Building Social Resilience and Inclusion in Disasters: A Survey of Vulnerable Persons' Social Media Use

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Abstract

Social media (SM) is increasingly used to reach out to populations for preparedness and response to disasters. Given the disproportionate impacts of disasters on vulnerable populations (e.g., older persons, persons socially/geographically isolated, persons living with disabilities, persons of low socio-economic means) in this study we focus specifically on the attitudes, needs and future plans of vulnerable persons towards accessing and sharing information via SM during extreme weather events. Advancing understanding in this area is important as there is growing evidence that people who may be described as more vulnerable may have different communication needs and less access to disaster related information and technologies. We present the results of a survey of 215 vulnerable persons in Victoria, Australia. Rather than consider vulnerable persons as a homogenous group, we examine how persons with different vulnerabilities perceive SM for accessing and sharing information in the context of disasters and report findings which challenge prevalent assumptions about vulnerable persons and SM. Overall we find that vulnerable persons are not passive recipients of support during disasters but have self-awareness, a strong desire to receive information and the capacity to usefully contribute to the provision of reliable information via SM. With a view to improving outcomes for vulnerable persons in disasters we offer an agenda for future research.

Keywords: Social media, vulnerable persons, disaster management, communication, community resilience.

1 Introduction

Over the last 15 years social media (SM) has grown to become a significant part of many peoples' lives and has had a profound impact on the way in which society functions and communicates. SM incorporates social networking, forums, blogs and micro-blogs, social book-marking, collaborative document creation and the sharing of audio, photographic and video files (Alexander, 2014). SM represents a significant technological innovation and has transformed digital information sharing and networking (Panagiotopoulos, Barnett, Bigdeli, & Sams, 2016). Organisations are increasingly relying on SM channels to inform, influence, and interact with the community. This is certainly the case when disaster events occur (Gill, Alam, & Eustace, 2015). Across the globe there are numerous examples where SM platforms have been reported to help keep people informed and safe before, during and after wildfires/bushfires (Abedin & Babar, 2018), floods (Al-Saggaf & Simmons, 2015), hurricanes (Kryvasheyeu et al., 2016), snowstorms (Panagiotopoulos et al., 2016) and tsunamis and

earthquakes (Peary, Shaw, & Takeuchi, 2012). Yet while emergency response organisations (EROs) and other actors increasingly understand the value of SM in disasters, and there is a growing body of literature in this area (e.g., Al-Saggaf & Simmons, 2015; Elbanna, Bunker, Levine, & Sleigh, 2019; Panagiotopoulos et al., 2016), to date there has been limited research undertaken to understand how SM is being used to connect to parts of the community which may be considered more vulnerable. Advancing research in this area is important as there is growing evidence that people who may be described as more vulnerable may have different communication needs and less access to disaster related information and technologies (Howard, Agllias, Bevis, & Blakemore, 2017) and suffer disproportionately during and post large-scale disasters (IFRC, 2005, 2013).

The term vulnerability originates from the Latin word 'vulnerare' meaning "to wound" and generally indicates the degree of exposure to the possibility of disruption or harm. In investigating the complex concept of vulnerability, researchers have developed a plethora of models, metrics and tools to depict, measure and assess vulnerability (e.g., Cutter, 1996; Luna, 2014; Zebardast, 2013). Yet vulnerability remains an "elusive and slippery concept" (Luna, 2018) which is defined and used differently across disciplines (Alwang, Siegel, & Jorgensen, 2001). While acknowledging the complexity and range of approaches to defining and categorizing vulnerable persons (e.g. Eakin & Luers, 2006; Wisner, 2004), and the difficulty in defining vulnerability in multi-disciplinary contexts such as disasters (Enang et al., 2019), the United Nations International Strategy for Disaster Reduction defines vulnerability as, "The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards" (UNISDR, 2016, p. 41).

We focus on older persons (aged 60+), those who are geographically and/or socially isolated (GSI) (e.g., live in a remote community and/or live alone in an urban area), people who suffer from physical limitations (PL) in terms of physical functioning, mobility, dexterity and those of low socio-economic (LSE) means. This is because these people are frequently identified as amongst the most vulnerable people in the disaster literature. The elderly were over-represented in those people who were impacted by the 2005 Hurricane Katrina in the USA (Gibson & Hayunga, 2006), 2011 earthquake and tsunami in Japan (Nakahara & Ichikawa, 2013) and, based on figures to date, during the current global coronavirus pandemic (COVID-19) (Onder, Rezza, & Brusaferro, 2020). Examples where isolation has increased the impact of disasters include Chicago's 1995 heatwave where a disproportionate number of deaths occurred among people living alone (Smoyer Tomic, 2003). In Australia, it has been identified that residing in a rural area substantially increases the risk of natural disasters and living with the ongoing threat of natural disasters can have adverse psychosocial, mental health and community impacts (Morrissey & Reser, 2007). People living with disabilities were more than twice as likely to have been injured during Tropical Cyclone Pam in Vanuatu (Bakera et al., 2017) and using data from Japan, persons living with disabilities are predicted to be four times more likely to die when a disaster strikes (OHCHR, 2015). One's socio-economic status can influence disaster awareness levels (Teo, Goonetilleke, Ahankoob, Deilami, & Lawie, 2018), ability to absorb losses and resilience towards hazards and impacts through lack of access to insurance, social safety nets and entitlement programs (Cutter, Boruff, & Shirley, 2003). Disasters such as Hurricane Katrina in 2005 (Masozera, Bailey, & Kerchner, 2007) and global pandemics such as COVID-19 (Buheji et al., 2020) illustrate how people of LSE means can be more vulnerable to disasters.

To ensure SM use better supports vulnerable people during disasters, an important first step is to identify vulnerable persons' attitudes, needs and future plans to use SM to access and share information in these critical contexts. Several surveys on the use of SM in the disaster context have been undertaken (e.g., American Red Cross, 2012; Canadian Red Cross, 2012; Reuter, Kaufhold, Schmid, Spielhofer, & Hahne, 2019; Reuter & Spielhofer, 2017) but the extent these studies are generalisable to more vulnerable populations is unclear. Our study addresses the following research question:

"What are the attitudes, needs and future plans of vulnerable persons towards accessing and sharing information via SM during extreme weather events?"

To answer this question, we report the results of an online survey administered to vulnerable persons in the Australian state of Victoria that explores their attitudes, needs and future plans to use SM to access and share information during extreme weather events. For the empirical component of our study, we focus on "extreme weather events" as this terminology was predicted to be more relevant to survey respondents than "emergencies" by interview and focus group participants (see Section 3.1). Extreme weather events are generally described by a range of attributes including the rate of occurrence (rarity), magnitude (intensity), temporal duration and timing, spatial structure and multivariate dependencies (Stephenson, Diaz, & Murnane, 2008). In our study we are interested in extreme weather events that are consistent with the local hazard profile of Victoria, Australia — namely, floods, storms, fire and heatwaves.

The remainder of the paper is structured as follows. In Section 2 we review related research and in Section 3 we describe our research method. We report our findings in Section 4. In Section 5 we discuss the findings against extant literature. In Section 6 we present our contributions to research and practice, offer an agenda for future research and acknowledge the limitations of the study. In Section 7 we conclude our paper.

2 Related work

In this section we examine the literature on the use of SM in disasters (Section 2.1). The scant literature on SM use by vulnerable persons in disasters is also considered (Section 2.2).

2.1 SM use in disasters

SM is a relatively new phenomenon and consequently, there is limited research on SM use in disasters predating 2007 (Alexander, 2014). Nonetheless the use of SM in disasters is increasing and researchers have shown a growing interest in the area. In this section we focus on five key themes addressed in the literature.

2.1.1 How SM is used in disasters

A body of research has focused on how SM is used in disasters (Alexander, 2014; Kim & Hastak, 2018). Based on a review of prior research and two case studies (a volcano eruption in Iceland and a mass panic at a music festival in Germany) four categories of SM use in crisis situations are outlined by Reuter, Marx, and Pipek (2012): *From organisations to the public* addresses the integration of SM into classical crisis communication activities such as EROs' use of Facebook to provide broadcast messages to members of the public. *From the public to the public* addresses the domain of self-help communities whereby SM can provide a platform for community groups that allow members of the public to ask questions, express their needs and fears, and offer assistance and support to others. *From the public to organisations* captures the

integration of citizen generated content and the various ways in which this can be analysed and used by organisations. *From organisations to organisations* addresses inter-organisational crisis management activities whereby SM can support a range of organisational actors in disasters to share information, communicate and network to improve inter-organisational awareness and informal processes.

2.1.2 Community initiated SM groups in disasters

Literature has focused on community initiated groups and how SM group administrators disseminate information, the questions asked by group members and community dynamics and influences (Bird, Ling, & Haynes, 2012; Kulemeka, 2014). For example, Bird et al. (2012) studied the emergence of community Facebook groups during the 2010/2011 Queensland and Victorian floods. They identified through an online survey that group administrators sourced information from formal organisations (e.g., EROs, local governments, Bureau of Meteorology, news media) and published information from citizens in near-real time. Group members posted information and questions, requested and received help and advice, while travellers posted and received information on road closures and flooding. Kulemeka (2014) undertook a content analysis of a community Facebook group comprised of people affected by the 2014 fire at the Hazelwood Coal Mine in Victoria, Australia and compared this to an Internet forum on Tianya following the 2008 earthquake in China (Qu, Wu, & Wang, 2009). Despite differences in culture, location and disaster events, members of both communities used SM to share or seek information, support each other, express emotion, try to make sense of events and organise action. Differences were evident in the types of threads occurring, when threads were created and preferences users showed toward threads (Kulemeka, 2014).

2.1.3 Organisational integration of SM in disasters

From an organisational perspective, research has investigated the way organisations have integrated SM into their internal operations. For instance, the Red Cross created the Ready2Help platform that matched individuals needing help with people who could offer it (Schmidt, Wolbers, Ferguson, & Boersma, 2017). Further examples include crowdsourcing and mapping platforms (e.g., QuakeMap used in the 2015 Nepalese earthquake) that guide relief efforts (Wolbers, Boersma, Ferguson, Mulder, & Groenewegen, 2016). The complexity of the organisational landscape in disasters has been examined in light of the emergence of digital networks. This research suggests the convergence of the organisational boundaries and activities, as well as the convergence of physical and online spaces (Hughes & Tapia, 2015; Schmidt et al., 2017). The need to carefully consider how SM is integrated with organisations' traditional communication strategies and technologies has been highlighted (Appleby-Arnold, Brockdorff, Fallou, & Bossu, 2019; Elbanna et al., 2019). As the interactions and relationships between organisations, individuals and technology move away from the bureaucratic, top-down logic, they become more complex and may result in behaviour that is difficult to predict (Luna & Pennock, 2018). For example, EROs often need to contend with "flash volunteers" and "disaster tourists" and the tensions these phenomena cause to their traditional prevention, preparedness, response and recovery (PPRR) protocols (Elbanna et al., 2019). Others have investigated the attitudes of emergency services personnel towards SM and their perceptions of organisations' current and future SM use (Reuter, Kaufhold, Spahr, Spielhofer, & Hahne, 2020). Recognising the complexities that SM can bring, guidelines have been developed to prevent chaotic use of SM in disasters (Kaufhold, Gizikis, Reuter, Habdank, & Grinko, 2019).

2.1.4 Information-related issues for SM in disasters

Information-related issues are critical in SM and disasters as the provision of transparent information can facilitate community resilience (Cohen, Goldberg, Lahad, & Aharonson-Daniel, 2017; Cooper, Fairbrother, Elliott, Walker, & Ch'ng, 2020). There has been a push towards the use of SM in disasters to transmit fast and clear information and to collect information from at-risk populations. For example, following the Japan Tsunami, platforms such as Twitter, Mixi, Facebook and Google's Person Finder served as a point where requests for assistance could be made, enabled the dissemination of information such as the location of local evacuation centres and provided a way for survivors to locate friends and family and let people know that were safe (Appleby, 2013). Nonetheless, disasters are characterised by several types of information challenges that SM does not necessarily resolve. For instance, there can be challenges surrounding the choice of the most appropriate channels for distributing and sharing information, the volume of information and the selection of the format and content of information (Gill et al., 2015; Hagar, 2013; Pang, Karanasios, & Anwar, 2020; Schmidt & Galea, 2013). There are challenges surrounding perceptions of the reliability and veracity of information on SM whereby agencies and citizens are afraid that social networks will produce inaccurate information of dubious provenance (Elbanna et al., 2019; Goolsby, 2010; Palen, Vieweg, & Anderson, 2011). Other research, however, suggests that harmful and inaccurate rumours are not particularly enhanced by SM because with mass participation, false rumours are easily corrected by knowledgeable people (Bird et al., 2012; Hjorth & Kim, 2011). The predominant use of SM by organisations is to broadcast generic information rather than provide targeted information (Karanasios, Cooper, Hayes, & Adrot, 2019). The lack of two-way communication has been problematic as those at risk in a disaster may lack specific advice about what actions their household should take to protect themselves and their property (Poblet-Balcell, Cooper, & Karanasios, 2018).

2.1.5 Sentiment and network analysis via SM in disasters

Research in SM has focused on sentiment and network analysis. SM provides people with a unique platform to express their thoughts and feelings publicly during times of disasters (Qiu, Xu, Wang, & Gu, 2020). Using data on Twitter referring to the Kashmir floods, Kaur and Kumar (2015) develop a model to assist authorities strategize during disaster based on public sentiments. Kim and Hastak (2018) leveraged data from Facebook in the city of Baton Rouge after the 2016 Louisiana flood to analyse the emergent networks after the flood. The researchers were able to explore connections and patterns based on aggregated interactions on Facebook, highlight the social roles and key players in the network and analyse the content of posts (Kim & Hastak, 2018). With the volume of data being generated on tools such as Facebook and Twitter it is likely that automated approaches to analyse data will grow.

2.2 SM use by vulnerable persons in disasters

Post-disaster reports across the globe have highlighted the disproportionate impact and number of fatalities amongst groups defined as 'vulnerable' (Deacon, 2018; Nakahara & Ichikawa, 2013). Typically, academic research that addresses disaster and SM treats individuals and communities as homogenous and there is relatively little research that has examined the use of SM by vulnerable persons in disasters specifically. In this section we highlight some of the exceptions in the literature.

The use of SM by people with disabilities during disasters and public emergencies was examined by Morris, Mueller, and Jones (2014). The US-based study involved a survey of

people with hearing, vision, cognitive, mobility, dexterity, and speech limitations and found that these people are at greater risk during emergencies because they may not receive or understand emergency alert information or may not be able to take the required actions (Morris et al., 2014). The study highlights that the use of SM for accessing and sharing information during emergencies is relatively low among the respondents and that differences in SM usage across people with different disability types are minimal, the exception being people who are deaf or who have speech limitations who use SM more than people with other disabilities. It is inferred from the findings that disaster communication strategies should be tailored to consider the diverse needs of people living with a variety of disabilities. Other studies point to the lack of tailored information on SM for vulnerable persons in disasters. In an analysis of information posted to Twitter and Facebook about extreme weather events in Victoria, Australia, Poblet-Balcell et al. (2018) identified there were few examples where the posts targeted vulnerable groups such as older persons, those socially/geographically isolated, people with disabilities and refugee/recent migrant communities— instead, SM was used to raise awareness of the need to check-in with others.

Some studies that have focused on information behaviours of vulnerable persons during disasters, and while SM was not the primary focus, have offered some insight into vulnerable persons' SM usage. Through a survey of residents of a local council area in Southeast Queensland that had experienced multiple natural hazards (predominately floods and bushfires) in recent years, Teo et al. (2018) studied the disaster information seeking needs and preferences of people from LSE backgrounds and how this affected their level of disaster awareness. The study revealed that television (60%) was the most trusted information source for both people from LSE and non-LSE backgrounds whereas SM did not feature highly for respondents from either background—with Facebook, Twitter and other SM considered a trusted source for disaster information by 18%, 2% and 8% of respondents respectively. This suggests that people from both LSE and non-LSE backgrounds still prefer traditional media to acquire disaster related news. Howard et al. (2017) report a series of focus groups undertaken in regional Australia on the communication channels used by vulnerable people to prepare for and respond to natural disasters. In focusing on older people, people with disabilities, culturally and linguistically diverse populations, families with young children and people from low-income households they identify that use of specific communication methods was attributable to membership of specific population groups. In terms of preferences for SM, it was found families with young children relied more on mobile phone apps, SM and websites for information on natural disasters whereas older people listen to the radio or expect phone calls on their landline (Howard et al., 2017).

Other studies examine the use of SM in disasters and during the analysis, by considering the demographic details of participants, offer insight into how people who might potentially be considered vulnerable, use SM. For example, Feldman et al. (2016) analyse a survey of residents in Newport Beach California to identify the ways in which people prefer to receive information about flood risks. By considering a range of socio-economic characteristics they identify that older persons prefer to use traditional media (TV, radio, newspaper, printed material, websites) when compared to SM sources (e.g., Facebook and Twitter) and expressed little desire to use SM in the future. Studies such as this which reveal the communication preferences of different groups are important as the effectiveness of risk communication has been found to be linked to factors that affect an individual's capacity to access relevant information.

We now outline the methods we adopted to answer our research question.

3 Methods

We first focus on the survey design (Section 3.1) and describe the characteristics of participants (Section 3.2). This is followed by a description of the analysis process (Section 3.3).

3.1 Survey Design

The aim of the survey was to identify the attitudes, needs and future plans of vulnerable persons to use SM to access and share information in the context of extreme weather events. The design of the survey was informed by extant research on SM use by vulnerable persons in disasters (Section 2) and a series of semi-structured interviews and two focus groups, undertaken as part of a wider study, with persons aged 60+, living with PL, of LSE means as well as GSI persons. In total 47 perspectives of vulnerable persons from rural and metropolitan areas of Victoria, Australia were included in the individual interviews and focus groups. Participants were asked about how they obtained information during disasters, the digital tools they used (including SM), the types of information sought and shared, and their attitudes towards various information providers and communication channels. The main themes identified from these interviews and focus groups related to: ICT and non-ICT information sources; digital technology and SM use patterns (in general and in relation to disasters); awareness of emergency services' use of SM; trust and attitudes towards SM; and the important role of informal community networks and relationships. Additional details pertaining to the interviews and focus groups, including participant recruitment, the interview protocol, data analysis procedures and findings can be found in Karanasios, Cooper, Adrot & Mercieca (2020).

The findings of the interviews and focus groups confirmed the existing instrument developed by Reuter and Spielhofer (2017) as relevant for our study. We adapted the instrument to include additional questions relating to: qualifying and demographic information; the various technology devices used by vulnerable persons; how much time vulnerable people spend using SM (typically and during extreme weather events); information needs; and perceptions on the helpfulness of information on SM provided by different types of organisations. As noted, the importance of informal networks and relationships as a source of information and support emerged as a key theme from the interviews and focus groups. Consequently, we included a set of questions to identify whether and how vulnerable persons use information from SM provided to them indirectly (e.g., via friends and family). Adding these questions increased the length of our survey, so several questions from the original instrument deemed less relevant to our research question were removed to minimise participant fatigue (i.e., questions on the downloading of smartphone apps and questions relating to working or volunteering in emergency services). We also changed the wording of the questions. For example, we revised questions to focus on "extreme weather events" rather than "emergencies". The resulting instrument employed quantitative and qualitative methods to generate descriptive statistical results and elicit reasons for participants' answers. The instrument is provided in Appendix One.

The survey was administered by Qualtrics[1] who sent a link to the online survey to people residing in Victoria who report to have used SM to search or share information during an

[1] www.qualtrics.com last accessed 12th July 2021.

extreme weather event, and who also identify as belonging to different vulnerable groups (i.e., aged 60+, GSI, living with PL and/or of LSE means).

3.2 Characteristics of survey participants

We collected 215 survey responses. The majority of participants (77.7%) reported to belong to one vulnerability group, with 15.8% reporting to belong to two vulnerable groups, 4.7% reporting to belong to three vulnerable groups and 1.9% belonging to four vulnerable groups. Respondents were from different national backgrounds, namely, Australian (75.4%), Asian (9.3%), European (8.4%), American (2.3%) and African (0.9%), however, most were from an English-speaking background (75.0%). Respondents included women (54.0%), men (45.6%) and other (0.5%) across diverse age groups but with around half (52.6%) of the respondents being 22-39 years old (Figure 1).

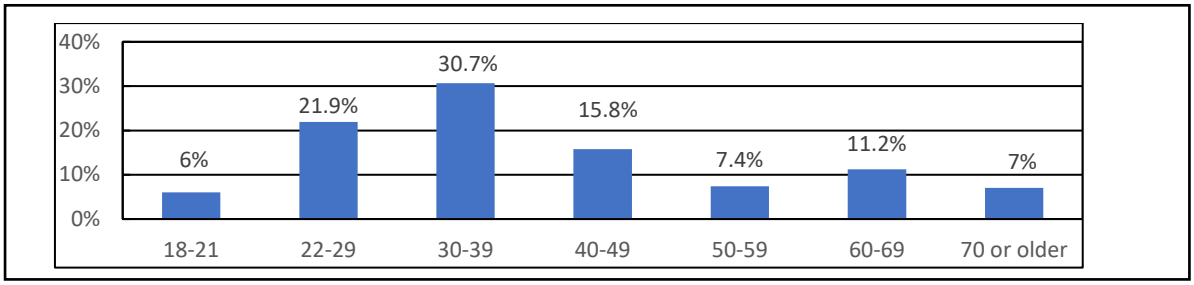


Figure 1. Age profile of participants

The highest level of formal education completed by most participants was High School (33.5%) or a Bachelor's Degree (27.4%). Respondents live in a variety of household types with the most common type comprising families with children (40.5%) and 33.5% of respondents having children under the age of 18. The employment status of participants included full-time (31.6%), part-time (15.9%), casual (7.4%), homemaker (7.4%), retired (10.2%), pensioner (5.2%), self-employed (5.1%) and unemployed (14%).

3.3 Survey analysis

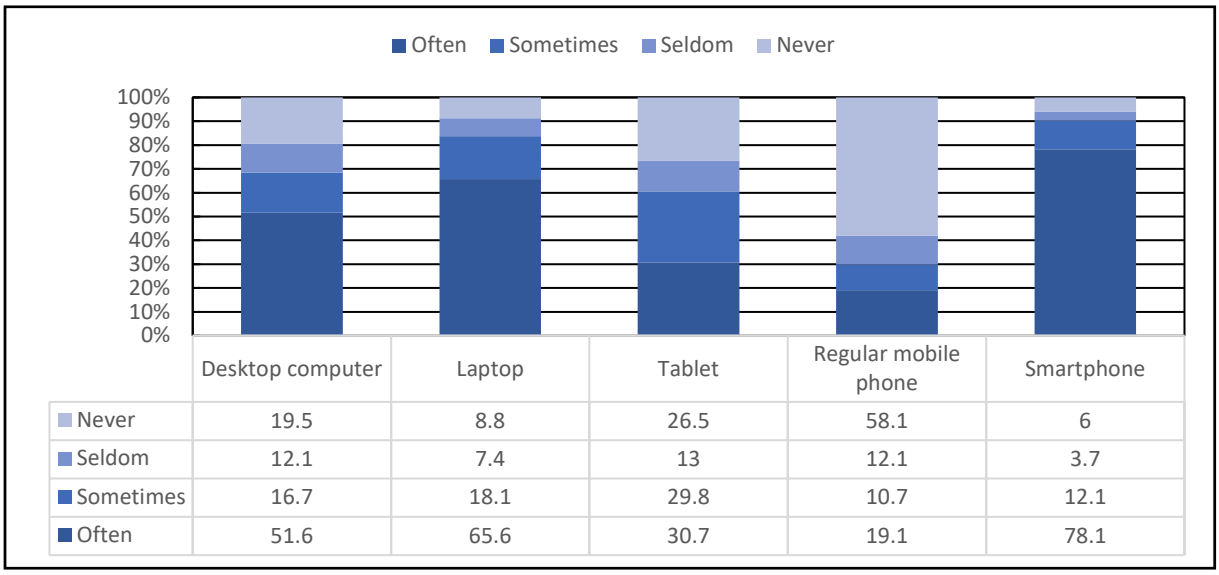
The survey was analysed using quantitative and qualitative techniques. For the initial quantitative analysis, the survey data was extracted and initially analysed using Excel. Basic frequencies for each question and cross-tabulations were undertaken to identify any significant differences across types of respondents. The response format for the quantitative items in the survey generally comprised a four or five-point Likert scale such as: never, seldom, sometimes, and often; or strongly disagree, disagree, neither agree/disagree, agree, and strongly agree. This type of data is ordinal and thus nonparametric methods are better suited (Kraska-Miller, 2013). To identify any differences based on vulnerability type (i.e., 60+, LSE, PL, GSI), we used SPSS 25 to complete a series of Kruskal-Wallis H one-way analysis of variance (ANOVA) tests (Chan & Walmsley, 1997). The Kruskal–Wallis test identifies if there are differences among three or more groups but does not identify which groups are different. To ascertain this, we used a series of post hoc paired Mann-Whitney U tests (also known as the Wilcoxon rank sum test), to determine which groups were different from others (Mann & Whitney, 1947; Wilcoxon, 1945). For this analysis we included the 167 responses where respondents reported only one vulnerability type to ensure the condition of independence was met. Summary tables for the quantitative results are in Appendix Two.

For the qualitative analysis, responses to open-ended questions were analysed in Excel based on an inductive approach. Two researchers analysed the responses to the open-ended questions and assigned participant statements to open code categories (Thomas, 2006). Through this process we obtained an overview of the relevant themes before focusing on the themes which help address our research question. As participant responses to the open-ended questions were typically brief, in the analysis presented here we summarise the high-level themes which emerged from each open-ended question and supplement this with participant quotes.

4 Empirical results

4.1 Current use of technology and views towards SM

Respondents were asked about their use of technology devices (Figure 2). The results show that smartphones are the most frequently used device with 78.1% of respondents reporting they used smartphones often. Respondents also reported that they often used laptops (65.6%) and desktop computers (51.6%). Tablets were used often by 30.7% of respondents, with 29.8% reporting they used tablets sometimes. Regular (non-Internet enabled) mobile phones were not used by 58.1% of respondents. Other technologies used included gaming consoles (5) and smart TVs (8). Of the five types of technology, only smartphones were used significantly differently by respondents with differing vulnerabilities ($\chi 2$ (3, n = 167) = 11.002, $p < .012$). Specifically, those aged 60+ were significantly less likely to use smartphones than LSE or GSI respondents.

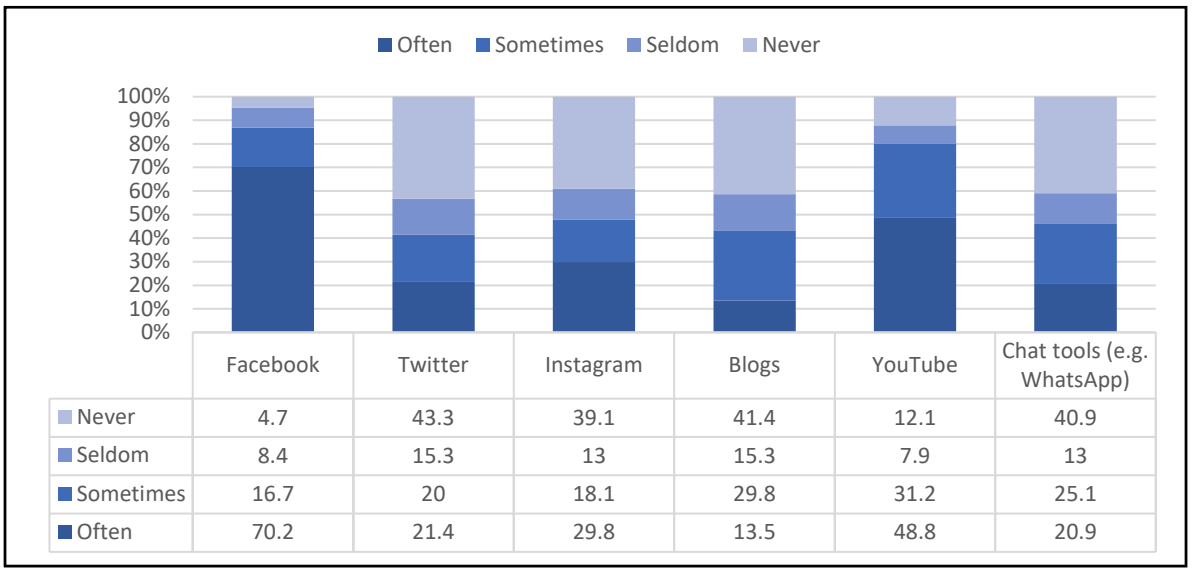


	Desktop computer	Laptop	Tablet	Regular mobile phone	Smartphone
Never	19.5	8.8	26.5	58.1	6
Seldom	12.1	7.4	13	12.1	3.7
Sometimes	16.7	18.1	29.8	10.7	12.1
Often	51.6	65.6	30.7	19.1	78.1

Figure 2. Common use of different technology devices

Figure 3 reports respondents' use of different SM applications. Facebook is by far the most frequently used type of SM, with 70.2% reporting they used Facebook often. Many also used YouTube often (48.8%), or at least sometimes (31.2%). Some SM applications were not popular amongst respondents. Many never used Twitter (43.3%), blogs (41.4%), chat tools (40.9%) or Instagram (39.1%). Several participants identified they used 'other' SM applications such as Reddit (5) and Snapchat (7). Four of the six SM applications (i.e., Twitter, Instagram, YouTube and chat tools) were used significantly differently based on the type of vulnerability reported. Respondents aged 60+ were significantly less likely to use: (i) Twitter than GSI respondents,

(ii) Instagram than LSE and GSI respondents, (iii) YouTube than LSE and GSI respondents, and (iv) chat tools than GSI respondents.



	Facebook	Twitter	Instagram	Blogs	YouTube	Chat tools (e.g. WhatsApp)
Never	4.7	43.3	39.1	41.4	12.1	40.9
Seldom	8.4	15.3	13	15.3	7.9	13
Sometimes	16.7	20	18.1	29.8	31.2	25.1
Often	70.2	21.4	29.8	13.5	48.8	20.9

Figure 3. Current use of different SM applications

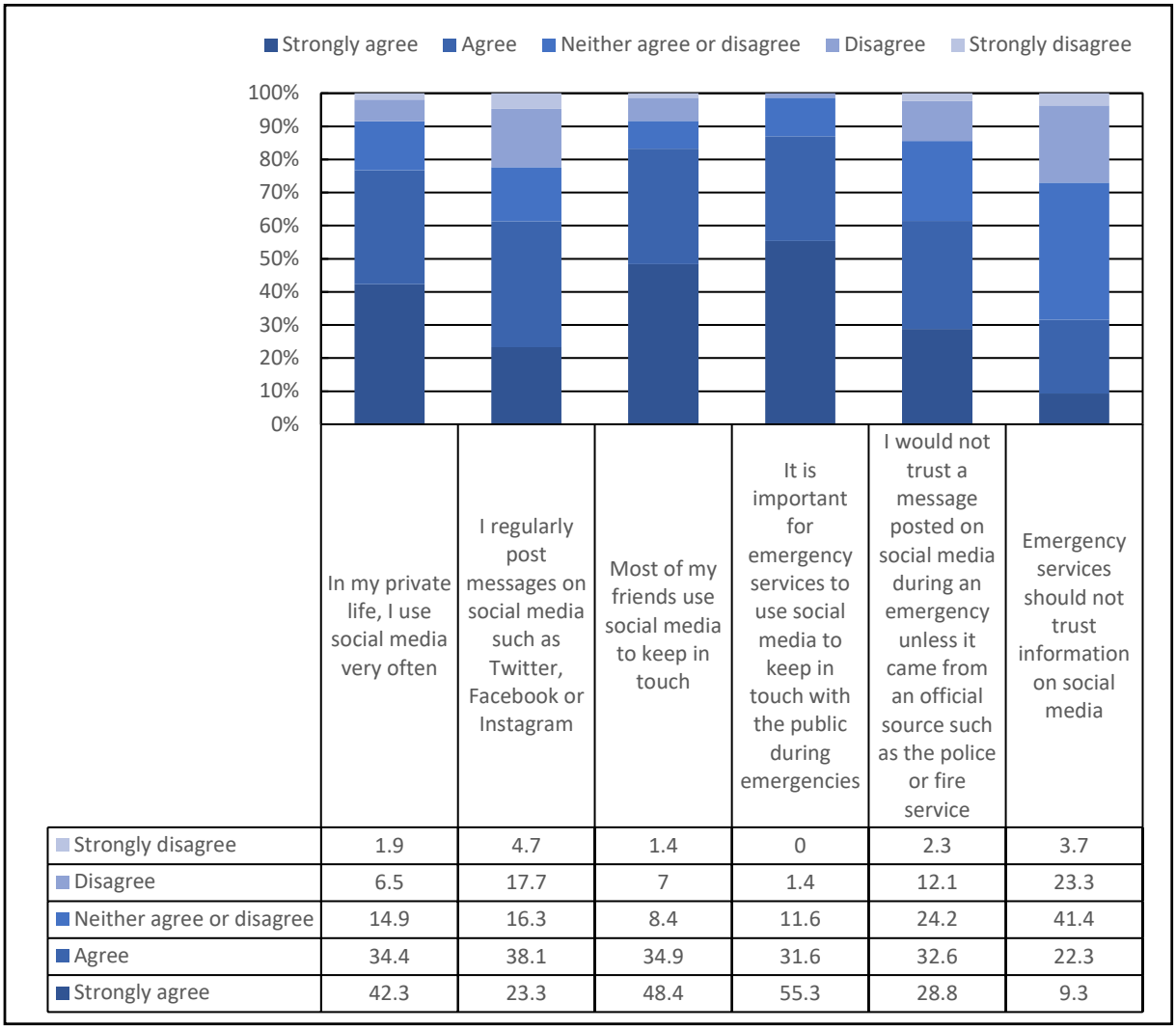
Most respondents either strongly agreed (42.3%) or agreed (34.4%) that they use SM very often in their private lives, with 61.4% regularly posting messages on SM (Figure 4). Most held the view that their friends also use SM to keep in touch (83.3%). The majority of respondents (86.9%) thought that it is important for emergency services to use SM with 61.4% reporting that they would not trust messages on SM, apart from those posted by official sources. Around one-third (31.6%) strongly agreed or agreed that emergency services should not trust information on SM. In contrast, almost another third (27.0%) strongly disagreed or disagreed that emergency services should not trust information on SM. Respondents from differing vulnerability groups responded significantly differently to four of the six items on SM use and trust towards SM. The four items concerned were: In my private life, I use SM very often; I regularly post messages on SM such as Twitter, Facebook or Instagram; Most of my friends use SM to keep in touch; Emergency services should not trust information on SM. Respondents aged 60+ were significantly less likely to: (i) use SM than LSE, PL, and GSI respondents, (ii) post messages on SM than LSE and GSI respondents, and (iii) perceive their friends use SM to stay in touch than LSE and GSI respondents. The fourth item asked respondents whether emergency services should not trust SM information. This reverse scored item was recoded so that a higher participant score indicates greater trust. GSI respondents were significantly more likely to believe emergency services should trust information on SM information than respondents aged 60+ years and from LSE backgrounds.

Awareness about existing safety services provided on Twitter and Facebook varied. Only 29.8% of respondents reported to be very aware of Facebook Safety Checks and 20% being very aware of Twitter Alerts. Knowledge of these SM tools were significantly different by type of vulnerability. GSI and LSE respondents were more aware of these SM tools than those aged 60+.

4.2 SM as an information source during disasters

When asked which communication channels they have used to get information about an extreme weather event, SM was the second most common channel used (73%) behind TV

(87%). Online news (72%) was a common source of information, followed by local radio (61%), online sites (59%), text messages (56%) and mobile apps (45%).



	In my private life, I use social media very often	I regularly post messages on social media such as Twitter, Facebook or Instagram	Most of my friends use social media to keep in touch	It is important for emergency services to use social media to keep in touch with the public during emergencies	I would not trust a message posted on social media during an emergency unless it came from an official source such as the police or fire service	Emergency services should not trust information on social media
Strongly disagree	1.9	4.7	1.4	0	2.3	3.7
Disagree	6.5	17.7	7	1.4	12.1	23.3
Neither agree or disagree	14.9	16.3	8.4	11.6	24.2	41.4
Agree	34.4	38.1	34.9	31.6	32.6	22.3
Strongly agree	42.3	23.3	48.4	55.3	28.8	9.3

Figure 4. Use and trust of SM

We were interested in how much time respondents actively spend on SM per day during an extreme weather event compared to the time they actively spend on SM on a typical day. There were 118 (54.9%) respondents who reported that they actively use SM more during extreme weather events when compared to a typical day. There were 82 (38.1%) who reported that they are less active on SM during extreme weather events and 15 (7.0%) who reported to be active on SM for the same amount of time under both conditions.

Respondents reported using SM to find out information on a variety of topics during an extreme weather event (Figure 5). Most reported they had looked for information about weather conditions or warnings (85%), damage caused by an event (66%) or road or traffic conditions (65%). Many reported they had also used SM to find out the location or status of friends or family (55%). Further, almost half the respondents used SM to find information about how others were coping with the extreme weather event (49%), what to do to keep yourself safe (49%) and to locate eyewitness videos or photographs (47%).

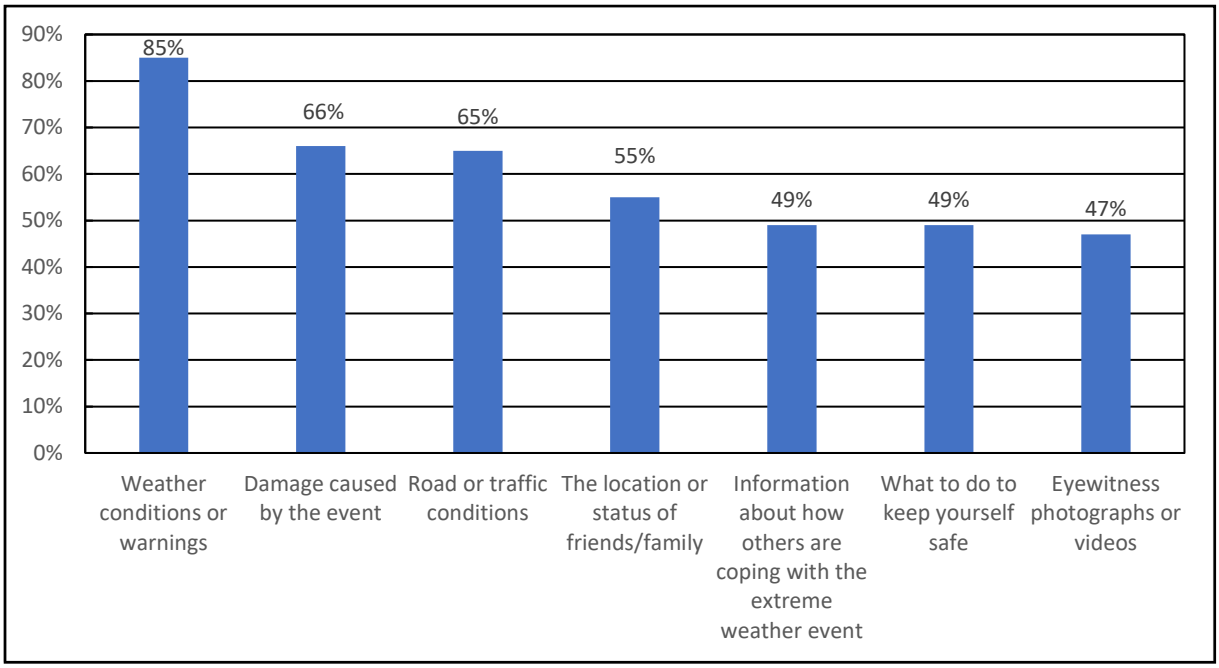
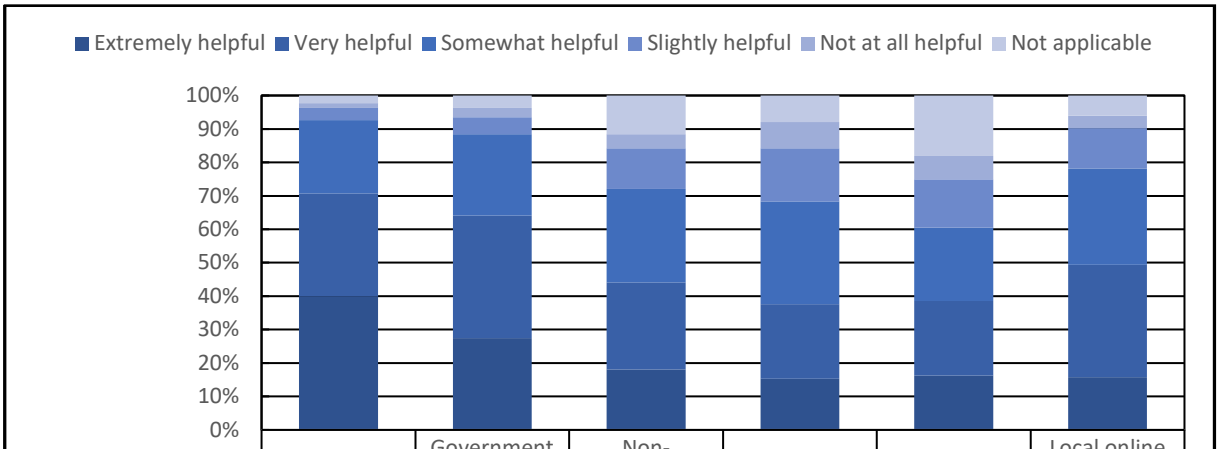


Figure 5. Types of information about extreme weather events sought using SM

We asked respondents how helpful they found the information they sought about an extreme weather event from a range of organisations using SM (Figure 6). It was anticipated this might not only illuminate the information preferences of vulnerable persons but reveal those organisations that might usefully review the information they provide to increase its relevance to different vulnerable groups. Results showed that the majority of respondents considered the information sought from EROs (70.7%) and government agencies (64.1%) as either extremely helpful or very helpful. A relatively high proportion considered the information sought from local online groups (49.3%), NGOs (44.1%), local community groups (38.6%) and local government (37.6%) as extremely helpful or very helpful. Some reported that information from local community groups (18.1%) and NGOs (11.6%) was not applicable to them.

For three of the six types of organisations (i.e., EROs, local community groups and local online groups) the level of perceived helpfulness was significantly different by type of vulnerability. GSI respondents rated the perceived helpfulness of information they sought via SM from different EROs more highly than LSE and PL respondents. A similar pattern was found for local community groups and local online groups except that GSI respondents only had more positive perceptions of the helpfulness of the information they sought via SM from these organisation than PL respondents.

Most respondents (88.4%) indicated that it was very likely or quite likely that they would use SM in the future to look for information as a result of an extreme weather event. In contrast, only 1.4% of respondents thought it not at all likely that they would use SM in the future to look for information about an extreme weather event, with 2.3% reporting it not very likely and 7.9% reporting to be neutral on this question. Respondents aged 60+ were significantly less likely to believe they would seek information from SM in the future than respondents from LSE backgrounds. There were no other significant differences between respondents' perceptions of whether they were likely to use SM to find out information about an extreme weather event in the future based on the type of vulnerability reported.



	Emergency response organisations (e.g. police, fire brigade)	Government agencies (e.g. Department of Human Services, Bureau of Meteorology)	Non-government organisations (e.g. Red Cross, Salvation Army)	Local government (e.g. local council)	Local community groups (e.g. Grey Nomads, surf clubs)	Local online groups (e.g. Twitter feed or Facebook page of local community group)
Not applicable	2.3	3.7	11.6	7.9	18.1	6
Not at all helpful	1.4	2.8	4.2	7.9	7	3.7
Slightly helpful	3.7	5.1	12.1	15.8	14.4	12.1
Somewhat helpful	21.9	24.2	27.9	30.7	21.9	28.8
Very helpful	30.7	36.7	26	22.3	22.3	33.5
Extremely helpful	40	27.4	18.1	15.3	16.3	15.8

Figure 6. Helpfulness of information on extreme weather events sought via SM from different organisations

When asked what would make them even more likely to use SM in the future to look for information as a result of an extreme weather event, a number of themes emerged. Issues related to characteristics of information were highlighted, including the need for 'official information' that enabled 'quick and live updates' from more 'reliable sources', that is, information that is 'easier to access' and 'more accurate'. Several respondents explained that they would use SM to cross-check information if they had doubts about the usefulness of other information sources, or, if there were no other information sources available. Characteristics of the event were also important. The 'type' of extreme weather event was identified by some respondents as likely to influence whether they would use SM in the future (e.g., size or type of natural hazard). The 'proximity to event or area' was important. For example, one participant stated they would be more likely to use SM, "If I had friends or family who lived in the affected area or if I lived in the affected area and wanted to let loved ones know I was safe." Safety concerns were also mentioned because "if I'm going out or travelling somewhere far. I want to be safe. I want to avoid dangerous area (sic)". Issues relating to friends and family were identified as particularly important for using SM in the future. On the one-hand respondents remarked that "if [the] event is likely to impact myself or extended family members" they could use SM to "… alert my friends and family". On the other hand, respondents revealed that the extent to which friends or family use SM during extreme weather events will influence their own future SM use. For some respondents, certain conditions needed to be met in order for them to use SM more often as a result of an extreme weather event. For instance, "if the extreme weather event hadn't affected Wi-Fi, data or phone signal". Not all respondents were able to provide specific insights into what would make them

more likely to use SM for gathering information in an extreme weather event providing responses such as, "Nothing", "I don't know", "Not sure", "N/A" as well as "I can't think of anything".

4.3 Use of information received indirectly via SM

Almost two-thirds of respondents (65.6%) had received information about extreme weather events via SM indirectly (e.g., had a conversation with a friend about a post they'd seen on SM about a flood). An additional 22.3% were not sure if they had received information about extreme weather events via SM indirectly. The most common type of information received indirectly was about weather conditions or warnings (75%), followed by information on damage caused by the event (55%) and road or traffic conditions (52%) (Figure 7). Over two-thirds (69.7%) of all respondents reported that they would either be very likely or quite likely to act on information from SM provided to them indirectly by friends or relatives as a result of an extreme weather event, with only 2.8% of respondents reporting that they were not at all likely to act based on such information. There was no significant difference in the likelihood of people acting on information sourced indirectly from family or friends' SM in the future based on the different types of vulnerability reported.

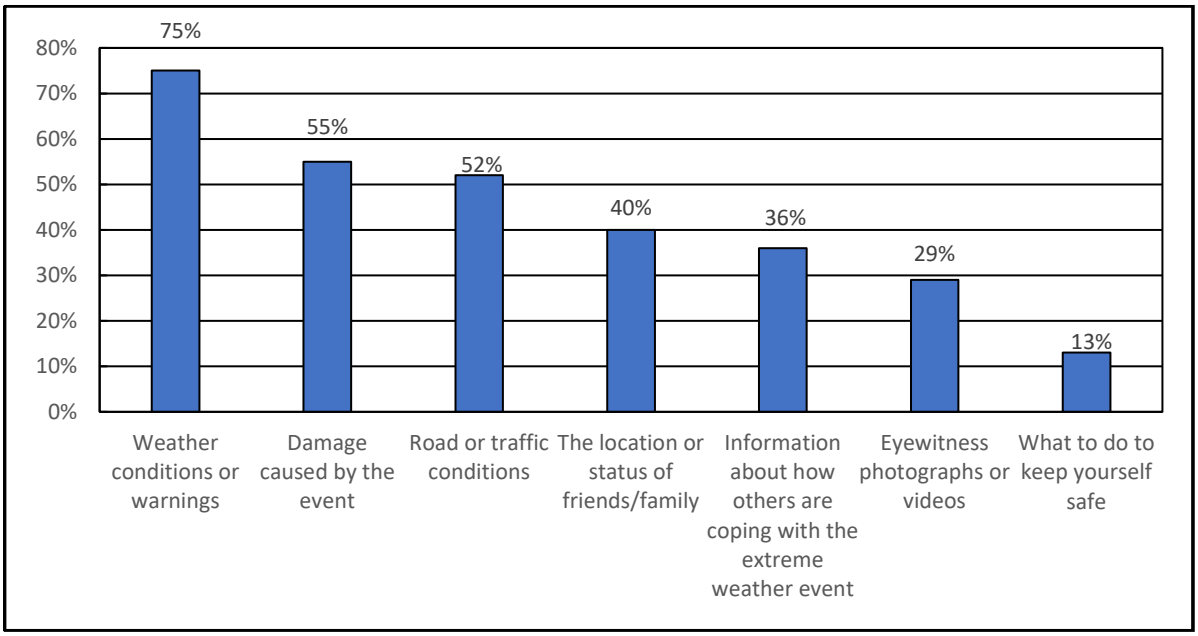


Figure 7. Types of information about extreme weather events received indirectly via SM

When asked what would make respondents even more likely to act upon information about an extreme weather event from SM indirectly through friends or relatives, a number of themes emerged. First, reliability was important, in terms of the perceived trustworthiness of the friend or family member providing them the information, as well as the perceived reliability of the original source that the friend or relative had acquired the information. Some respondents emphasised the importance of being able to verify the information provided by friends or relatives by triangulating this with other information sources. For some, the nature (e.g., severity, extent of threat posed) and proximity of the event (i.e., to themselves, to friends/ relatives) would influence the likelihood of them acting on information received from SM indirectly. Timeliness of the information was also a factor, with 'constant', 'faster', 'current', 'regular' updates being important. A number of respondents noted that "Nothing", "I don't know", "Not sure", as well as "I can't think of anything" would make them more likely to act

on information received from SM indirectly. Others felt they would need to directly hear or see the news as they lacked confidence in information received indirectly.

4.4 Sharing information using SM during emergencies

Almost two-thirds (62.3%) of respondents have used SM to share information as a result of an extreme weather event. Of those that have shared information, the most common type of information shared was about weather conditions or warnings (75%), followed by the actions they were taking to stay safe (57%), road or traffic conditions (49%) and reassurance that they are safe (46%). Sharing eyewitness videos (16%) and advice about actions others should take to stay safe (23%) were the least common types of information shared (Figure 8). Almost three-quarters of respondents (72.5%) reported that they would be either quite likely or very likely to use SM in the future to share information regarding an extreme weather event. Only 5.1% reported that they were not at all likely to do so. There was no significant difference in the likelihood of people using SM in the future to share information based on the different types of vulnerability they reported.

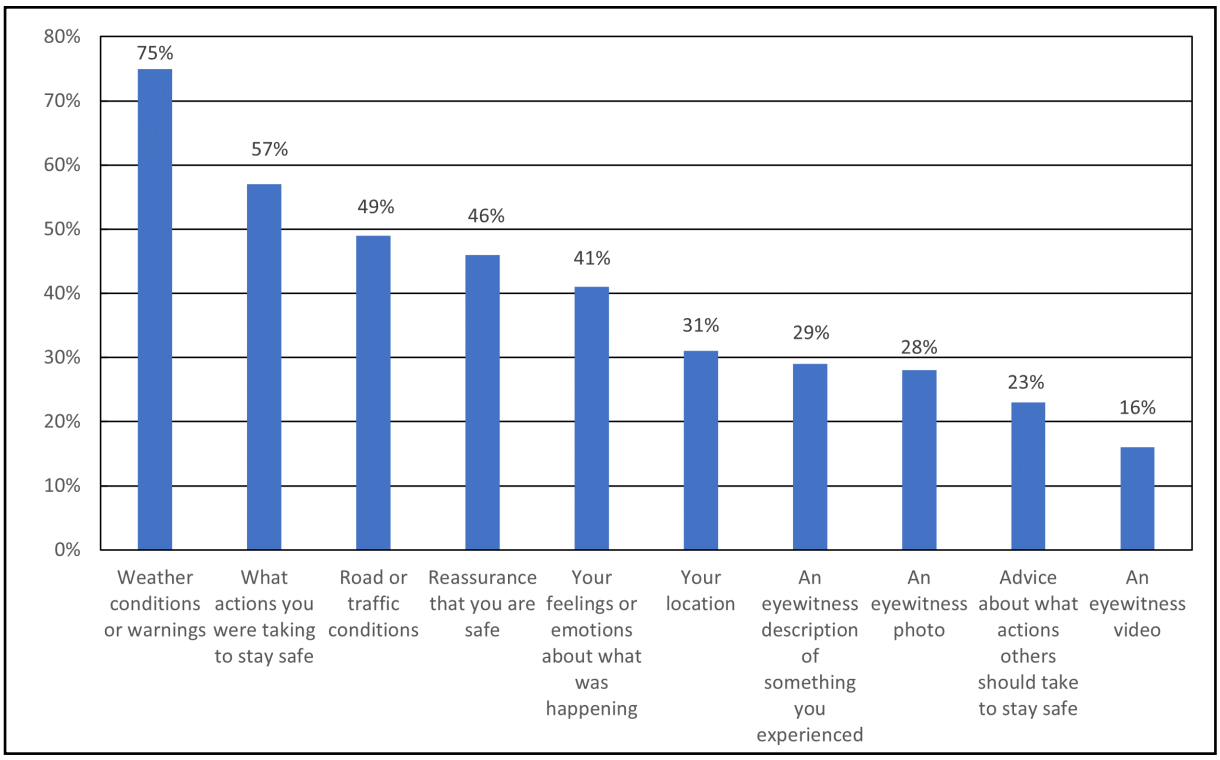


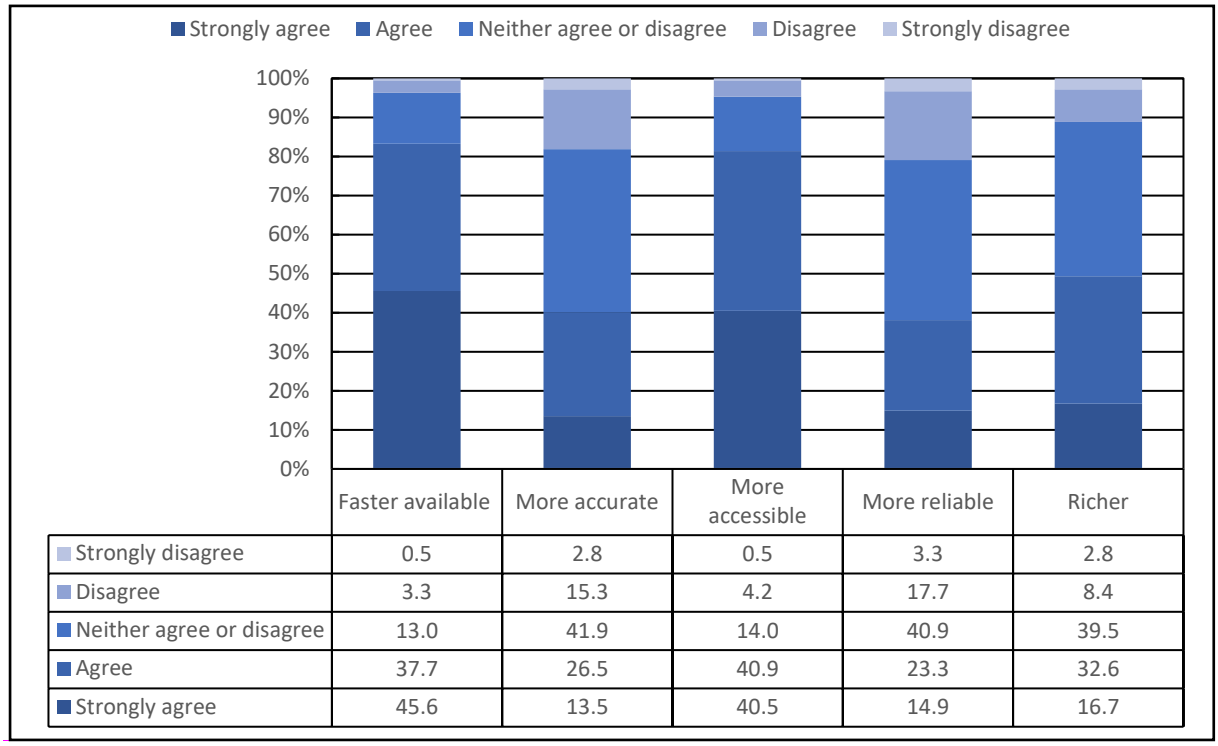
Figure 8. Types of information shared about extreme weather events using SM

We also asked respondents about what would make them even more likely to use SM to share information about an extreme weather event in the future. The most common theme that emerged related to inter-personal relationships such that if respondents felt family or friends were at risk, they would be more likely to share information on SM. The extent to which the respondent thought their posts would help others, and the need to be confident that the information they shared was reliable, also emerged as important. Having photographic evidence to post and the ability to give 'live updates' were reported as influencing factors. The need for easy to access to information from other sources (e.g., emergency services' pages) was considered to influence the likelihood that respondents would share information on SM. Further, proximity of the event, to either themselves or to friends and family, would increase the likelihood that respondents would share information on SM in the future. The severity of

the event was also a factor. For some respondents, specific technical conditions would need to be met, such as "Social media being more likely to show my posts within the main news feed" or if there were no other communication medium available (e.g., phone service). A number of respondents noted that "Nothing", "I don't know", "Not sure", "N/A" in response to what would make them more likely to share information on SM regarding an extreme weather event. Others noted that "[I] used [SM] a lot when we had our last flood event, and I don't think I could have used it more" and "if I used SM more generally" they would be more likely to post information as a result of an extreme weather event.

4.5 Preference for SM as an information source compared to alternative information sources

We asked respondents about why some people prefer to look for information on SM over more traditional media. Many respondents think that people prefer to look for information via SM sites because it is available more quickly (83.3%) and is more accessible (81.4%) (Figure 9). Yet while 40.0% of respondents either agreed or strongly agreed that people prefer to look for information via SM because it may be more accurate, 41.9% neither agreed nor disagreed, 15.3% disagreed, and 2.8% strongly disagreed that this was the case. Similar proportions of respondents perceived that people prefer to look for information via SM because it is more reliable (38.2%), with 40.9% of respondents neither agreeing nor disagreeing, 17.7% disagreeing and 3.3% strongly disagreeing. Almost half the respondents (49.3%) thought people prefer to look for information via SM because it is richer than information available via more traditional sources, with 11.2% either disagreeing or strongly disagreeing, and 39.5% neither agreeing nor disagreeing that this was the case.



	Faster available	More accurate	More accessible	More reliable	Richer
Strongly disagree	0.5	2.8	0.5	3.3	2.8
Disagree	3.3	15.3	4.2	17.7	8.4
Neither agree or disagree	13.0	41.9	14.0	40.9	39.5
Agree	37.7	26.5	40.9	23.3	32.6
Strongly agree	45.6	13.5	40.5	14.9	16.7

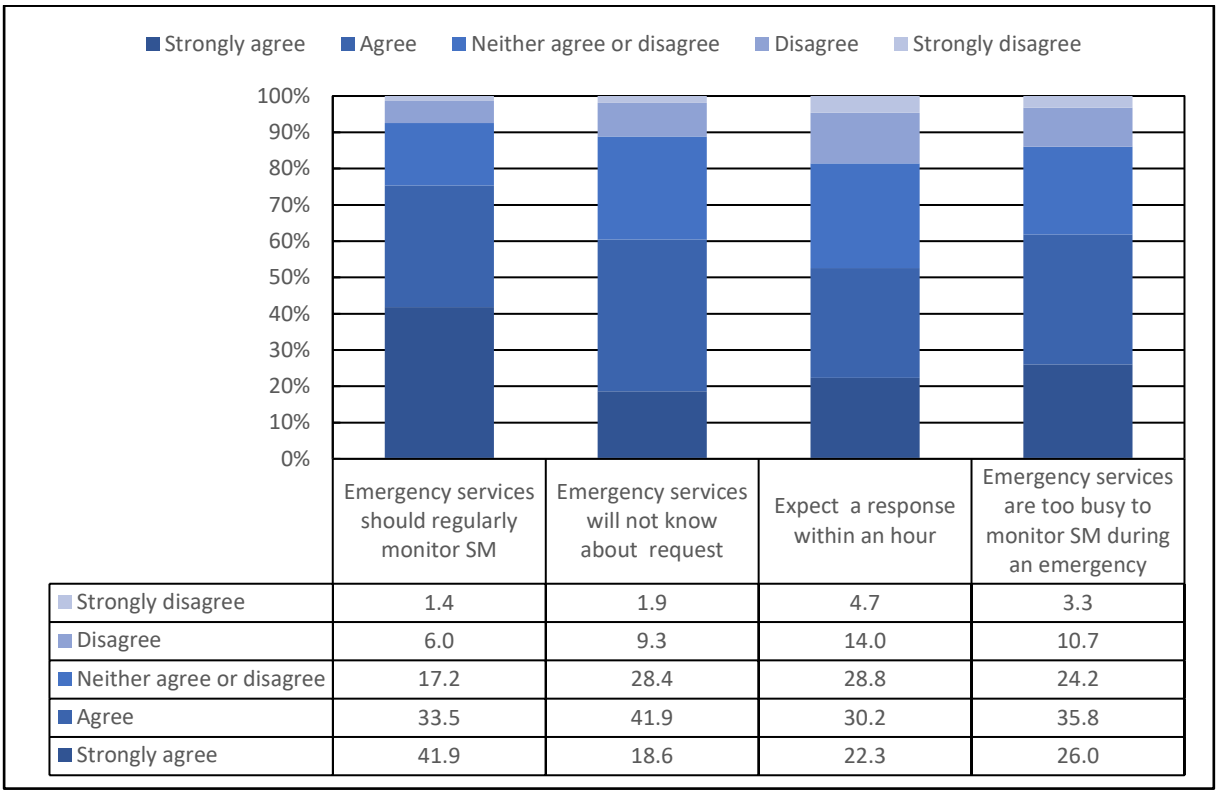
Figure 9. Perceived reasons people prefer to look for information via SM than other sources

Three of the five criteria for why some people prefer to look for information on SM (i.e., information: available faster, more accessible, and more reliable) were significantly different by the type of vulnerability reported. Specifically, LSE and GSI respondents are significantly

more likely than those aged 60+ to perceive that people prefer to use SM to look for information because the information is available faster. LSE respondents are also significantly more likely than PL respondents to perceive that people prefer to use SM to look for information because the information is available faster. In terms of accessibility, LSE and GSI respondents are significantly more likely than those aged 60+ and those identifying as living with PL to perceive people prefer to look for information on SM than other information sources because it is more accessible. With respect to people preferring to look for information via SM because it is more reliable than other information sources, GSI respondents rated this aspect significantly higher than those aged 60+.

4.6 Expectations towards emergency services

The survey included a series of questions exploring how respondents perceived EROs would or should react to them requesting help or information on their SM site. While 75.4% agreed that emergency services should regularly monitor their SM sites to be able to respond promptly to such a request, 60.5% of respondents believed emergency services would not know about such a request. Further, 52.5% of respondents would expect a response within an hour, yet 61.8% of respondents thought that emergency services are too busy during emergency events to monitor SM (Figure 10).



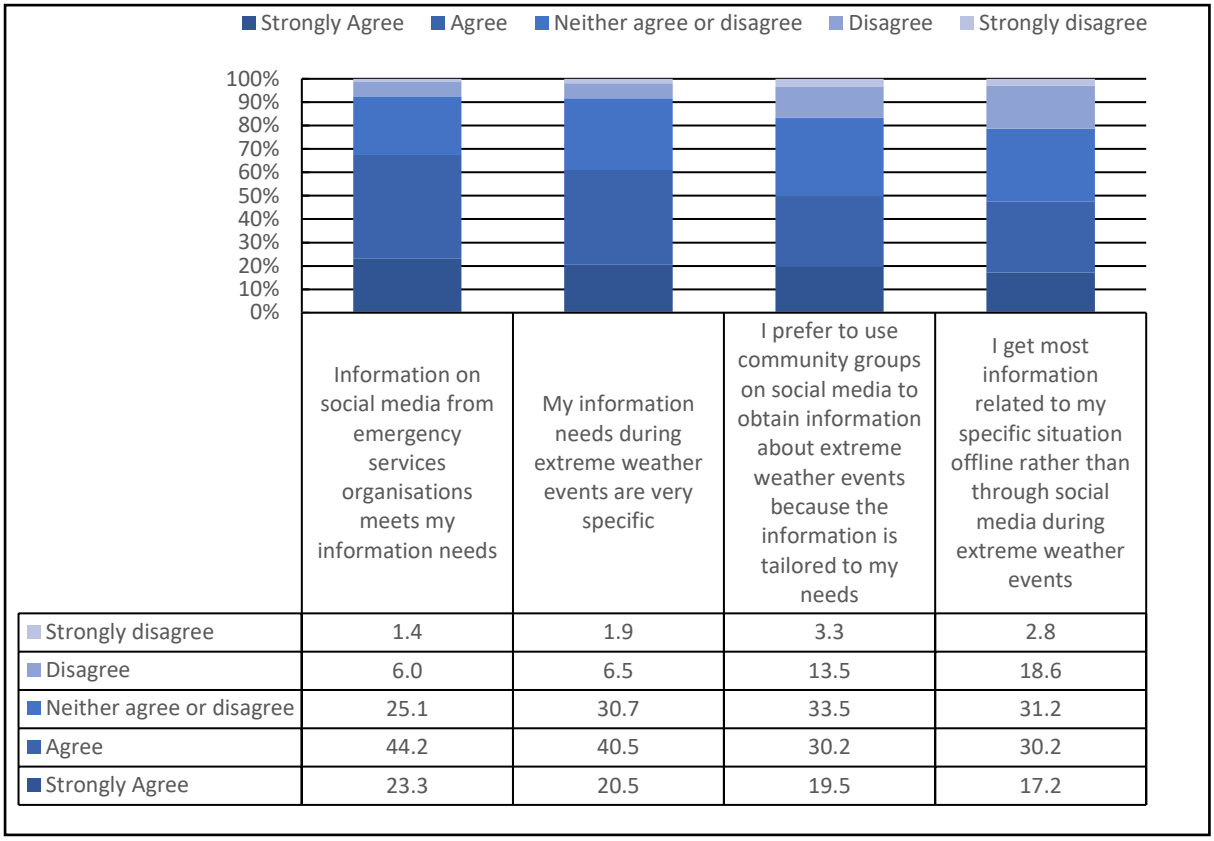
	Emergency services should regularly monitor SM	Emergency services will not know about request	Expect a response within an hour	Emergency services are too busy to monitor SM during an emergency
Strongly disagree	1.4	1.9	4.7	3.3
Disagree	6.0	9.3	14.0	10.7
Neither agree or disagree	17.2	28.4	28.8	24.2
Agree	33.5	41.9	30.2	35.8
Strongly agree	41.9	18.6	22.3	26.0

Figure 10. Expectations of emergency services' use of SM

Three of the four criteria capturing participant expectations of emergency services' use of SM (i.e., EROs should regularly monitor SM, expect a response on SM within an hour, and EROs are too busy to monitor SM) were significantly different by the type of vulnerability reported. GSI and LSE respondents had higher expectations of EROs regularly monitoring SM than those aged 60+. In terms of expecting a response within one hour there were no significant pairwise differences between the vulnerability types. For the third criteria regarding whether

EROs were too busy to monitor SM, the GSI group agreed that this was the case more so than the LSE respondents.

Over two-thirds of respondents (67.5%) agreed that the information on SM from emergency services organisations meets their needs (Figure 11). Many respondents (61.0%) believed their information needs during extreme weather events are very specific, with almost half (49.7%) preferring to use community groups on SM to obtain information because it is tailored towards their needs. Notably, just under half of the respondents (47.4%) reported that they obtain information specific to their situation offline rather than via SM during extreme weather events.



	Information on social media from emergency services organisations meets my information needs	My information needs during extreme weather events are very specific	I prefer to use community groups on social media to obtain information about extreme weather events because the information is tailored to my needs	I get most information related to my specific situation offline rather than through social media during extreme weather events
Strongly disagree	1.4	1.9	3.3	2.8
Disagree	6.0	6.5	13.5	18.6
Neither agree or disagree	25.1	30.7	33.5	31.2
Agree	44.2	40.5	30.2	30.2
Strongly Agree	23.3	20.5	19.5	17.2

Figure 11. Participant information needs during extreme weather events

For three of the four information needs criteria (i.e., ERO SM information meets my needs, my information needs are very specific, and I obtain most my specific information offline) were significantly different by type of vulnerability. GSI respondents were significantly more likely to believe that information provided by emergency services via SM meets their needs than those aged 60+ or respondents with PL. This same pattern was seen for the second question regarding the specificity of information needs although GSI respondents also rated their information needs as significantly more specific than LSE respondents. For the third question on preferences for specific information sourced offline, there were no significant pairwise differences.

Respondents were given the opportunity to provide additional comments regarding the use of SM before, during and after an extreme weather event. A number of themes emerged. Several respondents re-emphasised the need for confidence in the information and its source. Some highlighted what they perceived as limitations with SM that could be improved. For example, several respondents highlighted that in extreme weather events phone lines or

electricity may be down and thus SM may not be available to everyone, while others considered SM inferior to other information sources such as radio, was burdened by advertisements and suffered from having "fake information". Others focused on what they considered benefits of SM, for example, "It's always informative, and there will always be groups started to help those affected. Social media is amazing in pulling people together in a crisis". Several suggested features such as alert systems being built-in to SM and the need for more tailored information. It was noted by one participant that SM applications like Twitter were seen to be more professional and reliable than those like Instagram, yet another emphasised their preference for SM applications that used images. A number offered suggestions around what emergency services organisations could do to improve the usefulness of SM. For example, "Emergency services should have designated people working on social media" and "It is helpful for emergency services to continue to update their social media during an extreme weather event but at the moment they do not share enough information".

5 Discussion

Researchers and practitioners have called for research to focus on the specific information needs of vulnerable persons as well as how they use SM (IFRC, 2005, 2013; Pang et al., 2020). In response to this call, we undertook a survey of vulnerable persons in the Australian state of Victoria and focused on understanding their attitudes, needs and future plans to use SM to access and share information during extreme weather events.

5.1 Challenging prevalent assumptions about vulnerable persons and SM in disasters

Extant literature has traditionally focused on the ways in which vulnerable persons are more at-risk during disasters, implying a state of weakness, rather than adopting strength-based approaches which emphasise equality, autonomy and empowerment (Ogie & Pradhan, 2019). The reasons behind this tradition are understandable given that disasters present life or death situations and there is an urgent need to reduce their impact on those who may be less able to fend for themselves. However, recent shifts towards "shared responsibility" in emergency management, whereby the obligations for planning and mitigating against hazards are distributed among different actors (McLennan & Eburn, 2015) to reduce unrealistic expectations and unsustainable dependences on emergency services personnel (Lukasiewicz, Dovers, & Eburn, 2017), prompts questions around existing assumptions about vulnerability and vulnerable persons.

In the early stages of our study the importance of informal networks and relationships as a source of information and support for vulnerable persons emerged as important (Section 3.1). We therefore investigated information-related issues surrounding trust, accuracy and usefulness when people receive information from SM indirectly. As highlighted in Section 4.3 almost two-thirds of vulnerable persons (65.6%) reported they had received information about extreme weather events indirectly from SM and over two thirds (69.7%) reported they'd be either very likely or quite likely to act on information provided to them indirectly by friends or family. The relatively high proportion of vulnerable persons receiving and acting on information received from SM indirectly is not unexpected given that posts on SM by emergency organisations tend to target the general public as carers—effectively suggesting they 'check-in' with vulnerable persons (Poblet-Balcell et al., 2018). Poblet-Balcell et al. (2018)

note that that one reason for this may be because emergency organisations are assuming that vulnerable persons will be less likely or able to use SM to access such information. While this assumption may be accurate for many vulnerable persons, our study indicates that this is certainly not always the case.

Vulnerable persons in our study exhibit a strong desire to use SM during disasters to receive and share information—and in some cases were even more likely to view SM favourably than samples of the general population captured in other studies. This may be because vulnerable people recognise that their level of risk in disasters is higher and consequently, they adopt SM to strengthen their personal networks and improve their access to information. This is consistent with Risk Homeostasis Theory (Wilde, 1998) which proposes that if people subjectively perceive that their level of risk is higher than acceptable, they will compensate for this and modify their behaviour to exercise greater caution. In comparing the results of our study (n = 215) to those of Reuter and Spielhofer (2017) (n = 839), effect sizes for the difference between two independent proportions (with 95% confidence interval (CI) upper and lower limits shown in square brackets) (Cumming, 2012), reveal that vulnerable persons were significantly more likely to perceive that they: i) regularly use SM in their private lives (0.137 [0.068, 0.198] p < .001); ii) use SM in the context of extreme weather events (0.311 [0.239, 0.375] p < .001); and iii) will use SM in the future to search (0.303 [0.244, 0.353] p < .001) and share (0.245 [0.174, 0.31] p < .001) information on extreme weather events. Perceptions of SM compared to traditional media in terms of speed (0.072[0.01, 0.125] p < .024), accessibility (0.274[0.208, 0.331] p < .001), richness (0.524[0.459, 0.579] p < .001), reliability (0.161[0.092, 0.233] p < .001) and accuracy (0.27[0.202, 0.34] p < .001) were more positive for vulnerable persons. Our study's vulnerable participants were also considerably more aware of Twitter alerts (20% vs. 6%; 0.14[0.089, 0.201] p < .001) and Facebook safety checks (29.8% vs. 3%; 0.268[0.209, 0.333] p < .001) than the sample of the general population captured by Reuter and Spielhofer (2017). Thus, SM offers an increasingly valuable way for governments, EROs, NGOs and community organisations to reach out directly to vulnerable persons and for vulnerable persons to reach-out directly to organisations and their communities in ways which complement the wider information ecology of vulnerable persons.

In light of the positive view that vulnerable persons in this study held towards SM in the disaster context, further research into areas where their perceptions do differ from the general population is worthwhile. Such insights could be used to inform tailored SM solutions that maximise outcomes for vulnerable persons. For example, if we compare the expectations vulnerable persons hold of EROs in our study with the sample of the general population captured by Reuter and Spielhofer (2017), vulnerable persons were found to have a significantly higher expectation that emergency services should respond to a post on SM within an hour (52.5% compared to 41%; 0.116[0.041, 0.189] p < .002). This suggests that emergency services might usefully engage with vulnerable persons to better address and manage their expectations. As another example, significantly more respondents in our study (61.4%) reported that they would not trust messages on SM apart from those posted by official sources (compared to only 38% of the general population) (0.235[0.161, 0.305] p < .001). While some studies have indicated limited issues with the propagation of rumours via SM during disasters (Hjorth & Kim, 2011) others have reported concerns from citizens and organisations in relation to inaccurate information (Elbanna et al., 2019; Goolsby, 2010). Future research might investigate how to improve the accuracy and reliability of information to increase

vulnerable persons' trust in SM during disasters given they seem to have greater concerns surrounding these issues.

In addition to considering how the values, needs and future plans of vulnerable persons to use SM in disasters when compared to the general population, it is valuable to consider further, how people from different vulnerable groups compare with each other to support more nuanced approaches. We explore these differences next.

5.2 Comparison of perceptions of SM use in disasters between vulnerable groups

In addressing the research question our findings suggest that vulnerable persons should not be treated as a homogeneous group but rather, a nuanced approach to engage vulnerable persons using SM is required. Amongst the four types of vulnerable persons examined in our study, those identifying as GSI generally held more positive attitudes towards using SM to access and share information during disasters and were more likely to view their information needs as specific. The views of older persons, on the other hand, were the most divergent. Most of the significant differences between older persons were with those who are of LSE means and/or those who were GSI, whereby older persons typically reported lower levels of awareness and SM use than these two groups. This is not only consistent with research that has shown that older persons are less likely to use ICT and SM than the general population (Barnard, Bradley, Hodgson, & Lloyd, 2013) but further highlights that this is also the case when older persons are compared to other vulnerable groups. Notably, older persons in our study were less likely to believe the information on SM provided by emergency services meets their needs when compared to GSI respondents. Despite the significant differences identified between older persons and other vulnerable persons in a number of areas, they were also less likely to perceive their information needs during an extreme weather event are very specific. Given the projected growth in the number of older persons and increasing diffusion of ICT there is a pressing need to better understand how technology, including SM, can be better leveraged to support older persons during emergencies (Choudrie, Pheeraphuttranghkoon, & Davari, 2018). Studies which consider older persons' SM use within their broader information ecology would be of value in order to understand how their use of other tools, and their formal and informal networks, influence their SM use.

The potential of SM to break down barriers and change the lives of people living with disability has been frequently highlighted, nonetheless, accessibility concerns persist (Ellis & Goggin, 2013). By comparing the responses of people with PLs to other vulnerable groups, our study indicates that in the disaster context accessibility issues remain a concern for people living with disabilities. People with PL were significantly less likely to be positive about the accessibility of information on SM than those of LSE means and GSI persons, and less likely to be convinced that information on SM was available faster than persons of LSE means. People with PLs were less satisfied with the information provided on SM by emergency services and less likely to rate information on SM provided by EROs, community groups and local online groups as helpful compared to GSI persons. Therefore, organisations in the disaster context might usefully consider how they can better customise the information they provide on SM to meet the needs of those living with PLs (Morris et al., 2014).

In our study those of LSE means were less likely to find the information on SM provided by emergency services organisations to be helpful and were less likely to perceive their information needs were specific when compared to GSI respondents. Given education is used

as a common measure of socio-economic status (Australian Bureau of Statistics, 2011), it would be valuable to identify the extent to which the information provided by emergency services is designed to address the needs of people holding different levels of education. Our study also highlighted that people of LSE means were less likely to think emergency services will be too busy to monitor SM during an extreme weather event when compared to GSI persons. As those of LSE are often characterised by their limited access to resources (Australian Bureau of Statistics, 2011) it would be interesting to examine how this influences their perceptions of the resources available to emergency services organisations compared to other segments of the community.

6 Contributions, Directions for Future Research and Limitations

In this section we summarise our contributions research and practice, offer directions for future research and acknowledge the limitations of our study.

6.1 Contributions to research and practice

This paper offers several contributions to information systems research. First, although there is a growing body of research on SM and disasters (e.g. Bunker, 2020; Elbanna et al., 2019; Mirbabaie, Bunker, Stieglitz, Marx, & Ehnis, 2020; Pan & Zhang, 2020) and on vulnerable persons and disasters (e.g. Abedin & Babar, 2018; Al-Saggaf & Simmons, 2015; Kryvasheyeu et al., 2016; Panagiotopoulos et al., 2016; Peary et al., 2012), this is one of only a few studies to address the important topic of SM use by vulnerable persons in disasters specifically. Second, this study challenges prevalent assumptions in extant literature about vulnerable persons and SM in disasters. We provide empirical evidence that indicates vulnerable persons are not passive victims and in fact adopt a shared responsibility (McLennan & Eburn, 2015) towards disasters through their strong desire to use SM to receive and share information to help themselves and others. We also highlight, by comparing our results to a similar study (Reuter & Spielhofer, 2017), that vulnerable persons may be more likely to view SM favourably than the general population. Third, this study provides new insights to the literature on the information ecology of vulnerable persons in disasters by illuminating the importance of online and offline information sources, formal and informal networks, and information-related issues such as trust, accuracy and usefulness for vulnerable persons using SM in disasters.

This study also offers a number of contributions to practice. First, by demonstrating that vulnerable persons are not a homogeneous group, we are able to illuminate how people with different types of vulnerabilities perceive SM for accessing and sharing information in the context of disasters. The resulting insights can be used by relevant disaster organisations to review the information they provide vulnerable persons during disasters and tailor their SM strategies to better target individuals living with a variety of vulnerabilities. Second, our study highlights that vulnerable persons may have different expectations of EROs than the general population and organisations should usefully engage with vulnerable persons to better address and manage their expectations.

6.2 Directions for future research

As one of few studies to specifically examine the use of SM by vulnerable persons during disasters there are several important directions for future research that could further augment

understanding of the diverse information needs and practices of vulnerable populations during disasters. We summarise these directions in Table 1.

Theme	Suggested research directions
Nuanced and specific focus on the information needs and practices of vulnerable persons	- Investigation of the factors which influence the decision of vulnerable persons to use, or not to use, SM to access and share information during disasters. - Examination of how vulnerable persons who use SM during disasters differ to vulnerable persons who do not use SM during disasters. - Studies of how perceptions of SM use in disasters vary within categories of vulnerable persons— e.g., 'young old' (60-70), 'old-old' (70-80) and 'oldest-old' (over 80); disability types (physical, mental) etc. - Investigation of how different categories of vulnerability interact with each other and impact perceptions of SM use during disasters. - Identification of how characteristics such as gender and culture influence categories of vulnerable persons in their use of SM to access and share information in disasters. - Examination of how the social networks of vulnerable persons (e.g., friends, families, carers) influence their perceptions of SM use in disasters, including studies which adopt alternative units of analysis (e.g., households). - Studies which compare the information needs and practices of vulnerable persons to the general population in the disaster context.
Community initiated SM groups	- Identification of how community-initiated SM groups can enhance the inclusion of vulnerable persons across the PPRR phases of disasters. - Investigation of the needs of vulnerable persons in disasters by analysing relationship dynamics within community groups on SM. - Identification of how vulnerable persons contribute to, and benefit from, crowd-sourcing initiatives in the disaster context.
Information-related issues	- Examination of how information on SM can better target vulnerable persons to address their needs in the context of disasters. - Identification of strategies to enhance SM information flow from organisations to the public; from the public to the public, from the public to organisations and between organisations to ultimately improve outcomes for vulnerable persons in disasters. - Examination of how the accessibility, reliability, timeliness and veracity of information on SM can be enhanced to deliver better outcomes for vulnerable persons in disasters. - Studies on how information received indirectly via SM influences the behaviour of vulnerable persons in disasters.
Organisational integration of SM	- Investigation of how the complexities of the organisational landscape in disaster management can be managed to better leverage SM to address the specific needs of vulnerable persons. - Examination of how organisations can effectively integrate SM with traditional communication channels to better support the needs of vulnerable persons during disasters. - Identification of how vulnerable persons' expectations of emergency services organisations' use of SM can be managed. - Studies of how different types of organisations can best leverage SM to support specific groups of vulnerable persons (e.g., the elderly, those living with PLs etc.)
Sentiment and network analysis	- Investigation of whether sentiment and network analyses can be leveraged to design disaster management strategies that address the specific needs of vulnerable persons. - Identification of what SM sentiment and network analyses can tell us about the needs and role of vulnerable persons in disasters is; and identification of how such analyses can improve outcomes for vulnerable persons across the PPRR phases of disaster. - Undertaking sentiment and network analyses to give a voice to vulnerable persons and democratise participation in disaster management.

Table 1. Directions for future research

6.3 Limitations

There are several limitations to this research. Most notably, this study only focuses on SM users, it does not account for individuals who do not use SM (an estimated 20.1% of the population in Australia) (Kemp, 2021) and may be most vulnerable during emergencies. As non-probability sampling was used it cannot be assumed that our results are representative of vulnerable persons in Victoria and beyond. Our study was limited to an investigation of four types of vulnerability. In comparing results between the four vulnerable groups, we did not take into account those who identify as having multiple vulnerabilities. We thus did not investigate the impact of intersectionality and how these can potentially exacerbate vulnerability. Social categorisations such as race and gender can create overlapping and interdependence systems of disadvantage that impact the outcomes of vulnerable persons during emergencies and disaster. Our analysis did not consider these additional social categorisations.

In comparing vulnerable persons' attitudes, needs and future plans towards using SM to access and share information in disasters to the general population (Section 5.2) we utilised the study of Reuter and Spielhofer (2017). While both studies utilised the same survey instrument (albeit modified), they were undertaken at different times (2015 vs. 2018) and with participants from different geographical locations and cultural backgrounds (i.e., Australian vs. European citizens). While arguably there may be as many cultural differences between European countries (Reuter et al., 2019) as there are between Australia and these countries, it is important to be cautious when interpreting the comparative results.

7 Conclusion

Although vulnerable persons may suffer disproportionally during disasters, they are not simply passive victims and have been shown to have a strong desire to receive and provide reliable information. Conceptualisations of vulnerability in the literature are moving away from victimhood and viewing vulnerable persons as passive recipients of support, towards recognising those traditionally viewed as vulnerable as having self-awareness and capacities that contribute to social protection and risk reduction (Wisner, 2016). By identifying how vulnerable persons perceive SM use during extreme weather events we have highlighted how they are proactive in protecting themselves and their friends and family. Our findings indicate that SM can empower vulnerable persons in disasters and calls into question assumptions about the lack of technology and SM use by vulnerable persons when compared to the general population. Nonetheless, there is potential for SM to be further leveraged to deliver improved outcomes to those traditionally thought of as more vulnerable. We highlighted a potential mismatch between vulnerable persons' expectations of emergency services in responding to requests for help on SM and the extent to which emergency services will be aware of, and be able to respond to, such requests. Organisations and community groups might consider patterns of usage amongst vulnerable persons more carefully to ensure their SM strategies address their requirements.

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Appendix One - Survey instrument

1. We care about the quality of our survey data and hope to receive the most accurate measures of your opinions, so it is important to us that you thoughtfully provide your best answer to each question in the survey.

Do you commit to providing your thoughtful and honest answers to the questions in this survey?

I will provide my best answers
I will not provide my best answers
I can't promise either way

2. Have you ever used social media such as Facebook, Twitter, Instagram, etc. to find or share information as a result of an extreme weather event such as a flood, storm, fire or heatwave?

Yes
No

3. Please indicate which of the following (if any) you identify as being/having

Over 60 years of age
Geographically or socially isolated (e.g. live in a remote community, or live alone in an urban area)
Suffer from physical limitations (in terms of a physical functioning, mobility, dexterity etc.)
Low socio-economic means
None of the above

4. In which Australian state or territory do you currently live?

New South Wales
Queensland
South Australia
Tasmania
Victoria
Western Australia
Australian Capital Territory
Northern Territory
I do not currently live in Australia

5. What is your age?

18-21
22-29
30-39
40-49
50-59
60-69
70 or older

6. What is your gender:

Male
Female
Other

7. What is your highest level of education?

High school
Diploma
Bachelor degree
Master degree
Doctoral degree
Other (please specify):

8. Please specify your nationality

9. Are you from a non-English speaking background?

Yes
No

10. Do you have any children under the age of 18?

Yes
No

11 What type of household best describes your living situation?

Lone-person household
Family household with children
Family household without children
Group-household (two or more unrelated adults)
Other (please specify)

12. What is your current employment status?

Full-time
Part-time
Casual
Fixed-term
Shift worker
Self-employed
Pensioner
Retired
Homemaker
Unemployed
Other (please specify)

13. To what extent do you currently use the following type of technology?

Type of Technology	**Often**	**Sometimes**	**Seldom**	**Never**
Desktop computer				
Laptop				
Tablet				
Regular mobile phone (not a smart phone)				
Smartphone				
Other (please specify)				

14. To what extent do you currently use the following types of social media to share or look at information?

Type of Social Media	**Often**	**Sometimes**	**Seldom**	**Never**
Facebook				
Twitter				
Instagram				
Blogs				
YouTube				
Others (please specify)				

15. Typically how much time do you actively spend on social media?

	1	**2**	**3**	**4**	**5 or more hours**
Per day	----------|----------				
Per day during an extreme weather event	----------|----------				

16. Please indicate how strongly you agree or disagree with the following statements

Item	**Strongly agree**	**Agree**	**Neither agree or disagree**	**Disagree**	**Strongly disagree**
In my private life, I use social media very often					
I regularly post messages on social media such					

as Twitter, Facebook or Instagram					
Most of my friends use social media to keep in touch					
It is important for emergency services to use social media to keep in touch with the public during emergencies					
I would not trust a message posted on social media during an emergency unless it came from an official source such as the police or fire service					
Emergency services should not trust information on social media					

17. Which of the following communication channels have you ever used to get information about an extreme weather event such as a flood, storm, fire or heatwave?

TV
Local radio station
Online news
Mobile apps
Social media (Facebook, Twitter, Instagram, etc.)
Text message alerts
Online sites for extreme weather agencies or emergency services
None of the these
Other (please specify)

18. When using social media such as Facebook, Twitter, Instagram, etc. to find out information as a result of an extreme weather event such as a flood, storm, fire or heatwave, what kind of information have you looked for?

Weather conditions or warnings
Road or traffic conditions
Damage caused by the event
The location or status of friends/family
Information about how others are coping with the extreme weather event
Eyewitness photographs or videos
What to do to keep yourself safe
Other (please specify)

19. How helpful was the information you sought using social media about an extreme weather event from each of the following organisations?

Organisation type	**Extremely helpful**	**Very helpful**	**Somewhat helpful**	**Slightly helpful**	**Not at all helpful**	**Not applicable**
Emergency response organisations (e.g. police, fire brigade)						
Government agencies (e.g. Department of Human Services, Bureau of Meteorology)						
Non-government organisations (e.g. Red Cross, Salvation Army)						
Local government (e.g. local council)						

Local community groups (e.g. Grey Nomads, surf clubs)						
Local online groups (e.g. Twitter feed or Facebook page of local community group)						
Other (please specify)						

20. How likely are you to use social media in the future to look for information as a result of an extreme weather event such as a flood, storm, fire or heatwave?

Very likely
Quite likely
Neutral
Not very likely
Not at all likely

21. What would make you (even) more likely to use social media to look for information as a result of an extreme weather event such as a flood, storm, fire or heatwave in the future?

_____

22. Have you ever received information about an extreme weather event from social media *indirectly*, i.e., passed on to you by someone that found the information via social media— (e.g. had a conversation with a friend about a post they saw on social media in relation to a flood)?

Yes
No
Don't know/not sure

23. What information about an extreme weather event did you receive *indirectly* from social media?

Weather conditions or warnings
Road or traffic conditions
Damage caused by the event
The location or status of friends/family
Information about how others are coping with the extreme weather event
Eyewitness photographs or videos
What to do to keep yourself safe
Other (please specify)

24. How likely are you to act upon information from social media provided to you indirectly by friends or relatives as a result of an extreme weather event such as a flood, storm, fire or heatwave?

Very likely
Quite likely
Neutral
Not very likely
Not at all likely

25. What would make you (even) more likely to act upon information from social media provided to you indirectly by friends or relatives in the future as a result of an extreme weather event such as a flood, storm, fire or heatwave?

_____

26. Have you ever used social media to share information as a result of an extreme weather event such as a flood, storm, fire or heatwave (e.g. posted a status update about an accident, tagged a friend in a news story about a fire, uploaded a picture of a flood)?

Yes
No
Don't know/not sure

27. What kind of information have you shared using social media as a result of an extreme weather event such as a flood, storm, fire or heatwave?

Weather conditions or warnings
Road or traffic conditions
Reassurance that you are safe
Your feelings or emotions about what was happening
Your location
What actions you were taking to stay safe
An eyewitness description of something you experienced
Advice about what actions others should take to stay safe
An eyewitness photo
An eyewitness video
Other (please specify)

28. How likely are you to use social media in the future to share information with others during or after an extreme weather event such as a flood, storm, fire or heatwave?

Very likely
Quite likely
Neutral
Not very likely
Not at all likely

29. What would make you (even) more likely to use social media to share information as a result of an extreme weather event such as a flood, storm, fire or heatwave?

_____

30. Some people prefer now to look for information via social media rather than via TV, radio or traditional websites for the following reasons?

	Strongly agree	**Agree**	**Neither agree or disagree**	**Disagree**	**Strongly disagree**
The information via social media is available faster					
The information via social media is more accurate					
The information via social media is more accessible					
The information via social media is more reliable					
The information via social media is richer					

31. Imagine that you posted an urgent request for help or information on a social media site of a local emergency response organisation, such as your local police, coast guard, fire or medical emergency service. To what extent do you agree with the following statements?

	Strongly agree	**Agree**	**Neither agree or disagree**	**Disagree**	**Strongly disagree**
Emergency services should regularly monitor their social media so they can promptly respond to such a request.					

It is very likely that the emergency service will not know about this request.					
I would expect to get a response from them within an hour.					
Emergency services are too busy to monitor social media during an emergency.					

32. To what extent are you aware or have you heard of the following services provided via social media?

	Very aware	**Moderately aware**	**Somewhat aware**	**Slightly aware**	**Not at all aware**
Twitter alerts - used by key organisations to send alerts during emergencies.					
Facebook safety checks - allows you during an emergency to let friends and family know you and friends are safe.					

33. To what extent do you agree with the following statements?

	Strongly agree	**Agree**	**Neither agree or disagree**	**Disagree**	**Strongly disagree**
Information on social media from emergency services organisations meets my information needs					
My information needs during extreme weather events are very specific					
I prefer to use community groups on social media to obtain information about extreme weather events because the information is tailored to my needs					
I get most information related to my specific situation offline rather than through social media during extreme weather events					

34. Is there anything else you want to mention with regard to the use of social media before, during or after an extreme weather event such as a flood, storm, fire or heatwave?

Appendix Two – Summary Tables for Quantitative Analysis

Independent variable	**Dependent variable**	**Kruskal-Wallis H test χ^2, *df*, and *n***	***p*-value**	**Mean rank for each vulnerability type**	**Post hoc paired Mann-Whitney test ($p < .05$)***
Vulnerability type (i.e., Aged 60+, LSE, PL or GSI)	Twitter	8.206, 3, 167	.042	Age 60+ = 64.38 LSE = 84.90 PL = 83.40 GSI = 94.06	Age 60+ use Twitter significantly less than: • GSI
	Instagram	20.726, 3, 167	< .001	Age 60+ = 53.87 LSE = 86.35 PL = 78.12 GSI = 100.83	Age 60+ use Instagram significantly less than: • LSE • GSI
	YouTube	14.470, 3, 167	.002	Age 60+ = 59.75 LSE = 93.29 PL = 74.19 GSI = 92.41	Age 60+ use YouTube significantly less than: • LSE • GSI
	Chat tools	10.025, 3, 167	.018	Age 60+ = 60.37 LSE = 86.81 PL = 88.54 GSI = 91.88	Age 60+ use chat tools significantly less than: • GSI

Table A1. Kruskal-Wallis H test and post hoc paired Mann-Whitney test analyses of vulnerability type by SM application use

Note: (i) *Significance values have been adjusted by the Bonferroni correction for multiple tests

Independent variable	**Dependent variable**	**Kruskal-Wallis H test χ^2, *df*, and *n***	***p*-value**	**Mean rank for each vulnerability type**	**Post hoc paired Mann-Whitney test ($p < .05$)***
Vulnerability type (i.e., Aged 60+, LSE, PL or GSI)	In my private life, I use SM very often	18.143, 3, 167	< .001	Age 60+ = 53.15 LSE = 88.71 PL = 85.50 GSI = 95.32	Age 60+ use SM in their private lives significantly less than: • LSE • PL • GSI
	I regularly post messages on SM such as Twitter, Facebook or Instagram	12.228, 3, 167	.007	Age 60+ = 57.32 LSE = 91.78 PL = 89.60 GSI = 87.99	Age 60+ significantly less likely to post messages on SM than: • LSE • GSI
	Most of my friends use SM to keep in touch	16.553, 3, 167	.001	Age 60+ = 59.43 LSE = 85.96 PL = 76.35 GSI = 99.03	Age 60+ significantly less likely to perceive their friends use SM to stay in touch than: • LSE • GSI
	Emergency services should not trust information on SM†	12.390, 3, 167	.006	Age 60+ = 71.15 LSE = 75.22 PL = 81.02 GSI = 101.35	GSI respondents have significantly more positive attitude towards emergency services trusting information on SM than: • Age 60+ • LSE

Table A2. Kruskal-Wallis H test and post hoc paired Mann-Whitney test analyses of

vulnerability type by measures of SM use and trust towards SM

Independent variable	**Dependent variable**	**Kruskal-Wallis H test χ^2, *df*, and *n***	***p*-value**	**Mean rank for each vulnerability type**	**Post hoc paired Mann-Whitney test ($p < .05$)***
Vulnerability type (i.e., aged 60+, LSE, PL or GSI)	Awareness of safety service provided by 'Twitter alerts'	19.810, 3, 167	< .001	Age 60+ = 53.85 LSE = 83.31 PL = 83.98 GSI = 101.15	Age 60+ significantly less likely to be aware of 'Twitter alerts' than: • GSI • LSE
	Awareness of safety service provided by 'Facebook safety checks'	18.724, 3, 167	< .001	Age 60+ = 55.58 LSE = 95.60 PL = 71.33 GSI = 93.68	Age 60+ significantly less likely to be aware of 'Facebook safety checks' than: • GSI • LSE

Table A3. Kruskal-Wallis H test and post hoc paired Mann-Whitney test analyses of vulnerability type by awareness of Twitter alerts and Facebook safety checks

*Note: (i) *Significance values have been adjusted by the Bonferroni correction for multiple tests*

Independent variable	**Dependent variable**	**Kruskal-Wallis H test χ^2, *df*, and *n***	***p*-value**	**Mean rank for each vulnerability type**	**Post hoc paired Mann-Whitney test ($p < .05$)***
Vulnerability type (i.e., aged 60+, LSE, PL or GSI)	Helpfulness of information sought via SM from emergency response organisations (e.g. police, fire brigade)	11.706, 3, 167	.008	Age 60+ = 83.87 LSE = 72.46 PL = 67.87 GSI = 97.30	GSI rated perceived helpfulness of information sought via SM from EROs significantly higher than: • LSE • PL
	Helpfulness of information sought via SM from local community groups (e.g. Grey Nomads, Surf clubs)	10.509, 3, 167	.015	Age 60+ = 60.55 LSE = 70.94 PL = 48.29 GSI = 79.26	GSI rated perceived helpfulness of information sought via SM from local community groups significantly higher than: • PL
	Helpfulness of information sought via SM from local online groups (e.g. Twitter feed or Facebook page of local community group)	9.202, 3, 167	.027	Age 60+ = 69.98 LSE = 84.06 PL = 59.88 GSI = 88.78	GSI rated perceived helpfulness of information sought via SM from local online groups significantly higher than: • PL

Table A4. Kruskal-Wallis H test and post hoc paired Mann-Whitney test analyses of vulnerability type

by perceived helpfulness of information about extreme weather events sought via SM from different organisations

*Note: (i) *Significance values have been adjusted by the Bonferroni correction for multiple tests*

Independent variable	**Dependent variable**	**Kruskal-Wallis H test χ^2, *df*, and *n***	***p*-value**	**Mean rank for each vulnerability type**	**Post hoc paired Mann-Whitney test ($p < .05$)***
Vulnerability type (i.e., aged 60+, LSE, PL or GSI)	How likely are you to use SM in the future to look for information as a result of an extreme weather event such as a flood, storm, fire or heatwave?	12.666, 3, 167	.005	Age 60+ = 64.85 LSE = 94.19 PL = 71.23 GSI = 90.18	Age 60+ significantly less likely to perceive they'll seek information from SM in the future than: • LSE

Table A5. Kruskal-Wallis H test and post hoc paired Mann-Whitney test analyses of vulnerability type by likelihood of using SM in the future to obtain information about extreme weather events

*Note: (i) *Significance values have been adjusted by the Bonferroni correction for multiple tests*

Independent variable	**Dependent variable**	**Kruskal-Wallis H test χ^2, *df*, and *n***	***p*-value**	**Mean rank for each vulnerability type**	**Post hoc paired Mann-Whitney test ($p < .05$)***
Vulnerability type (i.e., aged 60+, LSE, PL or GSI)	People prefer to look for information via SM rather than TV, radio or traditional websites because the information is available faster	27.028, 3, 167	< .001	Age 60+ = 51.75 LSE = 93.17 PL = 70.00 GSI = 98.87	LSE and GSI significantly more likely to think people prefer to look for information on SM because it is faster than: • 60+ LSE significantly more likely to think people prefer to look for information on SM because it is faster than: • PL
	People prefer to look for information via SM rather than TV, radio or traditional websites because	21.213, 3, 167	< .001	Age 60+ = 61.35 LSE = 98.09 PL = 62.31 GSI = 92.26	LSE and GSI significantly more likely to think people prefer to look for information on SM because it is more accessible than: • 60+ • PL

	the information is more accessible				
	People prefer to look for information via SM rather than TV, radio or traditional websites because the information is more reliable	9.644, 3, 167	.022	Age 60+ = 69.43 LSE = 83.89 PL = 71.90 GSI = 97.77	GSI significantly more likely to think people prefer to look for information on SM because it is more reliable than: • 60+

Table A6. Kruskal-Wallis H test and post hoc paired Mann-Whitney test analyses of vulnerability type by perceived reasons people prefer to look for information via SM compared to other information sources

*Note: (i) *Significance values have been adjusted by the Bonferroni correction for multiple tests*

Independent variable	**Dependent variable**	**Kruskal-Wallis H test χ^2, *df*, and *n***	***p*-value**	**Mean rank for each vulnerability type**	**Post hoc paired Mann-Whitney test ($p < .05$)***
Vulnerability type (i.e., aged 60+, LSE, PL or GSI)	Emergency services should regularly monitor their SM so they can promptly respond to urgent requests for help.	16.208, 3, 167	.001	Age 60+ = 55.38 LSE = 88.45 PL = 82.17 GSI = 95.95	GSI and LSE significantly more likely to think emergency services should regularly monitor their SM than: • Age 60+
	If I posted an urgent request for help on the SM site of a local ERO I would expect to get a response from them within an hour.	9.332, 3, 167	.025	Age 60+ = 71.20 LSE = 86.84 PL = 67.46 GSI = 95.91	• No significant pairwise differences
	Emergency services are too busy to monitor SM during an emergency.	8.056, 3, 167	.045	Age 60+ = 82.18 LSE = 73.33 PL = 80.08 GSI = 97.71	GSI significantly more likely to think emergency services are too busy to monitor SM than: • LSE

Table A7. Kruskal-Wallis H test and post hoc paired Mann-Whitney test analyses of vulnerability type by expectations of emergency services' use of SM

*Note: (i) *Significance values have been adjusted by the Bonferroni correction for multiple tests*

Independent	**Dependent**	**Kruskal-**	***p*-value**	**Mean rank for each**	**Post hoc paired Mann-**

variable	variable	Wallis H test χ^2, *df*, and *n*		vulnerability type	Whitney test ($p < .05$)*
Vulnerability type (i.e., aged 60+, LSE, PL or GSI)	Information on SM from emergency services organisations meets my needs	14.886, 3, 167	.002	Age 60+ = 63.13 LSE = 86.97 PL = 70.17 GSI = 98.19	GSI significantly more likely to think information on SM from ESOs meets their needs than: • Age 60+ • PL
	My information needs during extreme weather events are very specific	18.273, 3, 167	< .001	Age 60+ = 64.00 LSE = 80.84 PL = 71.96 GSI = 103.82	GSI significantly more likely to think their information needs during extreme weather event are very specific than: • Age 60+ • LSE • PL
	I get most information related to my specific situation offline rather than through SM during extreme weather events	9.043, 3, 167	.029	Age 60+ = 74.48 LSE = 82.30 PL = 68.88 GSI = 98.06	• No significant pairwise differences

Table A8. Kruskal-Wallis H test and post hoc paired Mann-Whitney test analyses of vulnerability type by participant's information needs during extreme weather events

*Note: (i) *Significance values have been adjusted by the Bonferroni correction for multiple tests*

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