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The Adoption of social media analytics for crisis management – Challenges and Opportunities

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THE ADOPTION OF SOCIAL MEDIA ANALYTICS FOR CRISIS MANAGEMENT — CHALLENGES AND OPPORTUNITIES

Research paper

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Abstract

We live in a time when anyone can change from a passive bystander to an active communicator during a crisis. This makes user-generated content a potentially valuable source of information for emergency management agencies. However, at present, agencies still hesitate to use social media during crises. This research seeks to identify the challenges emergency management agencies face in using social media analytics within their organisations.

We conducted a systematic literature review and interviewed ten emergency management professionals across six expert interview sessions. Afterwards, we used the Technology-Organization-Environment Framework to conceptualise our findings. Our study reveals fruitful opportunities for the continuous collaboration of both information systems research and emergency management agencies. Accordingly, information systems research can support emergency management agencies in using social media data for efficient crisis management by enhancing awareness of the benefits of social media analytics and helping to overcome organisational and technological challenges.

Keywords: Crisis Management, Social Media Analytics, Emergency Management Agencies, TOE.

1 Introduction

The widespread use of mobile phones and social media has changed the way citizens and emergency management agencies (EMAs) communicate with each other in times of crisis (Ehnis et al., 2014; Mirbabaie et al., 2014). Whoever has a smartphone is not only able to call EMAs but can also take pictures or videos from the scene to share with their network on social media (Al-Saggaf and Simmons, 2015; Latonero and Shklovski, 2010). Social media enables widespread information diffusion during an extreme event, even before the responsible officials such as EMAs arrive at the location to help or solve the situation (Stieglitz et al., 2017a).

There is a decent amount of research revealing the increasing importance of social media for crisis communication (Stieglitz et al., 2018a). While traditional media coverage is often deemed insufficient, several studies indicate that people turn to social media, where information disseminates much more quickly (Huang et al., 2015; Mirbabaie et al., 2017, Stieglitz et al., 2018b). So far, EMAs use social

media primarily to publish reports after a crisis or to disseminate situational updates, warnings, advice, preparedness information or behavioural guidelines to the public (Eismann et al., 2016). They also attempt to correct misinformation and counter rumours on social media (Plotnick et al., 2015). The mentioned studies reveal that social media has significantly changed crisis communication by enabling the public to reach important actors like EMAs (Palen and Liu, 2007; Qu et al., 2011; Stieglitz et al., 2017b). Thus far, information systems (IS) researchers have focused on the use of social media by EMAs for communication, but there also is a small but growing body of research on the possibility of extracting and analysing user-generated content on social media for crisis management. However, EMAs do not currently take advantage of this valuable source of information, because they still use social media mainly for broadcasting information (Eismann et al., 2016; Reuter et al., 2016). This leads to the assumption that EMAs cannot have a precise picture of a situation when heading to a disaster scene; they need to rely on their experience and information from emergency calls to make decisions. If EMAs would use all information which affected citizens and eyewitnesses voluntarily provide on social media, they might be able to estimate the severity of a crisis earlier, make decisions more quickly and manage crises more efficiently.

The potential of using social media for crisis management is not yet realised by many EMAs, although IS researchers have revealed that social media analytics can be useful in several stages of a crisis (Ahmed, 2011; Houston et al., 2015). Previous studies have shown that a crisis can be detected through social media analytics even before the incident is communicated officially (Cameron et al., 2012; Crooks et al., 2013). Using social media analytics would provide EMAs the possibility of responding to crises more quickly and sending help earlier. Data collection methods and even social media analytics tools already exist (Ludwig et al., 2015b), and at least some EMAs are already using these inventions. For example, the American Red Cross uses social media to extract information provided by the public. However, this is an exception, as for most EMAs, social media usage is still an experiment (Imran et al., 2015). With our research, we seek to understand why social media analytics have not been adopted by most EMAs to respond quickly to crises and manage these situations in a more efficient way. Hence, we ask the following question:

What are the challenges for EMAs in adopting social media analytics for crisis management?

To answer this question, we conducted a systematic literature review (SLR) and expert interviews. As a practical problem is addressed by our research, we regarded expert opinions as a valuable resource in addition to the SLR. The combination of an SLR and expert interviews provided the opportunity to examine whether the challenges mentioned by the experts are represented conclusively in the existing literature. The challenges resulting from both methods are categorised based on the Technology-Organization-Environment (TOE) Framework (De Pietro et al., 1990; Tornatzky and Fleischer, 1990). To guide future research regarding the adoption of social media analytics in EMAs and to provide practitioners with recommendations for action, we derived propositions based on the challenges identified through the SLR and expert interviews.

2 Social Media Analytics

In recent years, IS researchers as well as practitioners have underlined the business value of social media analytics, particularly because of its great potential to enrich customer relationship management (Bygstad and Presthus, 2013; Kurniawati et al., 2013; Stieglitz et al., 2014). According to Zeng et al. (2010), “social media analytics is concerned with developing and evaluating informatics tools and frameworks to collect, monitor, analyze, summarize, and visualize social media data, usually driven by specific requirements from a target application.” Many organisations currently utilise social media analytics tools to turn social media data into valuable knowledge which can be utilised to enhance customer interaction and product development (Durgam and Sinha, 2014; Kurniawati et al., 2013; Rosemann et al., 2012).

In IS research, organisational use of social media analytics has been studied extensively, though analysing content on social media can also provide benefits in other application areas, such as crisis

management. Prior research has shown that at least a few EMAs use social media not only for communication with the public but also to extract useful information (Flizikowski et al., 2014; Power and Kibell, 2017). Some EMAs already use social media analytics tools like Hootsuite, Storify or Social Mention. Others make use of crowd-sourced maps like OpenStreetMap or Google Crisis Map (Reuter et al., 2015). EMAs acknowledge the benefits of extracting information from social media, for example gaining a better situational awareness (Lindsay, 2011; Power and Kibell, 2017; Reuter et al., 2016). EMAs also appreciate the possibility of monitoring social media in real time, thus always being informed about the current position of affected citizens, so they can assess the citizens' needs and alert them as well as first responders as soon as conditions change or new threats occur (Lindsay, 2011). During the 2016 Broadmeadows Tyre Fire in Melbourne, for example, the social media analyst from State Control Center Victoria was able to retrieve photos of the fire from social media. These photos were helpful in estimating the severity of the situation and choosing the equipment necessary to extinguish the fire (Power and Kibell, 2017).

Nevertheless, several technological, organisational and environmental challenges hinder EMAs in adopting social media analytics (Flizikowski et al., 2014; Gill and Bunker, 2012; Haworth, 2016). For example, one major concern of EMAs is that not only helpful information but also rumours spread quickly on social media (Lindsay, 2011; Van Gorp et al., 2015). EMAs also fear that terrorists could intentionally provide false information to draw first responders to a specific location and attack them there (Lindsay, 2011). Yet EMAs agree that social media analytics will be a consistent part of their work routines in the future (Reuter et al., 2015). So far in the IS domain, research has been done addressing technological challenges related to the use of social media analytics in a crisis management context, for example filtering only relevant information (Imran et al., 2014) and assessing the credibility of social media posts (Castillo et al., 2011). As prior research has shown that the level of social media use by EMAs is positively related to successful crisis management (Graham et al., 2015), it is highly important that non-technological challenges are also addressed by future research. To pave the way for future research in this direction, we aim to provide a comprehensive overview of not only technological but also organisational and environmental challenges related to the adoption of social media analytics by EMAs.

3 The Technology-Organisation-Environment Framework

In recent decades, technology adoption has been a central topic in IS research. Thus, a large number of models and theories attempting to explain technology adoption on an individual or firm level have been developed. According to Oliveira and Martin (2011), the technology acceptance model (Davis, 1986; Davis, 1989; Davis et al., 1989), the theory of planned behaviour (Ajzen, 1985; Ajzen, 1991), the unified theory of acceptance and use of technology (Venkatesh et al., 2003), the diffusion of innovation theory (Rogers, 1995) and the technology-organisation-environment (TOE) framework (De Pietro et al. 1990; Tornatzky and Fleischer, 1990) are most commonly used in adoption studies. To conceptualise the findings of our SLR, we decided to utilise the TOE framework for two reasons. First, while most of the mentioned models and theories describe technology adoption on the individual level, only the diffusion of innovation theory and the TOE framework are applicable to the organisational level (Oliveira and Martin, 2011). In our study, we focus on technology adoption on the organisational level, more specifically on the adoption of social media analytics by EMAs. Second, the TOE framework considers the environmental context of an organisation and thus has been described as a more holistic approach than the diffusion of innovation theory (Hoti, 2015). As EMAs are strongly embedded in government structures, we expected the environmental context to be relevant in our study.

According to the TOE framework, technology adoption processes in organisations are influenced by their technological, organisational and environmental context (De Pietro et al., 1990; Tornatzky and Fleischer, 1990). The technological context includes both internal and external technologies. The adoption of social media analytics in EMAs might be influenced by the characteristics of social media

such as volume, variety, velocity and veracity, also known as the four V’s of Big Data. The organisational context refers to the characteristics of an organisation. Important characteristics influencing the adoption process of organisations are their size, hierarchical structure, organisational culture and the amount of available resources (De Pietro et al., 1990; Tornatzky and Fleischer, 1990). In our research context, the top-down hierarchical structure of EMAs might be an important factor influencing the adoption of social media analytics. The environmental context encompasses the structure of the industry, an organisation’s competitors and its regulatory environment (De Pietro et al., 1990; Tornatzky and Fleischer, 1990). As EMAs are part of a government environment, factors such as legal restrictions related to collecting and analysing data from social media might influence their adoption of social media analytics.

IS researchers have applied the TOE framework to various types of technology adoption processes in organisations, for example the adoption of cloud computing (Lee et al., 2016; Rieger et al., 2013), e-business (Al-Somali et al., 2010), e-marketing (Duan et al., 2010), e-procurement (Hassan et al., 2011), business intelligence and analytics systems (Malladi, 2013) and social media (Cestyakara and Surendro, 2013; Omosigho and Abeysinghe, 2012; Poba-Nzaou et al., 2016). However, only a few studies investigate the adoption of social media in EMAs based on the TOE framework (Heverin and Zach, 2011; Sharif et al., 2013). In summary, several prior studies provide support for the TOE framework and confirm its validity for the adoption of various types of technology. Thus, we consider the TOE framework a suitable choice for the conceptualisation of challenges EMAs face in the adoption of social media analytics.

4 Research Design

We used a combination of two different methods to identify the challenges. We chose first to conduct an SLR (Vom Brocke et al., 2009; Vom Brocke et al., 2015) and, second, expert interviews (Mayring, 2015) with staff members of different EMAs. By combining these methods, we could compare the challenges related to the adoption of social media analytics perceived by emergency agencies and the impeding factors already identified in IS research. Lastly, propositions were derived by merging the key findings of both methods.

4.1 Part 1: systematic literature review

We aggregated previous work on our research topic by conducting an SLR based on a database search and a backward search (Vom Brocke et al., 2009; Vom Brocke et al., 2015). First, we searched five online databases using a combination of keywords and synonyms to ensure a broad search result (Table 1). In the final search term, singular and plural versions of each keyword were included. Furthermore, concepts were connected with an “AND” operator and keywords with an “OR” operator. The following databases were selected because of their broad coverage of IS articles: ACM, AiSeL, IEEE, ScienceDirect and SpringerLink. The database search returned a total of 549 results.

Concept	Search Terms
Crisis	Crisis, Disaster, Catastrophe, Emergency
Social Media	Social Media, Social Network, Social Networking Site, User-Generated Content, Twitter, Facebook, YouTube, Blog, Wiki
Emergency Agencies	Emergency Agencies, Public Safety Organisation, Public Security, Civil Defence

Table 1. Keywords used for database search

Then we inspected each abstract based on previously defined inclusion criteria to determine its relevance to our research question. All articles mentioning either 1) challenges EMAs face or could face with the adoption of social media analytics or 2) problems EMAs have or could have using social media analytics were included. We decided to include not only articles related to adoption but also to actual usage, because the adoption processes of EMAs might also be hindered by anticipated problems

with the use of social media analytics. Only peer-reviewed journal articles and conference papers were considered in this research, to ensure their scientific relevance. All papers assessed as relevant based on their abstracts were thereafter read completely to determine their absolute relevance. Overall, eleven papers were chosen as relevant during the database search. The subsequent backward search resulted in 32 additional findings, for a total of 43 relevant papers (Table 2).

Database	Link	Search Results	Relevant Papers
AiSeL	http://aisel.aisnet.org/	29	1
IEEE	http://ieeexplore.ieee.org/	115	3
ScienceDirect	http://www.sciencedirect.com	229	4
ACM	http://dl.acm.org/	4	1
SpringerLink	http://www.springerlink.com	171	2
Backward Search (on 11 papers)			32
Total			43

Table 2. Database search and backward search results

After the selection process, all text passages mentioning challenges related to the adoption of social media analytics by EMAs were extracted. Following the approach of inductive derivation (Glaser and Strauss, 2009), we identified reoccurring challenges by comparing these passages, and we derived 14 comprehensive categories. To synthesise the findings of our SLR, we compiled a concept matrix, as suggested by Webster and Watson (2002). The technological, organisational and environmental contexts of the TOE framework (De Pietro et al., 1990; Tornatzky and Fleischer, 1990) were used for the conceptualisation of the identified challenges. The resulting context matrix provides insights into challenges related to each context of the TOE framework, which are underrepresented in current research. By comparing these insights with the results of our expert interviews, we were able to propose relevant future research areas regarding the adoption of social media analytics by EMAs as well as recommended actions for EMAs.

4.2 Part 2: expert interviews

We aimed at closing the gap between scientific literature and practical expert knowledge to gain a broad, holistic scope of knowledge. Thus, we complemented the SLR with expert interviews. As crisis managers encounter the challenges elicited by the emergence of social media in their daily work environments, they are a valuable source of knowledge. The combination of these methods also provided the opportunity to examine whether the challenges perceived by the experts were represented conclusively in the literature. To avoid an interdependent process of identifying challenges, the interviews were conducted at the same time as the SLR. In six interview sessions, we interviewed ten staff members from different fire departments, a fire department research facility, a non-profit emergency consulting agency and a federal emergency and crisis prevention agency (Table 3). All included EMAs were responsible for large German cities. Each interviewee had already gained experience in using social media for crisis communication, but only half of the interviewees stated that their agency also attempts to extract information from social media. The interviewees were approached via personal contacts of the research team to some EMAs.

Type of EMA	Job Title	Current Use of Social Media	
		Crisis Communication	Social Media Analytics
State Fire Fighter Institution	1) Head of Emergency Management & Research 2) Emergency Management and Research Assistant	—	—

Fire Department 1	3) Chief Engineer 4) Executive Press Officer	X	—
Fire Department 2	5) Executive Press Officer	X	Facebook Statistics: Target Groups
Non-profit Emergency Consulting Agency	6) Chief Emergency Management and Crisis Prevention Consultant	X	—
Federal Emergency and Crisis Prevention Agency	7) Social Media Manager 8) Correspondent for New Media	X	Twitter Analytics: Manual Hashtag Search
Fire Department 3	9) Executive Press Officer 10) Social Media Team Member	X	Manual Traffic Monitoring on Own Platforms

Table 3. Description of interview partners: EMAs and their current use of social media

We chose to conduct semi-structured interviews, which allow asking follow-up questions, and created an interview guide including several main questions. The interviews were set up as follows. After a short introduction, interviewees explained how they defined a crisis and understood social media within their work environments, to establish a common ground during the interviews. Then more specific questions were asked regarding distinct challenges and potential solutions related to utilising, handling or managing social media data in crisis situations. Overall, the interviews lasted between 45 minutes and 90 minutes. All interviews were transcribed and were then analysed using the inductive category formation approach (Mayring, 2015). We used the software MAXQDA to detect and categorise the challenges related to the adoption of social media analytics as well as possible solutions mentioned by the experts. Guided by the theoretical background, we determined the TOE contexts as main categories and then built sub-categories directly from the interview material. The small size of the research group allowed for discussions which enhanced the reliability of the coding process.

5 Findings

5.1 Part 1: systematic literature review

The SLR revealed that researchers were most concerned with challenges belonging to the technological context of EMAs. In particular, the questionable *veracity of information* because of rumours and deliberately false information has already been extensively covered in IS literature. The quality of user-generated content, images and videos as well as the accuracy of location information were frequently described as not meeting the high standards expected by EMAs from information sources. It was also often stated that EMAs are hesitant to act based on information from social media, because of scepticism towards the quality control which can be provided. Researchers have already identified the large *volume of data* as well as the unpredictability of the amount of data as an impeding factor in the adoption of social media analytics. The *variety of data*, meaning the diversity of data formats which are being produced on social media, is also discussed in some articles. In particular, the integration of user-generated and official data into existing spatial data infrastructures represents a major problem.

A few articles pointed out that the high *velocity of data* relates not only to fast information dissemination but to acceleration of the spread of rumours. The speed of information dissemination becomes an even more severe challenge for EMAs, due to the lack of algorithms to handle the analysis of data in real time. Some articles mentioned that a sufficient *completeness of information* only seldom occurs, as most users do not enrich their photo and video posts with the time and location of the recording. A large proportion of included articles also focused on the solution of various *analytical challenges* hindering EMAs in adopting social media analytics. The authors claimed that there was a

need for appropriate methods to mine, filter, verify and summarise information from social media, and the question of how to handle and integrate redundant information still requires an answer. Specific challenges mentioned in this regard were 1) the impracticality of k-means algorithms to identify emergencies, as the number of emergencies is unknown beforehand (Unankard et al., 2015), 2) the difficulty of developing algorithms for text analysis which are able to deal with informal language and 3) the adaptation of algorithms intended for the English language to analyse social media posts written in other languages (Reuter and Schröter, 2015).

While most articles focused on technological challenges hindering the adoption of social media analytics, a decent number of articles revealed challenges belonging to the organisational context of EMAs. In this regard, many articles mentioned the *lack of resources*, comprising a lack of technical solutions for social media analytics, of financial resources, and of staff members, time, experience, knowledge and training. In a few studies, the *lack of guidelines* emerged as a further impeding factor, due to the importance of standards and policies for the workflow of EMAs. Several articles also emphasised the need for an *organisational culture* change before adoption, as the lack of trust in social media data of EMA staff members negatively influences the intention to use these data during crisis operations. In particular, authors called for a change in the evaluation of citizens — from victims to potentially valuable contributors of information in times of crisis. According to some articles, the top-down, procedure-driven and ordered *hierarchical structure* of EMAs also complicates the usage of new technologies such as social media analytics. In several papers, even a prohibition of social media use by (political) authorities has been reported (Hiltz et al., 2014; Reuter et al., 2016).

Compared with the technological and organisational context, the adoption challenges belonging to the environmental context of EMA have received considerably less attention in IS research. Several articles mentioned a variety of *legal issues* related to the collection and storage of social media data (security and privacy issues) as well as to decision-making based on information from social media (liability issues). Some articles also drew attention to the possibility of the *infrastructure failure* which frequently restrains social media use during natural disasters. According to a few articles, EMAs are hesitant to adopt social media analytics, because some population groups are more likely to use social media than others. Due to this *digital divide*, social media analytics might not provide EMAs with an accurate picture of the situation, as some groups of citizens might be underrepresented. A few articles also pointed out that the low *acceptance of platforms* might hinder the adoption of social media analytics by EMAs. In this regard, the authors mentioned the limited use of Twitter in non-English-speaking countries (Reuter and Schröter, 2015) as well as the uncertainty about whether users accept volunteered geographic information platforms, even when they are introduced for a specific crisis (Zook et al., 2010). Authors also voiced concerns about a certain instability of social media platforms, as the popularity of platforms often changes, and then users move on to other platforms.

Author(s), Year	Technological						Organisational				Environmental			
	Volume of Data	Variety of Data	Velocity of Data	Veracity of Information	Completeness of Information	Analytical Challenges	Lack of Resources	Organisational Culture	Lack of Guidelines	Hierarchical Structure	Infrastructure Failure	Digital Divide	Legal Issues	Platform Acceptance
Akhgar et al. (2013)				X							X		X	
Anikeeva et al. (2015)				X		X	X				X	X	X	
De Faria Cordeiro et al. (2011)	X	X		X		X								
De Longueville et al. (2009)				X	X	X								X

	Technological					Organisational					Environmental			
Erskine et al. (2013)	X	X	X	X		X					X			
Flizikowski et al. (2014)	X			X			X		X					
Fohringer et al. (2015)	X			X										
Fuchs et al. (2013)				X		X								X
Gill and Bunker (2012)	X			X		X	X		X		X		X	
Goodchild (2007)				X			X	X		X				
Goodchild and Glennon (2010)				X			X					X		
Haworth (2016)	X	X	X	X		X	X	X		X	X	X	X	X
Haworth and Bruce (2015)	X	X	X	X	X	X		X				X	X	
Hiltz et al. (2014)	X			X		X	X	X	X	X			X	
Huang et al. (2010)	X		X	X		X	X			X	X	X	X	
Hughes and Palen (2012)				X				X		X				
Kavanaugh et al. (2012)				X			X	X	X			X	X	
Koswatte et al. (2015)				X	X			X						
Latonero and Shklovski (2011)				X		X	X	X		X				
Le Boursicaud et al. (2016)				X	X									
Le Coz et al. (2016)				X	X									
Ludwig et al. (2015a)		X		X		X	X						X	
Ludwig et al. (2015b)				X			X						X	X
MacEachren et al. (2011)					X	X								X
Mirbabaie et al. (2016)				X		X								
Oh et al. (2013)				X										
Ostermann and Spinsanti (2011)	X	X		X		X							X	
Palen and Liu (2007)								X		X				
Plotnick et al. (2015)							X	X				X		
Poser and Dransch (2010)	X			X										
Reuter and Schröter (2015)			X	X		X	X			X			X	
Reuter et al. (2012)					X	X								X
Reuter et al. (2015)				X	X		X							
Reuter et al. (2016)				X			X	X		X			X	
Roche et al. (2013)	X	X	X	X		X								
Schnebele et al. (2014)				X				X						
Shanley et al. (2013)	X			X					X				X	
Spinsanti and Ostermann (2013)				X	X	X		X					X	
Tapia and Moore (2014)	X						X	X	X					
Unankard et al. (2015)			X			X								
Whittaker et al. (2015)	X			X				X		X				
Xu et al. (2016)					X	X								
Zook et al. (2010)				X		X					X			X
Total (43 papers)	15	7	7	36	10	22	17	15	6	10	7	7	15	7

Table 4. Concept matrix of SLR

5.2 Part 2: expert interviews

In line with the SLR, interviewees described volume, velocity, veracity and analytical challenges as hindrances to their adoption of social media analytics, whereas concerns about the variety and completeness of information were only raised in IS research (Table 5). According to the interviewees, the sheer volume and velocity of Facebook and Twitter data constitutes a major challenge. Several interviewees were not aware of computer-assisted social media analytics, and thus the task of analysing all posts manually seemed daunting. In this regard, interviewees also mentioned the lack of effective filtering techniques as an analytical challenge. The interviewees questioned the reliability of

information from social media and emphasised that EMAs need to rely on valid and relevant information. Thus, the low veracity of information was identified as a key challenge for the adoption of social media analytics. In contrast to the scientific literature, which focuses more on rumours, interviewees particularly emphasised pictures and videos as a problem, because these only show a small part of the reality and can be manipulated easily.

Code	Explanation
Volume of Data	<i>When I'm in the field, I have to think quickly and make fast decisions. Handling social media simultaneously would lead to an information overload.</i>
Velocity of Data	<i>During the attack of Nice, there were already pictures and videos online on how this truck went down the street before the first ambulance came there.</i>
Veracity of Information	<i>We are just at the beginning with social media. Most of the information — about 94% — is not reliable. It is a big challenge: How do I get valid information about the situation?</i>
Analytical Challenges	<i>How do I filter all this information? I think this will be possible in the future, but now, we're still in the beginning.</i>

Table 5. Technological challenges

In comparison with IS research focusing mostly on technological challenges, interviewees described the solution of the organisational challenges of EMAs (Table 6) as the most crucial factor in the adoption of social media analytics. In line with the results of the SLR, the need for human and financial resources was mentioned in all interviews; therefore, we identified this as the greatest organisational challenge. Moreover, most interviewed EMA staff members did not use social media in their private lives, so they did not have specific knowledge of social media analytics and their advantages. Employees are first and foremost trained to help people in a crisis situation but not to use social media or to analyse data. This, in turn, causes a lack of awareness, which means that emergency agencies are not aware of the possibility of using social media information during a crisis event; nor do they know about automated processes which simplify the task. According to the interviewees, the employment of younger staff with this knowledge could foster the adoption of social media analytics. However, the interviewees stated that they would require more financial resources to recruit new employees and to purchase tools allowing for computer-assisted social media analytics. The hierarchical structure of EMAs emerged as another impeding factor in the adoption of social media analytics. In this regard, the hierarchy between the communes and fire departments was particularly mentioned, whereas IS literature focuses more on the lack of managerial support. The interviewees also reported a lack of standards for the use of social media for communication and stated that the introduction of guidelines or standards would be an important preceding step for the adoption of social media analytics. In summary, the interviewees were most concerned with a lack of resources, knowledge and guidelines as well as with the hierarchical structure of EMAs, whereas the scientific literature also emphasised the need for a cultural change in EMAs.

Code	Explanation
Lack of resources	<i>In a worst-case scenario. Let's say an act of terror in the arena. We will definitely have a problem in handling that. But they were not even capable of allocating the personnel during the Munich attacks.</i>
Hierarchical Structure	<i>Yeah, we don't have an understanding of the different roles we have to play.</i>
Lack of Guidelines	<i>We don't have a social media standard.</i>
Lack of Knowledge / Awareness	<i>The people who work with SM here are not professionals. We didn't study crisis communication nor SM because we are just firefighters. I think [...] there is a lack of awareness and sometimes also a lack of interest.</i>

Table 6. Organisational challenges

Similar to the findings in IS research, the interviewees were considerably less concerned with their environmental context; nevertheless, two environmental challenges could be identified. First, interviewees questioned the usefulness of social media analytics, as natural disasters often come along with infrastructure failure, preventing citizens from posting information on social media. This challenge is also addressed in IS research, as can be seen in the SLR. Second, interviewees reported that employees in many EMAs face legal consequences for private and also professional social media use during work time. Thus, employees fear to lose their jobs and do not use social media at all. The interviewees also demanded a modernisation of privacy laws which would allow them to extract social media data for crisis management purposes without violating the strict German privacy law. These challenges are also represented in IS literature; however, the included articles frequently mentioned liability issues as another important legal issue. Nor did the interviewees see the problem of unstable social media platforms, a low acceptance of platforms or the digital divide.

Code	Explanation
Legal Issues	<i>Our data protection guidelines are very strict. So, everything that is outsourced or installed on some servers in America is a red flag.</i>
Infrastructure Failure	<i>When we have major events. For example, a BVB soccer game or a cup trophy celebration, the people who attend these public events often don't have cell phone reception anymore. So, Facebook or NINA don't do us any good, because the people don't get the information.</i>

Table 7. Environmental challenges

Besides the TOE challenges, we identified the code solution approach, which contains information on possible solutions the experts imagined during the interviews (Table 8). They were clearly convinced that more and younger staff would help them overcome the mentioned challenges. The experts also described the requirements for a future social media analytics tool. High usability is particularly important to them, as they need it in stressful and chaotic situations, while none of them was educated in the field of social media analytics. They also wish to have a tool which gives them an objective overview during a crisis. This means that they want to have a dashboard, including a map, with the aim of planning and spreading first responders efficiently. The interviewees also wish for a translation feature to extract data in different languages.

Code	Explanation
Solution Approach	<i>We need a generation change to see the added value. That this is not about extra effort, but the result is a benefit. [...] the best software is not useful if someone needs a manual to operate it. The software itself needs to be crisis-proof.</i>

Table 8. Solution approach

6 Discussion

After identifying the challenges of EMAs related to the adoption of social media analytics, we proceed to our discussion and the implications of our findings. To guide future research and to provide more insight into our findings, we derived propositions by merging the key findings of the SLR and the interviews. First, we created a table for each TOE challenge, including both the relevant text passages identified during the SLR and the relevant text passages coded during the analysis of the interviews. Then we focused on the challenges which were frequently mentioned in IS research as well as in the interviews. Lastly, we summarised the key insights from theory and practice by formulating a single proposition related to each challenge. Below we present our propositions, supported by references to articles from the SLR and interview quotes.

6.1 Propositions derived from technological challenges

Extracting information from social media should make sense and be beneficial for crisis management. If extracting information is perceived as an inhibiting factor and does not obviously come up with helpful information, *“acceptance on the side of crisis managers of social media analytics will be low [...] As long as the point of truthfulness is not discussed, it will be ok”*. Thus, the information should be credible (Haworth, 2016). EMAs also need to deal with a *“huge amount of information”*, which must be mined, filtered, verified and summarised (Spinsanti and Ostermann, 2013). This leads to the need to visualise information: *“Evaluate, represent [...] So that one can then directly hand it over to the crisis unit”*. Thus, we propose: **Technical solutions should support crisis managers in the sense-making and information validation process for a high acceptance of social media analytics.**

Due to information overload, a filtering algorithm might be needed (Ludwig et al., 2015a). Ostermann and Spinsanti (2011) conclude that algorithms to filter data should be customisable to fit the different information needs of individual users. Up to now, the filtering algorithms of social media analytics tools often do not allow for customisation, so it depends on crisis managers to get the information they need (Ludwig et al., 2015a). In one of our interviews, it was mentioned that information should be *“filterable to show information which is relevant to us [...] and we get it as fast as possible. So, you could adjust certain parameters [...] that would be great.”* This could also include different information for the various EMAs which operate during a crisis. The police will probably need different information than fire departments. Thus, EMAs might require dynamic algorithms which support them in dealing with the high amount of information (Ludwig et al., 2015a) and in *“summarising the findings”*. Hence, we suggest: **A customisation of filtering algorithms for the needs of EMAs might be needed for them to respond to their specific crisis situations.**

We stated that social media analytics tools should have a visualisation function and that filter algorithms should be customisable. This might enable EMAs to deal with the amount of data and overcome information overload, but additional functions also raise the complexity of performing social media analytics (Ludwig et al., 2015a). However, during a crisis, EMAs do not have *“[...] much time. We have a time slot of 40 to 50 seconds to report to our chief, what are the facts, deliver a memo and assess the given information”*. As a result, social media analytics should *“be kept short, user-friendly, visually simple. Because I will not do it every day”*. Thus, a single teaching should enable crisis managers to perform social media analytics: *“I have a few hours of instruction, and then you must be able to use it”*. We conclude as follows: **Social media analytics tools should have good usability, in particular during stressful crisis situations.**

“What is important, but that is also a very special issue, how is the technical infrastructure or security infrastructure built up in authorities.” This citation indicates that data storage is a crucial issue within EMAs. They often have security-relevant data which is stored *“in our own server [...] We have 25 people who are only working on IT and radio”*. In order to analyse social media content, data of different origins and types would need to be stored and combined in EMAs' databases (Shanley et al., 2013; Poser and Dransch, 2010). The literature suggests the implementation of user-generated data into a spatial data infrastructure, an SDI. This is often used by governments and might be useful for social media analytics, as it is standards-centric (Koswatte et al., 2015). The integration of authoritative and non-authoritative data could lead to a more profound knowledge of a crisis situation and thus could serve as an opportunity to enhance crisis management (Schnebele et al., 2014; Haworth and Bruce, 2015). We propose the following: **Technical solutions to integrate user-generated data into official SDIs might be needed.**

6.2 Propositions derived from organisational challenges

Citizens post information about a crisis on social media, and EMAs could use this information. Why are they hesitating? Most of our interviewees did not use social media analytics. Those who did differentiated between two types of data: *“[...] qualified feedback, this is the messages from our*

forces, and there are not qualified reports, which are the ones from the internet. Then, we have to look at how qualified the statement is." The literature suggests that the role of citizens as contributors might disrupt the strict hierarchy of EMAs. Whereas EMAs follow top-down communication, using social media analytics would mean bottom-up communication (Whittaker et al., 2015; Haworth, 2016). Therefore, EMAs might have to initiate a cultural change within their organisations, including the loosening of command-and-control structures and starting to value information provided by citizens (Haworth, 2016). A cultural change includes the idea "that the openness for social media is encouraged internally. This creates awareness for it. For social media and that it can be valuable to evaluate." We suggest the following: **EMAs need to understand the value of citizens serving as information sources during crisis situations.**

All experts agreed that the challenge of resources, meaning financial or human resources, is the biggest challenge: "The staff resource is simply the biggest problem"; "Then I also need financial resources to work up extracting information". This was often dependent on the fact that crisis managers thought they would have to extract information manually: "I would simply need manpower to perform additional manual social media analytics". The experts as well as the literature even went one step further and said that qualified staff is needed to perform this important task (Plotnick et al., 2015): "I have not studied any crisis communication. I have not studied social media. We are actually firefighters." As a solution, the literature suggests that a designated role should be defined within the EMA to perform social media analytics. This role should be filled by a person who has specialised knowledge (Hughes and Palen, 2012; Hiltz et al., 2014). However, our experts said it was important to get information analysed and verified by someone who was professionally trained and who had the respective work-related know-how of an emergency agent. The experts did not want to outsource the monitoring of their data to data scientists working at universities or in the private sector, as those have the technological knowledge but most likely lack the practical know-how. As a result, no one would understand a crisis from the perspective of EMA staff unless he or she received proper training: "But you will not set up a dedicated position for this. Rather, everyone works with special functions." People who have not followed the actual education required to become a firefighter are not wanted for this specific position, "because they don't know what we really need; they don't understand our perspective on a crisis situation". EMAs thus should understand the value of a person who is able to analyse data and extract relevant information. We propose the following: **A new role within EMAs should be defined in order to perform social media analytics on a daily basis.**

6.3 Propositions derived from environmental challenges

All interviewees mentioned that firm governmental support is needed before being able to perform social media analytics: "One would have to ask the government and elaborate questions about money or the conviction necessary for an interface, which would then take place before somebody gives a decree." In this statement, it also becomes clear that EMAs might need an order or a decree from their respective governmental authorities to obtain the necessary financial resources and adopt social media analytics. The literature also suggests that politics will play an important role in the adoption of social media analytics (Reuter et al., 2016) and also that change in EMAs is slow, and governmental support might be needed (Latonero and Shklovski, 2010). In accordance with these issues, we conclude: **Governmental support might foster the adoption of social media analytics in EMAs.**

Along with governmental support, another environmental drawback influences the adoption of social media analytics, namely law. Especially in our interviews, data privacy was an often-discussed issue: "What is aggravating in the administrations are repressions in the field of IT security. One often already fails at the terms and conditions of Facebook and Co. and the administrations say [...] we do not submit to a foreign right, especially as regards the use, storage, sharing of data." Citizens need to be aware of the fact that their posts on social media might be monitored, even if they post on the social network sites of public authorities (Shanley et al., 2013). Until now, social media have been relatively open and have allowed data to be transferred to third parties. A way to close the gap between citizens' right to data privacy and emergency agencies' need to perform social media analytics in order to help

others might be needed (Akhgar et al., 2013). We derive the following proposition: **Social media analytics should fit the privacy laws of countries EMAs operate in.**

Imagine that the decision is made to adopt social media analytics, and specific roles and their scopes are defined and financial resources are provided as well. The EMAs are using a social media analytics tool which helps them to aggregate and analyse social media data. A crisis occurs — and wrong decisions are made based on the analysis of unreliable social media content. Wrong data might also be spread intentionally by people who aim to manipulate the actions of the emergency agency (Shanley et al., 2013): *“I cannot tell my boss the tool has performed wrong. He will tell me, no you did wrong. And if he has made any organisational or strategic decisions, then I have a problem.”* As soon as the new process is going to be used, liabilities thus should be made clear. This challenge has also been identified in the literature (Haworth, 2016). As a result, every party, including citizens, EMAs and the providers of social media analytics tools, should be aware of “the legal and ethical issues that may be triggered by their activities, including issues of intellectual property, liability for faulty information, and defamation” (Haworth and Bruce, 2015). Laws and policy frameworks should also be adapted to the new processes (Shanley et al., 2013). Our last proposition is the following: **EMAs’ liabilities in using social media data should be defined and communicated.**

7 Conclusion

In our research, we analysed current challenges EMAs face in adopting social media analytics for crisis management. The challenges were identified by conducting an SLR and six expert interviews with ten emergency management professionals. Thereafter, we utilised the TOE framework to synthesise our findings from both methods. By merging the literature findings with the opinions of the experts, we contribute valuable propositions which could serve as starting points for future research or improvements initiated by emergency agency professionals. Our research revealed that EMAs currently do not benefit from the wealth of information available on social media, as TOE challenges severely hinder these agencies’ adoption of social media analytics. Our propositions will also help IS researchers to realise the considerable potential they have to contribute to the practical implementation of social media analytics tools into EMAs’ work environments. Also, given the wide scope of the research field with respect to the impact of social media on emergency management, we could not assume that our database search was exhaustive. Therefore, we also conducted a backward search to ensure that all relevant research papers were included in our database search.

According to the triangulation approach (Jick, 1979), a combination of different methods to examine a research area ensures more valid and comprehensive results. Therefore, we chose expert interviews as an additional method, which indeed provided more comprehensive findings regarding our research question. The expert interviews confirmed our SLR findings but also revealed some gaps between research and practice. However, since we only interviewed a small number of emergency agency professionals, mostly from German fire departments, our results may not be representative of different kinds of EMAs in other countries, even though we assess this as a minor limitation, because the results were similar to those from our SLR, where papers about different kinds of EMA in various countries were considered. Future research could determine whether our identified challenges are also mentioned by other types of EMA, such as the police, and whether our results can be applied to EMAs in other countries. It is also worth considering whether certain challenges, such as a low veracity of information, might be more relevant in prolonged crises than in shorter crises. Our results can also serve as a profound basis for large-scale quantitative studies. Future researchers could use our propositions as starting points to contribute solutions to our identified challenges. For example, IS researchers could develop a social media analytics tool for crisis management which provides customisable filter functions while maintaining a high degree of usability even in stressful situations.

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