlin Xue, Sushmita Ruj, Robert Malaney, Salil S. Kanhere, Aruna Seneviratne, Wen Hu, Helge Janicke, and Sanjay K. Jha. 2020. A Survey of COVID-19 Contact Tracing Apps. *IEEE Access* 8 (2020), 134577–134601. <https://doi.org/10.1109/ACCESS.2020.3010226>
- [2] Flor Alvarez, Matthias Hollick, and Paul Gardner-Stephen. 2016. Maintaining both availability and integrity of communications: Challenges and guidelines for data security and privacy during disasters and crises. In *2016 IEEE Global Humanitarian Technology Conference (GHTC)*. IEEE, 62–70.
- [3] David Chandler and Jon Coaffee (Eds.). 2017. *The Routledge handbook of international resilience*. Routledge, Taylor & Francis Group, Abingdon, Oxon, United Kingdom; New York, NY, USA.
- [4] Tina Comes. 2016. Designing for Networked Community Resilience. *Procedia Engineering* 159 (2016). <https://doi.org/10.1016/j.proeng.2016.08.057>
- [5] Tina Comes and Bartel Van de Walle. 2014. Measuring disaster resilience: The impact of hurricane sandy on critical infrastructure systems. In *Proceedings of the 11th International Conference on Information Systems for Crisis Response and Management (ISCRAM)*. 195–204.
- [6] Ulrik Franke and Joel Brynielsson. 2014. Cyber situational awareness – A systematic review of the literature. *Computers & Security* 46 (2014), 18–31. <https://doi.org/10.1016/j.cose.2014.06.008>
- [7] Margarita Grinko, Marc-André Kaufhold, and Christian Reuter. 2019. Adoption, Use and Diffusion of Crisis Apps in Germany: A Representative Survey. In *Proceedings of Mensch und Computer 2019*. Association for Computing Machinery (ACM), 263–274.
- [8] Matthias Hollick, Anne Hofmeister, Jens Ivo Engels, Bernd Freisleben, Gerrit Hornung, Anja Klein, Michèle Knodt, Patrik Lieser, Imke Lorenz, Max Mühlhäuser, Peter Pelz, et al. 2019. emergenCITY: A Paradigm Shift Towards Resilient Digital Cities. In *World Congress on Resilience, Reliability and Asset Management (WCRRAM)*. 383–406.
- [9] Sabiölla Hosseini, Leonhard Frank, Gilbert Fridgen, and Sebastian Heger. 2018. Do Not Forget About Smart Towns: How to Bring Customized Digital Innovation to Rural Areas. *Business & Information Systems Engineering* 60 (2018), 243–257. <https://doi.org/10.1007/s12599-018-0536-2>
- [10] Marc-André Kaufhold. 2021. *Information Refinement Technologies for Crisis Informatics: User Expectations and Design Principles for Social Media and Mobile Apps*. Springer Vieweg, Wiesbaden, Germany. <https://doi.org/10.1007/978-3-658-33341-6>
- [11] Marc-André Kaufhold, Markus Bayer, and Christian Reuter. 2020. Rapid relevance classification of social media posts in disasters and emergencies: A system and evaluation featuring active, incremental and online learning. *Information Processing & Management* 57, 1 (2020), 102132. <https://doi.org/10.1016/j.ipm.2019.102132>
- [12] Marc-André Kaufhold, Nicola Rupp, Christian Reuter, Christoph Amelunxen, and Massimo Cristaldi. 2018. 112.social: Design and Evaluation of a Mobile Crisis App for Bidirectional Communication between Emergency Services and Citizens. In *Proceedings of the 26th European Conference on Information Systems (ECIS2018)*. AIS Electronic Library (AISeL), P1–17.
- [13] Marc-André Kaufhold, Nicola Rupp, Christian Reuter, and Matthias Habdank. 2020. Mitigating information overload in social media during conflicts and crises: design and evaluation of a cross-platform alerting system. *Behaviour & Information Technology (BIT)* 39, 3 (2020), 319–342. <https://doi.org/10.1080/0144929X.2019.1620334>
- [14] Jean-Claude Laprie. 2008. From dependability to resilience. In *38th IEEE/IFIP International Conference on Dependable Systems and Networks*. IEEE, G8–G9.
- [15] Milad Mirbabaie, Deborah Bunker, Stefan Stieglitz, Julian Marx, and Christian Ehnis. 2020. Social media in times of crisis: Learning from Hurricane Harvey for the coronavirus disease 2019 pandemic response. *Journal of Information Technology* (2020), 195–213. <https://doi.org/10.1177/0268396220929258>
- [16] Milad Mirbabaie, Christian Ehnis, Stefan Stieglitz, Deborah Bunker, and Tanja Rose. 2020. Digital Nudging in Social Media Disaster Communication. *Information Systems Frontiers* (2020). <https://doi.org/10.1007/s10796-020-10062-z>
- [17] Saraju P. Mohanty, Uma Choppali, and Elias Kougiannos. 2016. Everything you wanted to know about smart cities: The internet of things is the backbone. *IEEE Consumer Electronics Magazine* 5, 3 (2016), 60–70. <https://doi.org/10.1109/MCE.2016.2556879>

- [18] Christian Reuter and Marc-André Kaufhold. 2018. Fifteen years of social media in emergencies: A retrospective review and future directions for crisis Informatics. *Journal of Contingencies and Crisis Management* 26, 1 (2018), 41–57. <https://doi.org/10.1111/1468-5973.12196>
- [19] Christian Reuter and Marc-André Kaufhold. 2021. *Crisis Informatics*. Cambridge University Press.
- [20] Stefan Stieglitz, Milad Mirbabaie, Jennifer Fromm, and Stefanie Melzer. 2018. The Adoption of social media analytics for crisis management—Challenges and Opportunities. In *Proceedings of the 26th European Conference on Information Systems (ECIS2018)*. AIS Electronic Library (AISeL), P1–19.
- [21] Stefan Stieglitz, Milad Mirbabaie, Björn Ross, and Christoph Neuberger. 2018. Social media analytics – Challenges in topic discovery, data collection, and data preparation. *International Journal of Information Management* 39 (2018), 156–168. <https://doi.org/10.1016/j.ijinfomgt.2017.12.002>
- [22] Siavash Valipour, Florian Volk, Tim Grube, Leon Böck, Ludwig Karg, and Max Mühlhäuser. 2016. A formal holon model for operating future energy grids during blackouts. In *Proceedings of the 5th International Conference on Smart Cities and Green ICT Systems (SMARTGREENS 2016)*. IEEE, 146—153.
- [23] John Zarocostas. 2020. How to fight an infodemic. *The Lancet* 395, 10225 (2020), 676. [https://doi.org/10.1016/s0140-6736\(20\)30461-x](https://doi.org/10.1016/s0140-6736(20)30461-x)