Behaviour & Information Technology

ISSN: 0144-929X (Print) 1362-3001 (Online) Journal homepage: https://www.tandfonline.com/loi/tbit20

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To cite this article: Christian Reuter, Stefan Stieglitz & Muhammad Imran (2019): Social media in conflicts and crises, Behaviour & Information Technology, DOI: 10.1080/0144929X.2019.1629025

To link to this article: https://doi.org/10.1080/0144929X.2019.1629025

Published online: 20 Jun 2019.

BEHAVIOUR & INFORMATION TECHNOLOGY
https://doi.org/10.1080/0144929X.2019.1629025

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Social media in conflicts and crises

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ABSTRACT
The growing importance of social media in conflicts and crises is accompanied by an ever-increasing research interest in the crisis informatics field in order to identify potential benefits and develop measures against the technology's abuse. This special issue sets out to give an overview of current research on the use of social media in conflicts and crises. In doing so, it focuses on both good and malicious aspects of social media and includes a variety of papers of conceptual, theoretical and empirical nature. In six sections, the special issue presents an overview of the field, analytical methods, technical challenges, current advancements and the accepted papers before concluding. Specific topics range from cyber deception over information trustworthiness to mining and near-real-time processing of social media data.

ARTICLE HISTORY
Received 22 May 2019
Accepted 2 June 2019

KEYWORDS
Social media; crisis informatics; emergency

1. Introduction

Social media is used in crises and conflicts for different reasons and by several actors, such as affected citizens, bystanders, media as well as emergency services. On the one hand, social media can help with sharing useful information that might help to overcome the crisis. However, examples also show that terrorists use social media to recruit new members and disseminate propaganda while social bots influence economic and political processes (Reuter 2019). Therefore, researchers need to investigate how to better exploit the potentials of social media during conflicts and crises. At the same time, academics need to develop countermeasures, such as fake news detection and counter-narratives.

The aim of this special issue is to showcase current research on social media in conflicts and crises. This includes investigating the dynamics of participation and interaction enabled by social media, which entails both good (participation, volunteerism) but also malicious (fake news, rumours, suppression, political persecution) aspects. We invited papers that provide rich descriptions and/or evaluations of the design and/or actual use of social media for collaboration and/or widespread participation in any phase of a conflict or crisis. Papers were asked to be conceptual, theoretical and/or empirical in nature, with a preference for theoretical work based on empiricism.

Sample topics included studies of the use of social media in conflicts and crises, which entail aspects like rumours, fake news, manipulation, cyber deception, information warfare; innovations in design or use of social media that solve potential problems such as issues of information overload, assessment of information trustworthiness, or ethical issues such as privacy; issues and techniques for mining and near-real-time processing of social media data to enable early decision-making or detection of misinformation (Imran et al. 2015); as well as innovative human–computer interaction techniques and methodologies relevant to the design, analysis and evaluation of applications useful for social media in conflicts and crises. We received 17 submissions and selected 6 articles for this special issue.

This article aims at introducing the topic of the special issue and is structured as follows: Firstly, we will present a summary of different use patterns of social media use in conflicts and crises (Section 2). Then we will shed light on methods for the analysis of social media which are applicable to conflicts (Section 3) and technical challenges for data processing (Section 4) before current advances in the area are presented in form of accepted articles of this special issue (Section 5). Finally, we draw general conclusions (Section 6).

2. Social media use patterns

In reaction to the variety of emergency situations and respectively, responses to them, efforts have been made to categorise social media usage (Reuter, Hughes, and

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Kaufhold 2018; Reuter and Kaufhold 2018). Their objective is, firstly, to encourage the systematic analysis of behaviours and interrelations, and secondly, to simplify the advancement and usage of qualified technology: Differentiating between types of sender (X-axis) and recipient (Y-axis) of digital content, in Reuter, Marx, and Pipek (2012) the authors created a classification template for cooperation in crises. The actors considered are authorities (A) – emergency services, among others – and citizens (C). Thus, the crisis communication matrix makes out four different information flows on social media in emergencies: Firstly, the public level which is used by citizens and volunteers to exchange information (C2C). Secondly, Organisations also make use of social media to inform the public (A2C). Thirdly, the information generated on this level is further used and analysed by crisis response organisations (C2A). Lastly, the inter-organisational level on which organisations communicate with each other (A2A).

2.1. Citizens to citizens (C2C) – self-coordination and help

Social media are possible, although not the only, means for people use to help each other and coordinate their efforts. Therefore, a large part of citizens' activities on social media are aimed at exchanging information with other citizens. Contrary to what many may expect studies have found that citizens' reactions to crises are mostly rational. Instead of panicking or looting they are invaluable participants of rescue and response work (Helsloot and Ruitenberg 2004). To grasp and classify these efforts, Reuter, Heger, and Pipek (2013) differentiate activities in the *real* from activities the *virtual* world: Neighbourly and on-site work done by 'emergent groups' (Stallings and Quarantelli 1985) is thus distinguished from efforts of 'digital volunteers' (Starbird and Palen 2011), whose sphere is the internet and who's work, therefore, is mainly online-based.

Looking at the types or information shared or more generally at the content of communication between citizens taking place in times of emergencies, several conclusions can be drawn. Social media in general and Twitter, in particular, are used, firstly, to gather, structure and synthesise information on both the incident and people (Eismann, Posegga, and Fischbach 2016; Qu, Wu, and Wang 2009; Qu et al. 2011; Starbird 2013). Secondly, so-called digital volunteers who make use of increasingly dense networks and citizens alike engage in crisis mapping (Goolsby 2010; Kogan et al. 2016) and complete tasks that authorities are unlikely to undertake (Starbird and Palen 2011; White, Palen, and Anderson 2014). Thirdly, citizens also provide emotional support and express solidarity (Starbird and Palen 2012; Wilensky 2014). Generally, activities can be divided into two phases: While efforts during the preparedness and response phases are mainly limited to retweeting warnings and crisis tracking, they are centred around relief activities and sharing external resource links in the recovery phase (Reuter, Heger, and Pipek 2013).

2.2. Authorities to citizens (A2C) – crisis communication and public alerting

Next, to the aforementioned utilisation of social media as a tool of communication and coordination amongst citizens, authorities increasingly make use of social media as a tool of crisis communication. Contents shared include tactics of avoidance of and behaviour in emergencies (Reuter et al. 2016).

This change in communication patterns has altered the relationship between citizens and authorities (Hughes and Palen 2012). Although many positive effects arise – such as increasingly close relations between public and institutions and improved scale of outreach – there are also challenges: upholding a constant flow of information and correcting mistaken information generated by the public requires high effort (Denef, Bayerl, and Kaptein 2013; Kaewkitipong, Chen, and Ractham 2012). This is often complicated by a lack of adequately trained staff, guidance and trustworthiness (Plotnick and Hiltz 2016). Furthermore, authorities tend to communicate to the public without coordinating their efforts. This adds to the chaos of information generated by the public. Possible solutions to these problems are better structured hashtags and the creation of new features for better documentation of information (Hughes et al. 2014; Starbird and Stamberger 2010).

2.3. Citizens to authorities (C2A) – integration of citizen-generated content

The communication between authorities and citizens is not a one-way road: using data-mining, citizen-generated content is analysed in order to statistically approximate benchmarks of interest, e.g. citizens' alertness (Johansson, Brynielsson, and Quijano 2012). These measures are very accurate because of the large amount of social media posts to be found online. A further possibility to profit from citizen-generated content lies in photographs posted online. The inherent unreliability of photos with unclear origin (Mendoza, Poblete, and Castillo 2010) could be mitigated by crowdsourcing to verify the authenticity of their content (Reuter, Marx, and Pipek 2012). Another possible track for future

developments is that the content generated by volunteers will improve in quality because these actors gain an understanding of the importance of their role so that authorities will be able to rely on the information shared (Hughes and Tapia 2015).

Research has identified several possible approaches to profit from citizen-generated content and its processing. They range from crowdsourcing (Ludwig et al. 2017) over the combination of different statistical methods to shorten the time-span necessary to analyse data (Castillo 2016) to (automated) information extraction techniques which improve situational awareness (Vieweg et al. 2010) or event and sub-event detection (Sakaki, Okazaki, and Matsuo 2010). Moreover, the analysis of the geographical location of social media messages promises enhancement of the quality of content shared by authorities (de Albuquerque et al. 2015). In order to alleviate the problem concomitant with the large amount and low quality of citizen-generated content, Moi et al. (2015) have developed a mechanism to filter data in order to provide emergency services with a small amount of useful and accurate information.

These efforts notwithstanding, processing social media content still confronts authorities with unaddressed challenges including the characterisation and acquisition as well as processing of relevant data, among others (Imran et al. 2015). Adding to these is the fact that not all emergency responders actually use the tools at hand, because of the persisting difficulty of acquiring, screening and analysing the ever-increasing volume of data in crises (Hughes and Palen 2012; Reuter, Amelunxen, and Moi 2016).

2.4. Authorities to authorities (A2A) – inter- and intra-organisational crisis management

To date and in contrast to the other patterns of information exchange, inter- and intra-organisational coordination and communication of authorities (A2A) is only rarely abetted by social media platforms. Nonetheless, social media can facilitate the enhancement of inter-organisational awareness and informal processes: The social network features of information sharing, communicating as well as expanding personal and organisational networks are particularly popular among emergency management students (White et al. 2009). However, the very same students are aware of the shortcomings and risks of these platforms including the unreliability of information, identification of users, possible breaches of privacy and technological failures. Overall, the establishment of social networks for inter-organisational purposes may prove helpful (Pipek et al. 2013; Reuter 2014).

3. Social media analytics in conflicts

Social Media are a valuable source of data in the context of crisis management. However, although there is a variety of different methods to analyse these data, researchers and decision-makers still face problems when it comes to the usage of data during crisis situations (Stieglitz et al. 2018). Crisis situations such as terrorist attacks, major accidents or environmental disasters trigger online debates the moment they take place. Messages from the location of the incident posted in real-time are blending with expressions of compassion and everyday chat. Yet not necessarily everything shared is relevant for or actually from the event in question. It is an analytical and practical challenge for emergency management staff to select those social media platforms that are predominant during the event and on these platforms to separate situationally relevant from irrelevant messages. If such challenges can be addressed successfully, the extraction of relevant data and the definition of appropriate criteria can enable predictions of the further development of a crisis or even of the emergence of crisis situations. However, not only tracking and analysing data from social media is challenging but also effectively spreading information to the public. Emergency management agencies such as police, firefighters and paramedics start to use social media to communicate to publics affected by crises. To ensure that their messages are received by the parties involved a profound understanding of how messages are diffused in social media networks is required. For example, having advanced methods to automatically identify the most important nodes in a network helps with spreading messages quickly to people in need.

It is not trivial to process social media in an effective way. The high complexity of social media analytics can be illustrated by the characteristics of social media data as 'big data', referring to the 5 V's: volume, velocity, veracity, variety and value. Not only the sheer amount of data but also the speed of data generation and processing different media formats such as text, images and videos are challenges that have not yet been adequately addressed. Methods frequently used for social media analytics are:

3.1. Text mining

This method aims at interpreting text messages and summarising or grouping them. It can be used to find patterns and important keywords in discussion, identify redundant information in and across messages and to generate features for text classification. It is an effective method to create summary reports in crisis management,

identify rumours and fake news or distinguish between different types of messages (e.g. generated by bots) and relate them to topics in social media (Stieglitz, Bunker, et al. 2017). Sentiment analysis enables organisations to classify social media messages according to their emotionality (e.g. positive/negative posts). In the context of crisis communication, the application of this method might help to detect crisis situations at an early stage or to get awareness of changes in public communication.

3.2. Classification and machine learning methods

Machine Learning can, e.g. be used for message classification (Basto-Fernandes et al. 2016; Zhao et al. 2016). It can be based on features generated by text mining but also on other attributes such as time, location or author. Advanced methodological approaches such as convolutional ('deep') networks for automated feature generation, three-way classification and multi-class classifiers are ways to support the machine learning process. In crisis situations, machine learning can be a powerful approach to identify communication patterns, topics and trends. It can also help to identify relevant actors and dynamics in social media communication (Mirbabaie et al. 2014; Stieglitz, Brachten, et al. 2017).

3.3. Complex network analysis

Network Analyses have a crucial role in the social media analytics methodological toolkit. For example, centrality measures can assist in tasks and the right types of centrality measures of actors need to be identified, e.g. betweenness centrality in order to identify information hubs and Eigenvector centrality to identify the most influential actors in the network. Community detection in multiplex networks is a key method to identify clustering or fragmentation of networks into different roles and to study the phenomenon of fragmentation. The structure of the network has a large impact on the information dynamics of topics, e.g. the spread of rumours (Stieglitz et al. 2018).

3.4. Future directions

All of these methods have been frequently used for the analysis of social media data (Stieglitz et al. 2018). However, in the context of crisis management, many problems are still unsolved such as: How to detect false information and rumours early? How trustworthy are certain information and data sources? How to visualise data in a meaningful way to support decision-makers? How can we provide real-time analytics for decision-makers?

Social media analytics might also be applied to long-term crisis situations such as political or social movements. In this context, social media analytics can provide valuable insights into communication patterns, discussed topics and involved actors. On the one hand, this information can be used to overcome stages of instability in society. On the other hand, however, data might also be misused by governments and other political actors. Therefore, researchers have to consider the ethical implications of their studies.

Even though researchers from different disciplines started to apply their methods and theories to social media communication, there is still a lack of comprehensive theories and models. On the one hand, promising theories still exist in different academic areas that have hardly adapted to social media yet. Examples from communication science are the concepts of the spiral of silence and echo chambers (Ross et al. 2019) or the concept of collective sensemaking (Stieglitz, Bunker, et al. 2017). Moreover, predictive models about the evolution of topics over time, e.g. on information cascades, have made large strides forward but have not been systematically added to the portfolio of social media analytics methods. Aside from incorporating theories from other disciplines researchers also need to develop new theoretical approaches.

4. Social media data processing and technical challenges

Several research studies have shown that the data shared on social media platforms at the onset of a disaster situation contain valuable informative nuggets which could be useful for a number of disaster response and management tasks, if analysed timely and effectively (Imran et al. 2015; Castillo 2016). Among different types of information which can be extracted from social media, reports of affected, injured or deceased people, infrastructure damage and urgent needs of affected people are prominent ones (Imran et al. 2013). Furthermore, social media platforms often break critical events faster than traditional media such as TV. For instance, the first report about the Westgate Mall attack in Nairobi, Kenya in 2013 was shared on Twitter and almost 30 min before any local TV channel reported the event (Zahra et al. 2018). Such low-latency access to useful data highlights another important application of Twitter and other social media platforms, which is the early detection of critical emergency events.

Despite the fact that social media is a potential source for disaster response, extracting useful pieces from social media data is still a challenging task including real-time parsing of brief and informal messages, handling

information overload, determining information credibility and prioritising useful information. These challenges can be mapped to classical information processing tasks such as filtering, classifying, extracting, aggregating, ranking, visualising and summarising information (Imran et al. 2015). For example, automatic classification techniques help reduce information overload by filtering out irrelevant messages while summarisation techniques help gain situational awareness by extracting important summaries from the relevant messages. Next, we discuss some of these challenges.

4.1. Data variety and real-time classification

Data quality in terms of readability, grammar and sentence formation vary across social media platforms. Twitter messages are usually very brief, informal, unstructured and often contain spellings and grammar mistakes. Some of these issues can be resolved using simple preprocessing steps.

However, finding informative signals from social media communications require processing millions of data points. Toward this end, one key task is to identify relevant and useful information and discern irrelevant and noisy content. One well-known approach for this task is supervised classification. A machine learning algorithm is trained to understand the concept of relevance and irrelevance by providing human supervision. The relevant messages, that is the output of the first task, can further be processed to separate them according to specific information needs of humanitarian organisations. For instance, a task to assess urgent needs of an affected population could include categories about shelter needs, food or water needs, blood or donation needs, among others. Machine learning algorithms can be trained to understand the concept of each of these categories just as in the case of relevance understanding.

One key factor that hinders machine training, however, is the scarcity of labelled data. Particularly at the onset of a disaster situation, anticipating all different types of needs of vulnerable people is not possible. Thus, obtaining labelled data to train machine learning classifiers prior to an event becomes difficult. Learning machine learning classifiers during an ongoing situation has its own challenges. Although thousands of social media messages can be collected in the early hours of a disaster, sampling messages for human labelling is a non-trivial task. Many messages tend to be duplicate (e.g. retweets) and others simply do not contain relevant informative signals. Many convey prayers and thoughts and similar concepts. Therefore, an emerging challenge in the online classification of social media data is to keep the categories used for classification up-to-date. Imran, Chawla, and Castillo (2016) propose a framework based on Expert-Machine-Crowd (EMC) which performs classification of items while continuously identifying novel concepts in data streams. Another data-driven technique to identify crisis-related topics in stream is proposed by Imran et al. (2015). Here, the authors use an unsupervised topic modelling technique to generate candidate topics from which novel topics are selected by checking topic novelty, size, cohesiveness and inter- as well as intra-similarity with other topics.

Transfer learning and domain adaptation techniques help with both learning knowledge representation from one domain and applying it to other domains. Alam, Joty, and Imran (2018) and Imran, Chawla, and Castillo (2016) proposed a domain adaptation with an adversarial training approach which uses graph embeddings and deep learning techniques to classify social media data from different event types. They make use of both unlabelled and labelled data to train deep learning models using the stochastic gradient descent (SGD) algorithm. Nguyen et al. (2016) highlight other applications of deep learning techniques in the domain of crisis informatics. Particularly, they tackle the problem of data classification.

4.2. Data summarisation and ranking

Even after the supervised classification of social media data, the amount of processed data that is potentially useful for disaster response can be too large for humans to derive actionable knowledge from them. To tackle this particular challenge several techniques have been proposed. For instance, data summarisation, which is a technique to make a short summary from a large set of documents, has gained attention in the crisis informatics community. Rudra et al. (2016a) proposed a framework based on integer-linear-programming (ILP) for Twitter data summarisation. The framework first groups tweets into different situational classes and uses the ILP-based optimisation technique to generate abstractive summaries consisting of 200 words using data from each day of a disaster event. In another work, the authors first identify sub-events from an ongoing disaster situation and generate abstractive summaries of those subtopics (Rudra et al. 2016b, 2018).

Identification of serviceable messages during a disaster situation help humanitarian organisations address time-critical public requests. Nevertheless, social media information load during major disasters hinders organisations' timely response which is often coupled with limited human resource availability. Situations like this need timely identification and prioritisation of serviceable requests on social media. Purohit et al. (2018a) propose

a formal model of serviceability called Social-EOC (Social Emergency Operations Center) which determines different serviceable elements associated with messages to filter the ones that actually contain some sort of request. Furthermore, the proposed technique performs discovery and ranking of highly serviceable requests (Purohit et al. 2018b).

4.3. Transforming data into actionable insights

Previous research work in the domain of crisis informatics has largely focused on the concept of situational awareness, i.e. understanding the exact scope of an event. Depending on their roles and duties, different humanitarian organisations may have different information needs ranging from a general understanding of an event to specific response operations, e.g. sending paramedics to rescue injured people due to an earthquake. Zade et al. (2018) frame this as a problem of information actionability. Based on a large-scale survey they identified different factors that define the actionability of social media data. Among others, timeliness, location, information source credibility and context are important factors which define actionability. Given that social media data is often noisy, learning these factors is a challenging task. Future work in the crisis informatics community needs to focus on building more robust computational models to automatically determine the actionability of social media posts, ideally in near-real-time.

5. Accepted articles in this special issue

We received 17 submissions for the special issue which partly address some of the open issues mentioned above. After two rounds of rigorous reviewing, six articles were accepted for publication.

5.1. Sense-baking patterns

The article '"Breaking" News: Uncovering Sense-Breaking Patterns in Social Media Crisis Communication during the 2017 Manchester Bombing' by Milad Mirbabaie and Julian Marx (University of Duisburg-Essen) addresses the deployment of social media during crisis situations as a medium of instant broadcasting. The increasing use of open channels by crisis responders, media organisations and individuals creates a plethora of opportunities but also raises legitimate questions about accuracy, source integrity and detrimental effects. The Manchester Bombing turned out to be a case peppered with many unconfirmed and false rumours. The authors argue that the initial broadcast of a novel piece of information takes on a crucial role in the build-up of social media crisis communication. These 'sense-breaks', which almost exclusively occur in early stages of a crisis, shape how communication develops and knowledge can be created from social media. The study further concludes that individual actors are primarily accountable for sense-breaking actions, whereas media and crisis response organisations act rather hesitantly. The later an actor steps in the harder it is to shape the dissemination of messages. Emphasising this correlation may help officials with both getting systems in place that address the proactive engagement in early crisis stages and debunking as well as confirming activities.

5.2. Empirical insights

The article 'Use of Twitter in the Cameroon Anglophone Crisis' by Julius Tanyu Nganji and Lynn Cockburn (University of Toronto) addresses social media as a key communication channel during crises and conflicts. In addition to traditional media, social media are used to mobilise people for a common cause and to communicate vital information. Very little is known about social media use during crisis in the context of sub-Sahara Africa. The article presents how Twitter is used in the ongoing Cameroon Anglophone Crisis by several groups including the government, Anglophone activists, media organisations and average citizens. Using critical theoretical perspectives to examine tweets from 1 September 2016 to 31 December 2018, this article identifies key themes. These themes include the placement of the crisis in a contested, historical context, debates about naming the crisis, key concepts, the depiction of several forms of violence and potential options for resolution. Social media is used by the government, Anglophone activists and non-affiliated people to sway public opinion on the crisis and to solicit the attention of local, Diaspora and broader international communities. Social media use has loosened the grip of the government's control of media messaging and expanded the public narratives available in Cameroon. Yet at the time of writing social media use does not appear to have lessened the impact of the crisis.

5.3. Creating descriptive and visual summaries

The article 'Descriptive and Visual Summaries of Disaster Events using Artificial Intelligence Techniques: Case Studies of Hurricanes Harvey, Irma, and Maria' by Firoj Alam, Ferda Ofli and Muhammad Imran from Qatar Computing Research Institute studies Twitter multimodal data during three major natural disasters

to determine its usefulness for disaster response. The article explores several computational techniques to address various social media data processing challenges in the humanitarian domain, e.g. the issue of information overload during large-scale disasters. The authors report that textual and imagery content on social media provide complementary information, which is crucial to increase situational awareness. They propose a methodological approach that combines several computational techniques to process the multimodal content on social media in a unified framework in a way that maximises their effectiveness for situational awareness tasks and hence helps humanitarian organisations in their rapid response efforts. The experimental study on three major disaster events demonstrates how various types of useful information obtained by the proposed methodology can inform crisis managers and responders and facilitate the development of future automated systems for disaster management. The experimental work includes NER analysis, sentiment analysis, topic modelling on emerging topics (i.e. finding sub-events), image filtering and damage assessment on the set of relevant images, and visualisation of the results on a map. One of the notable findings is how NER analysis in certain humanitarian categories can provide emergency managers with fine-grained insights about 'who' is doing 'what' and 'where'.

5.4. Addressing information overload

The paper 'Mitigating Information Overload in Social Media during Conflicts and Crises: Design and Evaluation of a Cross-Platform Alerting System' by Marc-André Kaufhold, Nicola Rupp, Christian Reuter and Matthias Habdank (Technische Universität Darmstadt, Universität Siegen and Universität Paderborn) examines the technological potential and barriers of social media use during conflicts and crises. Social media allow emergency services to both reach the public easily in the context of crisis communication and receive valuable information (e.g. eyewitness reports, pictures and videos) from social media data. However, the vast amount of data generated during large-scale incidents can lead to issues of information overload and a lack of quality. To mitigate these issues, this paper proposes the semi-automatic creation of social media alerts including keyword, relevance and information quality filters based on cross-platform social media data. We conducted empirical studies and workshops with emergency services across Europe to collect requirements. Then, we iteratively designed and implemented an approach to support emergency services and performed multiple evaluations, including live demonstrations and field trials, to examine the potential of social media-based alerts. Finally, we presented the findings and implications based on semi-structured interviews with emergency services, highlighting the need for usable configurability to mitigate information overload and white-box algorithm representation to support the transparency of information quality assessment.

5.5. Incorporation of help requests

The article 'Repertoires of Collaboration: Incorporation of Social Media Help Requests into the Common Operating Picture' by Christian Ehnis and Deborah Bunker (The University of Sydney) addresses dynamic and emergent multi-stakeholder scenarios. In this context, the authors investigate complex decision-making and how it is supported by Emergency Management Organisation (EMO) 'command and control' disaster response systems. Nowhere is this more evident than when the general public use social media platforms to report crisis incidents when the official emergency management hotline (e.g. Triple Zero (000) in Australia) is overwhelmed or not available. This paper analysed interview data from five Australian EMOs and outlines and discusses these issues in detail. As a result of this analysis, the authors suggest that developing a supplementary 'repertoires of collaboration' approach to incorporate social media posts into the development of situational awareness during a disaster event would help with improving disaster response outcomes. The authors also recommend a way forward through the application of the Negotiated Arrangements for the Common Operating Picture (COP) in Extreme Events framework.

5.6. Towards a conceptual framework

The article 'A conceptual framework for developing solutions that organise social media information for the emergency response team' by Danilo P. Freitas, Marcos R. S. Borges and Paulo Victor R. Carvalho (Universidade Federal do Rio de Janeiro) addresses the use of information from social media in emergencies and presents a conceptual framework for the development of applications that support teams in the processes of capture, selection and prioritisation of content. The framework is geared towards working in the response phase of an emergency and acts with the integrated view on the activities, including the association of messages with rescue actions. Turning this rich social media material into an additional feature that is operational, reliable and performing in the context of a crisis presents a major challenge. In addition to the framework, an instance in the form of an application is also presented which was

used in simulations with real data of two major crises that occurred in 2017. The simulations and their results demonstrate the real possibility of using this information in response to emergencies. The entire process of building the framework was carefully recorded, showing the steps, functionalities and principles that govern the development of a tool for this purpose. The framework and the results of the simulations were presented to emergency management experts who considered their design an important advance in emergency management.

6. Summary

In sum, our special issue contains an overview of current research on the use of social media in conflict and crises and summaries of the six papers accepted for this issue. The core aim of this special issue was to investigate the various dynamics which result from participation in and interactions on social media platforms during conflicts and crises, focusing on both positive and malicious practices.

Therefore, we mapped out four main social media use patterns (Section 2). Our main findings are that the use of social media is a highly resource-demanding endeavour for authorities and that the use pattern 'authorities to authorities' is less prevalent than the other patterns.

We then turned to social media data analytics during conflicts (Section 3). We identified three recurring methods for social media analytics, text mining, classification and machine learning as well as complex network analysis and touched upon problems pertaining to future use. On the one hand, we were able to ascertain that there is a persistent lack of comprehensive theories and models for research in this field. On the other hand, basic questions on the use of social media analytics during conflict are still unanswered and researchers need to address ethical questions more sufficiently, due to the high potential for misuse of social media data.

Afterwards, we discussed social media data processing and related technical challenges (Section 4), including real-time classification, summarising and ranking data, as well as transforming data into actionable information. Here, the challenges of determining useful of information and real-time analysis stood out.

Lastly, we presented the six papers that were accepted for this special issue (Section 5). While Mirbabaie and Marx focus on the deployment of social media during crises as a real-time broadcasting medium, Nganji and Cockburn observe that social media has increased the scope of public narratives and lessened the government's grip on media regarding Cameroon's Anglophone Crisis. Alam, Ofli and Imran, in turn, examine techniques to enhance situational awareness for disaster response personnel, whereas Kaufhold, Rupp, Reuter and Habdank contend that new techniques are necessary to prevent emergency services from suffering information overload and a decrease in information quality. Ehnis and Bunker examine Australian emergency services' command and control and argue for the incorporation of social media in decision-making processes to increase situational awareness. The last paper, written by Freitas, Borges and Carvalho, addresses the possible use of social media messages for direct rescue missions during emergencies and presents a framework to better utilise data in that regard.

We would like to thank the editor-in-chief of BIT, Prof. Panos Markopoulos, for giving us the opportunity to edit this special issue and all of the reviewers for their contributions to make this special issue possible.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

The work of Christian Reuter has been funded by the German Federal Ministery of Education and Research and the Hessen State Ministry for Higher Education, Research and the Arts within their joint support of the National Research Center for Applied Cybersecurity. This work has also been funded by the DFG within the CRC 1119 CROSSING and CRC 1053 MAKI.

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