

# Increasing adoption despite perceived limitations of social media in emergencies: Representative insights on German citizens' perception and trends from 2017 to 2021

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## ABSTRACT

The value of social media in crises, disasters, and emergencies across different events, participants, and states has been examined in crisis informatics research. While some studies examined social media use representatively for their target audience, these usually only comprise a single point of inquiry and do not allow for a trend analysis. This work provides results (1) of a representative survey with German citizens from 2021 on use patterns, perceptions, and expectations regarding social media during emergencies. Furthermore, it (2) uses longitudinal data and compares these results to previous surveys and provides insights on temporal changes and trends from 2017, over 2019 to 2021. Our findings highlight that social media adoption in emergencies increased in 2021 and 2019 compared to 2017. Between 2019 and 2021, the amount of information shared on social media remained on a similar level, while the perceived disadvantages of social media in emergencies significantly increased. In light of demographic variables, the results of the 2021 survey confirm previous findings, according to which older individuals (45+ years) use social media in emergencies less often than younger individuals (18–24 years). Furthermore, while the quicker availability of information was one of the reasons for social media use, especially the potential information overload was a key factor for not using social media in emergencies. The results are discussed in light of the dynamic nature of attitudes regarding social media in emergencies and the need to account for heterogeneity in user expectations to build trustworthy information ecosystems in social media.

## 1. Introduction

Social media became an integral part of everyday life with around 4.6 billion users worldwide, which accounts for nearly 60% of the world's population [1]. This large number of social media users has increased significantly in recent years, as ten years ago, this figure was still around 1.5 billion. Change can be observed here both in the user numbers of individual platforms and in the associated relevance of respective platforms. According to the Digital 2022 report [1], the social media platforms with the largest active user base are Facebook with around 2.9 billion, YouTube with around 2.6 billion, WhatsApp with around 2 billion, Instagram with around 1.5 billion, WeChat with around 1.3 billion, TikTok with around 1 billion, and Twitter with approximately 436 million monthly users. The increasing use of mobile phones enables users to communicate and document whenever, whatever, and however (e.g., texts, videos, pictures) they want to Ref. [2]. This also facilitates the use of social media in any situation. In this context, social media has also been used during emergencies for at least two decades: After September 11, 2001, for example, wikis created by ordinary citizens

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were used to gather information about missing persons [3], and the US Federal Emergency Management Agency (FEMA) and the Red Cross used Web-based technologies to inform the public and make status reports available internally and externally [4]. Social media nowadays serve an important function in disaster risk reduction and disaster communication: in a bidirectional setting it does not only provide an additional channel for emergency services to disseminate information for both emergency preparedness and response, citizens may also publish important information (e.g., multimedia files and status updates) to enhance the situational awareness of emergency services [5]. As social media platforms rank as the fourth most popular source to access emergency information [6]. The use of social media by local governments to communicate with citizens in times of crisis is also increasing [7].

The COVID-19 pandemic shook the world and put even countries that are rarely affected by crises into an emergency situation. A large part of managing the global crisis consisted of limiting personal contact as much as possible and spending as much time as possible at home to contain the spread of the virus [8]. Therefore, governments worldwide restricted citizen mobility, physical gatherings, and public life [9]. This resulted in citizens spending a lot of time at home in front of their computers or mobile phones. Thus, a lot of work, classes, or lectures were moved to platforms online [10–12]. Accordingly, in order to be in contact with other people, social media and technology assumed an even greater role in many facets of everyday life [8,13]. Even less tech-savvy people were dependent on such digital tools from one day to the next. Therefore, people's digital practice changed drastically and a “new virtual togetherness” emerged by switching from physical and location-dependent interactions to virtual ones [13]. However, not only individuals used social media during the COVID-19 pandemic. Among other things, a multitude of new apps were developed [14] and governments around the world have been organizing activities to promote citizen participation during the lockdown, such as in Spain [15].

As some of these developments have positive effects [13], at the same time many people emphasize that this health crisis is also an information crisis [16]. For instance, during the COVID-19 pandemic, a plethora of misleading information circulated globally via social media and increasingly became the subject of interdisciplinary research [17,18]. The pandemic further contributed to an elevated perception of living in a time of crisis: the long-term crises of the COVID-19 pandemic, the climate crisis, and the associated risk of disasters [19,20], as well as Russia's current war against Ukraine [21] are important examples. This feeling is also noticeable in Germany, where the population was lucky enough to be barely impacted by crises for many years. However, in summer 2021, large parts of Germany were affected by a severe flood, which not only caused terrible damage but also cost human lives [22].

Do the recent crises and the resulting increase in digitalization in all areas of life or the perception of living through a time of crisis change attitudes and expectations towards the use of social media in crisis situations? Interactions via social media have become an important part of responding to crises, including disasters and political unrest. They are leveraged by both professional emergency services (ES) and volunteers for information sharing, expressing solidarity, and coordinating actions [23].

Since around 2006, social media use in emergencies and crises emerged as a major research field. Often referred to as crisis informatics, the research domain “views emergency response as an expanded social system where information is disseminated within and between official and public channels and entities” [3]. Despite the growing body of research analyzing social media use in emergencies, the knowledge about different usage patterns, differences in platform adoption, and underlying intentions is still limited. Furthermore, there is little work examining attitudinal and perceptual factors, particularly citizens' attitudes in such contexts. For example, most studies focus on the specific use of social media during a particular emergency [23]. Further, the relevance and popularity of individual platforms is changing over time. Accordingly, a change could also be observable in the use of social media or the expectations and attitudes users have of them in emergency situations, such as during the COVID-19 pandemic. However, research on changes of citizens' use and perception of social media over the years is still limited. Our work thus strives to answer the following research questions:

- What were German citizens' use patterns, perceptions, and expectations towards social media during emergencies in 2021 (RQ1)?
- How did these patterns, perceptions, and expectations regarding social media during emergencies change between 2017 and 2021 (RQ2)?

In this paper, we analyze the attitudes of the population of Germany towards the use of social media in emergency situations. In this context, our empirical contribution is twofold: Our main focus is on providing insights from a (1) current representative survey from 2021. Our results indicate that traditional sources of information are still preferred over social media in emergencies, that citizens often have no clear expectations how emergency services should deal with social media, and that younger individuals use social media in emergencies more often than older ones. Furthermore, while potential information overload is a barrier to using social media in emergencies, the faster availability of information facilitates the use of social media in emergencies. In comparison to existing surveys analyzing social media in emergencies, we also take the current results as an opportunity to identify (2) trends and changes in attitudes over time compared to results from previous surveys (2017 and 2019). Among others, we saw that the use of social media in emergencies increased from 2017 to 2021, although the perceived disadvantages of social media use were rated more severe in 2021. After reviewing related work (Section 2), we describe our survey methodology (Section 3), and present the quantitative results (Section 4). After that, we discuss the results (Section 5) and draw a conclusion (Section 6).

## 2. Related work

The use of social media in emergencies has considerably increased since 2001. This appears to be true irrespective of the emergency's extent [24]. In light of this trend, it is no surprise that the importance of social media for emergency services is increasing, both for preventive purposes and in the event of emergencies [25]. A variety of events can be covered by the term *emergency*. In the context of this work and hence in distinction to prior work focusing on bigger disasters [26–30], we choose a broad definition [31,32] of emergencies, referring not only to academically conceptualized emergencies and disasters [28], but also to emergency situations in

which only a few individuals may be affected and call upon emergency services' standard procedures for help (e.g., burglary). Adopting a broad emergency notion acknowledges that diverse participants may define emergencies in light of prior experience and common understanding of the notion; the shared interpretation informs individual action and establishes the circumstances that social media may address in these situations. Since citizens' attitudes towards social media are the core of our research interest, we assumed that there is no differentiation between social networking sites, instant messengers, and mobile apps with communication functionalities among our participants. Hence, we adopt Kaplan et al.'s [33] definition of social media.

In each of the emergency scenarios described, communication via social media may prove beneficial. As incidents usually differ by their nature and scope, actions pursued by individuals via social media may differ significantly. Citizens, however, may also have high expectations towards emergency services and want to contact them regardless of the emergency type. Unlike other studies that, for example, only focus on the perceptions of people directly involved, we defined individuals as users of social media during emergencies regardless of whether they were directly involved as a primary source of information, as this can also generate interesting insights.

### 2.1. The use of social media in everyday life and emergencies

Numerous quantitative studies document the general prominence of social media in people's everyday lives. For instance, a 2021 survey found that 72% of U.S. residents over the age of 18 use them [34]. In addition, a 2017 survey revealed that more than two-thirds of American adults use social media to obtain news [35]. Social media adoption in the U.S. has stagnated in recent years after a decade of steady growth [36]. Whereas between 2018 and 2019 only Instagram significantly increased the share of users in the total population [36], only Reddit and YouTube achieved this between 2019 and 2021 [34]. Social media use among the German population over the age of 14 is surveyed annually on behalf of the German public broadcasters. In contrast to the US, the adoption is lower, with a total of 59% of Germans using social media in 2021 [37]. However, with regard to the proportion of Germans using social media on a daily basis, a clear increase can be observed in recent years. It has increased from 25% in 2019 [38] to 31% in 2021 [37]. A breakdown of the proportion of Germans who use individual platforms at least weekly reveals a more differentiated picture. Whereas between 2018 and 2021 the share of weekly users of Snapchat (2019: 7%; 2020: 9%; 2021: 10%), Twitter (2019: 4%; 2020: 5%; 2021: 4%), XING (2019: 3%; 2020: 4%; 2021: 3%), LinkedIn (2019: 2%; 2020: 4%; 2021: 3%), and Twitch (2019: 4%; 2020: 3%; 2021: 5%) remained relatively constant, an increasing trend becomes evident with regard to WhatsApp (2019: 63%; 2020: 68%; 2021: 70%), Instagram (2019: 19%; 2020: 20%; 2021: 26%), and Tiktok (2019: 2%; 2020: 3%; 2021: 9%), and a slightly decreasing trend with regard to Facebook (2019: 31%; 2020: 26%; 2021: 28%) [37–39]. Over this period, no comparative data is available for YouTube. However, in 2021 21% of Germans watched TV shows and 34% other content on the platform at least weekly [37].

Besides everyday life, crisis informatics research [40] examines opportunities and challenges of social media usage in emergencies by both authorities, such as emergency services [5,41], and citizens [42,43]. Previous research has contributed to the state of the art with empirical insights on the use of social media, approaches for the gathering and processing of big social data, and the design and evaluation of information systems [24,44]. Initially, published studies primarily focused on the examination of English social media data originating from a limited number of platforms, especially Twitter [45]. While the vast majority of case studies were based on US-located emergencies, the research was soon complemented by a trend of non-US case studies [46,47], such as in Asia [48–52] or Europe [53–55]. These often qualitative studies are complemented by quantitative studies about the attitudes of both authorities and citizens on social media use in emergencies [5,56], for example, to inform the design of guidelines for the use of social media in emergencies [41,57].

The range of different emergency situations, reactions to them and the wealth of case studies by renowned researchers such led to the categorization of the possible uses of social media. Following this approach, a classification matrix for cooperation during crises that depends on both the sender and the recipient of digital content was elaborated by Reuter et al. [58]. Including citizens (C) and authorities (A), for example emergency services, the matrix differentiates between four information flows: Crisis communication (A2C), self-help communities (C2C), inter-organizational crisis management (A2A), and the incorporation of citizen-generated content (C2A). By analyzing data sets of various emergencies, Olteanu et al. [59] identified, information on affected individuals, donations and volunteering, sympathy and emotional support, caution and advice, infrastructure and utilities, and other useful information as the information types usually discussed on social media during emergencies. The categorization of information is often used as an input for machine learning algorithms supporting the automatic assessment of information credibility or detection of relevant content, among others [60,61].

The research on usage patterns and information types was complemented by the identification of different social media roles in emergencies. Most remarkably, Starbird and Palen [62] established the notion of *digital volunteers*, which was quickly supplemented by Reuter et al. [63], who proposed different types of social media users and a differentiation of roles in the real and virtual realm, leading to the design of a role typology [23]. According to the typology, roles were identified that either belong to the domain of citizens (public) or authorities performing their activities in the real or virtual realm. Besides both emergent citizen groups and incident management teams operating in the real realm, social media brought forward independent volunteer and technical communities (V&TCs) [64] and virtual operation support teams (VOSTs) [65], which comprise of *trusted volunteers* [66] assisting emergency services in the monitoring and analysis of social media data, in the virtual realm.

### 2.2. Quantitative research on citizens' perception of social media use in emergencies

Different quantitative surveys examined the use of social media in emergencies. While the following is a brief overview of this research, key results of these are also summarized in Table 1. In 2012, the American Red Cross [67] conducted an online survey with 1017 respondents and a telephone survey with 1,018 respondents to examine how citizens use social media during emergencies. More

**Table 1**

Key findings from related quantitative studies and findings that will be reported in this paper.

<b>Adoption of SM in everyday life</b>
<ul style="list-style-type: none"> <li>US 2021/DE 2021: Majority of citizens uses SM (72%/59%) [34,37]</li> <li>US 2018/2021: Adoption of most SM platforms stagnates [34,36]</li> <li>DE 2019/2021: Proportion of daily SM users increased (2019: 25%; 2021: 31%) [37,38]</li> <li>DE 2019/2020/2021: Constant proportion of weekly users of Snapchat, Twitter, XING, LinkedIn, and Twitch, increasing trend for WhatsApp, Instagram, and Tiktok, decreasing trend for Facebook [37–39]</li> <li>DE 2021, 2019, 2017: Overall SM use remains constant (2017: 98%; 2019: 97%; 2021: 98%)</li> </ul>
<b>SM usage in emergencies</b>
<ul style="list-style-type: none"> <li>US 2012/CA 2012/INT 2014/INT 2015: Traditional news sources are preferred over SM [67–70]</li> <li>US 2012: 12% used SM to seek or share information [67]</li> <li>INT 2015: 43% used SM to seek information, 27% used SM to share Information, 58% are likely to seek information on SM [70]</li> <li>CN 2020: 55% of SM users sought and 45% shared pandemic-related information on SM [71]</li> <li>AU 2021: 26% used SM to seek or share information. For this, Facebook (90%) and Twitter (27%) were most common [72]</li> <li>DE 2021, 2019, 2017: Traditional news sources are preferred over SM (2021)</li> <li>DE 2021, 2019, 2017: SM use in emergencies increased (2017: 54%; 2019: 89%; 2021: 70%)</li> <li>DE 2021, 2019, 2017: WhatsApp (57%), Facebook (except messenger) (33%), YouTube (26%) and Facebook Messenger (22%) as most commonly used SM (2021)</li> <li>DE 2021, 2019, 2017: Messengers are rather used to share information, SM platforms are rather used to search for information (2021)</li> </ul>
<b>Impact of demographic characteristics on SM usage in emergencies</b>
<ul style="list-style-type: none"> <li>US 2012: Younger people, households with children, holders of college degrees more likely to use SM [67]</li> <li>AU 2021: Women and households with children are more likely to use SM [72]</li> <li>CROSS 2015: Women and citizens with children view SM use more positive [70]</li> <li>DE 2021, 2019, 2017: Younger people are more likely to use SM (2021)</li> </ul>
<b>Searched information in emergencies</b>
<ul style="list-style-type: none"> <li>US 2012/INT 2015: Weather (79%/78%), traffic information (64%/70%), and damage caused by event (62%/63%) as most searched information [67,70]</li> <li>INT 2014: Situational and practical information of highest interest [68]</li> </ul>
<b>Shared information in emergencies</b>
<ul style="list-style-type: none"> <li>CA 2012: Intention to use SM to inform loved ones about own safety [69]</li> <li>US 2012: Weather (58%), own safety status (55%), and own feelings (55%) most shared [67]</li> <li>INT 2015: Weather warnings/conditions (66%), traffic or road conditions (64%), and photos of eyewitnesses (53%) most shared [70]</li> <li>DE 2021, 2019, 2017: Temporal differences in most shared information types (2017, 2019, 2021)</li> <li>DE 2021, 2019, 2017: No change in amount of shared information between 2019 and 2021</li> </ul>
<b>Advantages of SM in emergencies</b>
<ul style="list-style-type: none"> <li>INT 2014: SM as useful communication channels to disseminate and receive information [68]</li> <li>INT 2014: Citizens could support disaster response by providing situational information [68]</li> <li>CROSS 2015: Faster availability (77%) and higher accessibility (54%) of SM [70]</li> <li>CN 2020: SM is faster (81%), more accessible (77%), richer in content (74%), more accurate (59%), and more reliable (53%) than traditional media [71]</li> <li>DE 2021, 2019, 2017: Faster availability (2019: 61%; 2021: 57%) and higher accessibility (2019: 60%; 2021: 56%) of SM</li> <li>DE 2021, 2019, 2017: Perceived faster availability of SM is associated with more frequent SM use in emergencies</li> </ul>
<b>Disadvantages of SM in emergencies</b>
<ul style="list-style-type: none"> <li>INT 2014: Limited reach, unreliable information, no control over information dissemination, spread of misinformation [68]</li> <li>INT 2015: Untrustworthy information - 38% would not trust messages on SM, except from official sources, 30% think ES should also not trust information on SM [70]</li> <li>AU 2021: High amount of irrelevant messages (53%) [72]</li> <li>DE 2021, 2019, 2017: False rumors (2019: 54%; 2021: 76%), unreliability during emergencies (2019: 54%; 2021: 51%), and data privacy (2019: 50%; 2021: 49%)</li> <li>DE 2021, 2019, 2017: Perceived disadvantages of SM more serious in 2021 compared to 2019</li> <li>DE 2021, 2019, 2017: Perceived information overload represents a barrier to SM use in emergencies</li> </ul>
<b>Expectations towards ES</b>
<ul style="list-style-type: none"> <li>INT 2015: SM use by ES is important (73%) [70]</li> <li>INT 2016–2017: Expectations towards SM by ES vary for different risk cultures [73]</li> <li>INT 2015/US 2012/CA 2012: Regular monitoring of own SM pages (69%/70% 66%) [67,69,70]</li> <li>CA 2012: 63% expect help upon SM request [69]</li> <li>US 2012/INT 2015: 36%/41% expect help/response upon SM request within 1 h [67,70]</li> <li>DE 2021, 2019, 2017: Consistent expectation that ES should continuously monitor social media (2019: 58%; 2021: 62%)</li> <li>DE 2021, 2019, 2017: ES should inform the population in everyday life (57%), use as many SM as possible (48%), and answering direct messages (46%), but should not adopt colloquial language used in SM (40%) (2021)</li> <li>DE 2021, 2019, 2017: Slightly increasing expectations towards SM use by ES, Increasing dissatisfaction with available SM offerings by ES (2019; 2021)</li> </ul>

The year refers to the time of data collection. Results of this study are presented in italics. Meaning of abbreviations: CA = Canada, CN = China, DE = Germany, ES = emergency services, INT = international, cross-country study, SM = social media, US = United States of America.

than half of the interviewees use social media every day. The study shows that social media is primarily used to both seek and share information, however, this has only actually been done by 12% of the population in an emergency situation. It is interesting to note that while the study participants are primarily interested in *factual* information regarding weather (79%), traffic information (64%), and damage caused by the event (62%), they are actually more inclined to share personal information. The study also underscored that whereas social media is an increasingly popular source of emergency information, TV, radio, online news as well as emergency apps are still more popular sources in this regard. The most trusted sources include family and friends (80%), local emergency offi-

cials (79%), and news media (or reporters) (77%). The study also focused on age and social media use, finding that younger people are more likely to use social media in emergencies (85% of 18–34 year olds vs. 60% of 35 year olds and older), as are households with children (78% vs. 64%). Similarly, it appears that individuals with a college degree would be more likely to rely on the use of social media in emergency situations (74% vs. 36%).

Within the framework of an iSAR + project study, 130 crisis management professionals and 317 citizens were surveyed on the opportunities and challenges of integrating social media into crisis response management [68]. Respondents in this study see the main benefit of using social media in crisis situations as finding and sharing information. In emergency situations, social media are perceived primarily as a communication channel, especially for communicating with friends and family. Most of the respondents named the current status of the crisis development as well as any information that might prove useful in overcoming the crisis as particularly interesting information in such situations. An interesting result of this study also is that both groups of respondents answered the questions relatively similarly. Despite the advantages that respondents see in the use of social media, this study also concludes that traditional media are still the preferred way to obtain information during a crisis situation. In conclusion, interviewees generally had a positive attitude toward social media usage. It should be noted, however, that this study is not representative, since primarily students and people between 21 and 30 were surveyed.

The Canadian Red Cross conducted a study with 1000 Canadian citizens to examine the adoption of social media and mobile devices in crisis communication and what they expect from emergency services in terms of their current and future performance [69]. The survey showed that 84% of respondents use social media at least several times per week, with Facebook being by far the most used platform (97% of respondents participate here), the second most used platform according to this survey was YouTube (42%), followed by Twitter (24%). Participants were also asked about their expectations of emergency responders, to which 55% replied that they assume police and fire departments to currently monitor social media, at the same time respondents expect more in this regard. Further, 63% of respondents expect that emergency responders are prepared to respond to emergency calls on social media. Meanwhile, only one in three respondents thinks emergency services would currently respond to such a request for help posted on social media. Although expectations for emergency responders regarding social media are increasing, the majority still prefers traditional media to obtain information in a crisis situation. Respondents between the ages of 35–44, women, and those with children living in their household were particularly interested in such an offer. Thus, while social media were seen as a useful complement to established channels, they were not considered a substitute for traditional media.

Furthermore, to investigate the attitudes of citizens toward the use of social media in private and emergency contexts, Reuter and Spielhofer [70] analyzed a survey of 1034 citizens across Europe. When asked about their social media use, 63% of the respondents confirmed that they use social media on a daily basis. Facebook emerged as the most popular platform (73%), followed by YouTube (69%). At the same time, 62% of respondents stated to never use Twitter, and 73% of respondents also never use Instagram. However, the survey also revealed that in comparison to traditional media channels, respondents were less likely to use social media for information gathering in an emergency (42%). Further, the survey showed that young people and women were more likely to use social media. Thus, women and parents with children under the age of 18 had a significantly more positive perception of the use of social media in emergencies. It also showed that the extent of social media use decreased almost linearly with increasing age of the participants. Regarding their future use of social media in emergencies, more than half of participants (58%) said they were quite or very likely to use social media to seek information, highlighting different advantages of social media use in an emergency (see Table 1).

Another survey by Zander et al. [72] examined the Australians' use of social media during hazards. Using a sample of 1665 participants, they conclude that in emergency communication, social media remains underutilised. Of those who used social media in emergencies (26% of the total sample), a clear majority used it for information gathering (90%), while fewer people used it for alerting others about a hazardous situations (51%), and only 4% used it for both reasons. Most used Facebook (90%) and Twitter (27%) to seek or provide information during hazards. The regression model revealed that compared to people who relied on local authorities' decisions, those with a high capacity for emergency preparation were more likely to use social media in hazardous situations. Respondents who view social media platforms as the best source of real-time information in emergencies were 75% more likely to have utilized social media during a hazardous situation than those who indicated the opposite. While age failed to explain social media use in the event of a hazard, gender was an important factor, with females using social media more often than males. Households with children were also more likely to use social media during hazards, indicating that family structures may play a role in emergency communication. The main obstacles to social media use in hazardous situations were the dissemination of rumors and contradictory information (53%).

### 2.3. The use of risk cultures as a research framework

Research has also focused on different risk cultures [74], which dominate in certain countries of the world and are typically defined as a configuration by the criteria of *framing* incidents, *trust* towards authorities, and the target of *blaming* regarding the incident's impact [75]. Roughly, risk cultures have been characterized on a continuum of collectivism and individualism [76,77]. In state-oriented risk cultures, such as Germany or China [71], the population holds the view that disaster prevention is principally practicable, and usually interprets disasters as events determined not only by natural forces but also by the human environment. There is substantial trust in public authorities, who are expected to be capable of emergency prevention and management. There is also a considerable level of trust in the mass media and widespread adherence to official instructions, whereas the population exhibits only limited knowledge and little awareness regarding coping mechanisms, as well as a low level of confidence in individual capabilities. Citizens in individualistic risk cultures such as the Netherlands also believe that disasters can be avoided and negative consequences mitigated. Disasters are seen as situations that can be managed and controlled by humans. Although trust in the authorities is not exceptionally low, citizens nevertheless maintain the position that it is the responsibility of each individual to be informed about and pre-



pared for risks, demonstrating a comparatively broad knowledge of coping mechanisms. In a fatalistic risk culture, the population perceives hazards as “unpredictable and unavoidable,” thereby insinuating that nature or a divine power dominates humans. Due to previous shortcomings, distrust of authorities and the mass media is pronounced, with the latter usually perceived as clientelistic and subjective. In addition, there is little confidence in individual problem-solving capabilities. Despite their disillusionment, large segments of the population still expect state action in emergencies, although government communication (e.g., warnings) is not taken seriously.

Using the analytical lens of risk cultures, a quantitative study focusing on the usage of social media during emergencies among European countries (Germany, the Netherlands, Italy, and the United Kingdom) shows that there are differences in the current use of social media in emergencies [73]. Moreover, expectations towards social media monitoring by authorities, perceptions of barriers to social media use, and the likelihood of a future adoption of mobile apps vary across countries. The state-oriented culture is clearly reflected in the results of the study: The observation that at least two-thirds of German citizens expect regular social media monitoring by emergency services underscores the high expectations Germans have of their authorities. While findings on the Netherlands supported their previous identification as an individual-oriented risk culture with comparatively lower expectations towards authorities, only 37% of the UK's population share such expectations. Here, the prevailing risk culture is fatalistic, with little trust in authorities and mass media, and hazards are perceived as “unpredictable and unavoidable” [75]. The findings also indicate that the Italian population relies comparatively heavily on social media, which may reflect the frequency of disruptive events impacting wider segments of the population (e.g., disasters). In contrast to a more fatalistic risk culture, suggested in previous research, and with evidence of a willingness to take individual action, Italian respondents appear to be open to improving authorities' social media monitoring of emergencies.

Furthermore, Wang et al. [71] contribute findings on Chinese social media users' communication behaviors during public health emergencies. Their survey of 2074 participants shows that Chinese mobile social media users obtain information about the pandemic mainly from TV news (81%), mobile social media (78%), and text message alerts (54%). Furthermore, 55% of respondents indicated that they had utilized mobile social media to seek pandemic-related information, and 45% had shared pandemic-related information. Those results were higher than in Germany, Italy, the Netherlands, and the United Kingdom [73], which reported that 45% of respondents utilized social media to communicate during emergencies. However, only 18% of respondents have downloaded an emergency services-related app, which is a little more than Germany's 16%; this is in line with the expectation of the state-oriented risk culture, wherein citizens' strongly rely on the emergency agencies and the state to provide emergency rescue when they encounter emergencies. In general, many citizens agreed that as an information source, mobile social media was faster (81%), more accurate (59%), more accessible (77%), more reliable (53%), and richer in content (74%) than traditional media.

#### 2.4. Research gap

While there is a broad research landscape on social media in emergencies, it is often qualitative in nature, uses opportunity-based samples, and is often limited to a single social media platform [47,59]. The number of participants and amount of data might be high, but in a lot of cases they do not ensure representativeness in relation to the socio-demographic attributes of the target population, such as gender, age, income, education, and region. To some extent, this reduces the generalizability of the studies' findings from a methodological perspective [56]. Since previous representative surveys were conducted before recent high-impact emergencies, such as the COVID-19 pandemic [18] or the 2021 European floods [22], our study seeks to contribute with current and novel insights on use patterns, perceptions, and expectations of German citizens (first gap). Furthermore, with Germany (representing a state-oriented risk culture [75]), the results of this study can help to better understand developments in other countries which are also dominated by a state-oriented risk culture.

This research not only allows for generalizations, but also elucidates the often ignored social groups that do not engage on social media during crises [78]. Therefore, research that provides insights into general attitudes, how they are influenced by socio-demographic characteristics, and especially if and how usage and attitudes change over time [24], is still limited (second gap). Due to the general increase in social media adoption [1], we are interested particularly in the question whether (1) social media use during emergencies increases over time and whether (2) more information is shared via social media in emergencies. Furthermore, given the growing experiences with social media, we are also interested in the question of how (3) perceived disadvantages of social media in emergencies evolve over time (third gap). These gaps point to the necessity of quantitative and longitudinal work that could enable triangulation with more qualitative studies.

### 3. Method

This paper presents the results of a longitudinal study. These sub-studies were conducted in 2017 (N = 1024) [24], 2019 (N = 1219) [78], and 2021 (N = 1090), respectively. The approach presented here is a longitudinal *trend* study as opposed to a longitudinal *panel* study. Thus, rather than surveying the same individuals each year, a new sample was collected [79]. Therefore, conclusions can be drawn about trends in general, as opposed to deriving trends at the individual level. While the focus is on the latest study of 2021, a comparison makes it possible to observe whether social media expectations and behavior have undergone any changes in the recent years. Since social media is a fast-developing field, even these short time intervals can yield interesting insights. However, some of the items varied slightly between these surveys. For instance, more recent and detailed questions about social media platform use included in the most recent survey have been merged so that they cover the same dimensions included in other studies regarding social media use in emergencies. Because some items varied between years, comparisons could not always be made between all three samples. In addition, respondents' notions of *social media* might have also evolved over time.

### 3.1. Survey design

The surveys generally comprised 15 questions, most of which had a closed-response format, with the exception of three questions that had open-ended response options (see appendix for questions). First, participants were asked about their consent for participation (Q1), age (Q2), gender (Q3), education (Q4), region (Q5), and income (Q6). They were then asked how frequently they use social media in everyday life (Q7), whether they were ever affected by an acute emergency (Q8), and how helpful they considered different information sources in emergencies (Q9). Thereafter, they were asked to which extent they used different social media (Q10) and which types of information they shared (Q11) during emergencies. We then requested participants to assess the benefits (Q12) and barriers (Q13) of social media use. Besides primarily 5-point Likert scale items (Do not agree at all – Fully agree), participants were given the opportunity to add open-ended answers to the latter two questions. Furthermore, we elicited the participants' expectations to emergency services' activities in social media (Q14). The last question was open-ended and sought more details about respondents' social media experiences in emergencies (Q15). Since the open-ended questions were not mandatory, only a few participants provided answers ( $N < 30$ ). Therefore, the analysis primarily focuses on the quantitative data and only occasionally uses the open-ended responses for illustration - no formal content analysis was conducted here due to the small number and short nature of the open-ended responses.

Participants were familiarized with the relevant terminology. Emergencies were described as unexpected events (e.g., earthquakes, epidemics, fires, floods, or severe accidents) that affect multiple people and warrant immediate intervention to mitigate negative impacts. Social media were described analogously to the German dictionary as social networks that allow users to interconnect, communicate, exchange, and create content. For all items developed, we adhered to standards for valid item formulation, specifically positive, unambiguous, brief, concise, and comprehensible wording, a restriction to one statement per item, and the avoidance of suggestive questions [80]. Although questions should relate to the present, we drew on past experience due to the rarity of emergencies. Therefore, potential memory effects should be factored in when evaluating the results. In summary, most questions were answered either on a 5-point Likert scale or on a categorical scale (e.g. age group, gender).

### 3.2. Data collection and ethical considerations

The latest survey was implemented using a panel of GapFish (Berlin) in November 2021. As an ISO-certified panel provider, GapFish can guarantee data, panel, and survey quality as well as security through a range of (segmentation) metrics for every survey conducted on its panel of 500,000 active respondents. Based on data from the Federal Statistical Office of Germany, the sample of  $N = 1090$  participants was selected to represent the German adult population in age, gender, education, federal states, and income (see Table 2). These characteristics allow us to draw inferences about the usage patterns of Germans with minimal biases, as it avoids selection biases that tend to occur in surveys that depend on where participants are recruited, typically privileging groups with more available time. The study was conducted in accordance with the requirements of the local ethics committee at our university. These requirements include, among others, the avoidance of unnecessary stress, the exclusion of risk and harm, and the anonymization of participants. Besides demographic variables, no particularly sensitive data (e.g. regarding ethnicity, religion, health data) was collected. Participants were transparently informed about the study's procedure and goals, and subsequently gave their informed consent to participate. The previous representative surveys in 2017 and 2019 were conducted by the same principles with the help of a panel provider (see Refs. [24,78] for details). The data is available here: <https://tudatalib.ulb.tu-darmstadt.de/handle/tudatalib/3832>.

### 3.3. Data analysis

The data was analyzed with Microsoft Excel and RStudio Version 4.0.5. The analysis consisted of three parts: First, (1) the data was descriptively analyzed to assess the response proportions for the Likert items and categorical items describing use cases and attitudes regarding social media in emergency situations. Furthermore, (2) inference statistics were calculated regarding demographic differences in social media use in emergencies in the latest sample of 2021. Finally, (3) inference statistics were calculated regarding longitudinal differences in behaviors, attitudes, and perceptions regarding social media use in crises.

For inferential statistics, the applied methods varied depending on the scale level of both dependent and independent variables. Specifically, we used (1) multiple logistic regression to assess demographic factors (age, gender, education) and perceived (dis-)advantages associated with social media use in crises. Furthermore, we used (2) Pearson's chi square test to assess differences in social media use (in general and in crises) and data sharing practices in different years. Finally, for assessing differences in perceived disadvantages of social media in crises in different years, we applied the Wilcoxon rank sum test. Corresponding p-values were corrected for multiple comparisons using the Benjamini-Hochberg method [81].

**Table 2**

Representative demographic variables and values of the 2021 sample. German federal states are represented by ISO 3166-2 abbreviations (e.g., BB represents DE-BB, which is the state of Brandenburg).

Variable	Values
Age	18–24 (8,9%), 25–34 (14,3%), 35–44 (15,0%), 45–54 (16,8%), 55–64 (18,3%), 65+ (26,6%)
Gender	Female (51,1%), male (48,7%), diverse (0,1%), not stated (0,1%)
Education	Lower secondary education (28,2%), middle or high school (55,9%), academic degree (16,0%)
State	BB (3,0%), BE (4,5%), BW (13,5%), BY (16,0%), HB (0,8%), HE (7,6%), HH (2,3%), MV (1,4%), NI (9,7%), NW (21,7%), RP (5,0%), SH (3,6%), SL (1,1%), SN (5,0%), ST (2,3%), TH (2,6%)
Income	Less than 1500€ (23,7%), 1500€ to 2600€ (30,9%), 2600€ to 4500€ (29,0%), more than 4500€ (16,4%)

In order to be able to perform these analyses, the dependent variables were created as follows:

- **Social media use in emergencies** (categorical: yes/no) was determined by the specific respective item (see Fig. 3), which asked which sources of information were used in crises (e.g. newspaper, television, social media, etc.).
- **Social media use in general** (categorical: yes/no) was determined by assuming that social media was used if any of the various social media explicitly mentioned (see Fig. 1) was used (Facebook, Twitter, YouTube, etc.).
- **Information Sharing** (categorical: yes/no) on social media in crisis situations was determined by assuming that information was shared when one of the various types of information (see Fig. 6) explicitly mentioned (weather conditions, confirmation that one is safe, an eyewitness picture, etc.) was responded to positively.
- Perceived **disadvantages of social media in crises** (ordinal: summed score) were determined by summing Likert-answers to the specific question (see Fig. 5) of which disadvantages are perceived (information is not reliable, information is not trustworthy, there are many rumors in social media, etc.).

#### 4. Findings

This section provides an overview of the results in terms of perceptions, attitudes, and behaviors regarding social media use in emergencies. Here, the focus is on the latest representative survey conducted in 2021. Still, a longitudinal perspective is taken to assess changes over time in perceptions, attitudes, and behaviors, compared to previously conducted surveys in 2017 and 2019. If no specific year is mentioned, the results refer to the latest survey of 2021.

##### 4.1. Social media use in general

First, the respondents were asked to indicate the extent to which they engage in certain activities related to social media use in general (see Fig. 1). Accordingly, 89% of respondents use a smartphone daily, if not hourly. Only 5% of respondents use their smartphone only every few days or once a week, and 5% of respondents never use a smartphone. The use of a smartphone is thus the activity that most respondents engage in. Activities that also had a high level of engagement were watching television with 79% of respondents doing this daily to hourly, listening to the radio with 62% of respondents doing this daily to hourly, and reading newspapers or magazines, which is done daily by 39% of respondents. Differences emerged with respect to the frequency of use of different social media applications: WhatsApp is used daily to hourly by 79% of respondents, Facebook by 45%, Instagram by 30%, TikTok by 11%, Telegram by 10%, Snapchat by 9%, and Twitter by 8%. Only 12% of respondents post content about themselves on a daily or hourly basis, while 36% never do.

We also asked the participants whether they had ever been affected by an emergency situation. The majority (60% of the participants) denied this, but about one third (31%) had already been affected by an acute emergency situation, while 8.5% of the respondents were uncertain in this regard. This result is interesting in light of the fact that the definition of such a situation, which we used in our survey and passed on to the participants, includes epidemics. Thus, each of the respondents should have already been affected by such a situation. This finding implies that the COVID-19 pandemic is not perceived as an emergency situation by some people, e.g. because there is no acute, short-term danger.

##### 4.2. Social media use in emergencies

###### 4.2.1. Which information sources are used in emergencies?

To explore the use of social media in emergencies with greater detail, we asked which sources of information respondents found most helpful in such situations. We specifically asked about experiences in acute emergency situations, which is why some respondents did not provide information here or indicated that they had not used it.

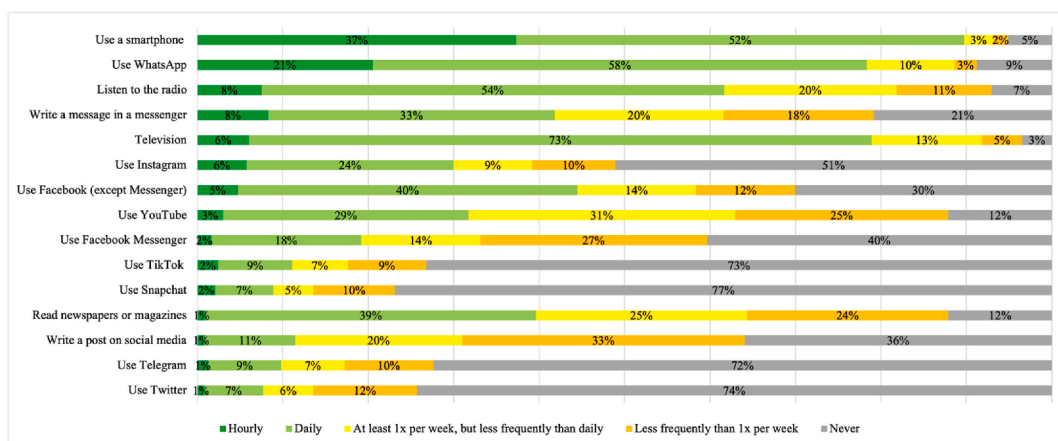


Fig. 1. Q7: Please indicate how often you engage in the following activities on average.



It can be observed (see Fig. 2) that respondents particularly valued personal conversations, such as contacting emergency services, as a quite helpful to very helpful (58%) source of information, as well as personal conversations with, for example, family members, friends, or neighbors (63%), or telephone calls to these trusted persons (62%). *Traditional* information sources, such as television or radio, were also rated as quite helpful to very helpful by 45% and 47%, respectively. Newspapers and magazines, by contrast, were considered as not very helpful or not helpful by 21% of respondents, although 22% of respondents rated them as fairly helpful to very helpful. Emergency apps such as KATWARN or NINA, on the other hand, were not (yet) used by 39% of respondents, although 31% of respondents rated them as quite helpful to very helpful.

Fewer respondents also considered social media a helpful source of information, with 28% of respondents rating them as quite helpful to very helpful, while 18% indicated that social media was absolutely or somewhat unhelpful as a source of information. Other Internet services were considered quite helpful to very helpful by 20% of respondents.

#### 4.2.2. Which social media channels are used in emergencies?

We also asked more specific questions about the extent to which respondents had used different social media channels in emergency situations (see Fig. 3). It is striking that in such situations only WhatsApp was used by the majority of respondents: Specifically, 24% of respondents used WhatsApp to share and search for information, 28% used the app only to share information, and another 5% used it only to search for information. At the same time, 44% of respondents stated that they had never made use of the app in a crisis situation. The frequent use of WhatsApp corresponds with participants' assessment of utility of information sources (see Q9), whereby contact with personal contacts, such as friends and relatives, or professional emergency services are considered to be the most helpful. All other social media services queried were not used by the majority in such a situation. The least used were TikTok, where 90% of respondents said they had not used it, Snapchat with 91%, Twitter with 88%, and Telegram with 87%. However, it should be noted at this point that these platforms generally have fewer users than the other platforms.

Overall, it can be seen that messenger services such as WhatsApp and Facebook Messenger were predominantly used to *share* information, while social media platforms such as Twitter, Instagram, Facebook, and YouTube were used rather to *search* for information. YouTube is particularly note-worthy, with the largest difference between the proportion of respondents who use the channel to search for information (18%) and the proportion who share information themselves (2%).

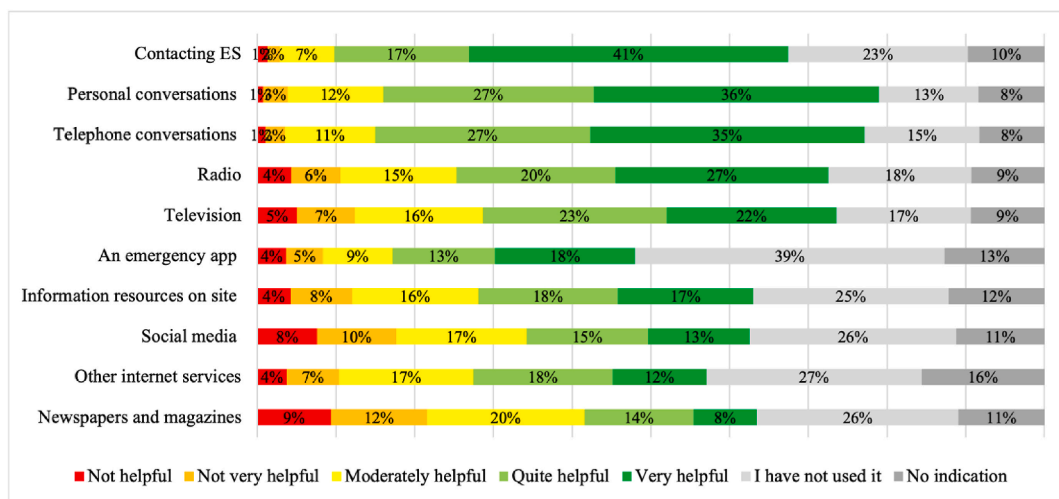


Fig. 2. Q9: Please indicate how helpful you considered the following sources of information in an emergency situation you have been affected by yourself.

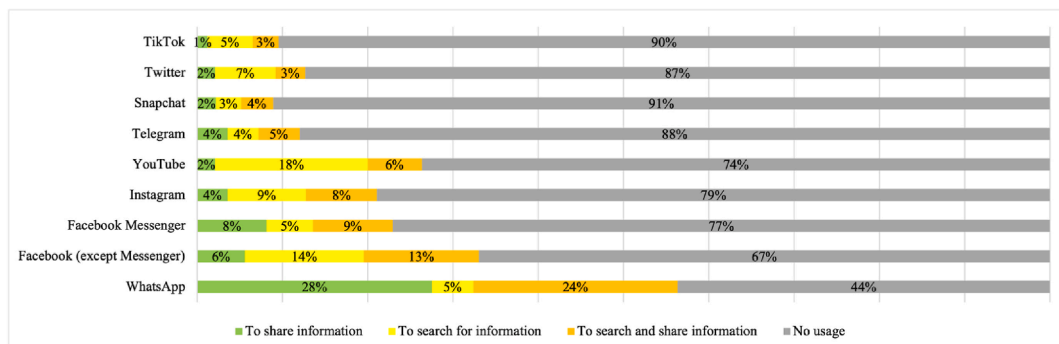


Fig. 3. Q10: Please indicate to what extent you have used the following social media in an emergency situation that affected you.

#### 4.2.3. Do demographic differences affect social media use in emergencies?

Apart from social media use patterns across the population, a relevant question concerns use patterns of specific social groups to allow for potentially targeted support. To assess this, we conducted a logistic regression with social media use in emergencies (yes/no) as dependent variable and age, gender, as well as education as predictors. The logistic regression model was statistically significant,  $\chi^2(15) = 92.66$ ,  $p = < .001$ . Older age groups above 45 years (45–54 years: OR = 0.27, 95% CI [0.12, 0.56]; 55–64 years:

OR = 0.21, 95% CI [0.09, 0.43]; 65+ years: OR = 0.12, 95% CI [0.05, 0.26]) thereby were less than half as likely to use social media in emergencies than younger individuals (18–24 years). For the predictors gender and education, on the other hand, no such effects were found (see Table 3). No differences can be observed between genders or different education groups.

#### 4.2.4. Which perceived advantages and disadvantages affect social media use in emergencies?

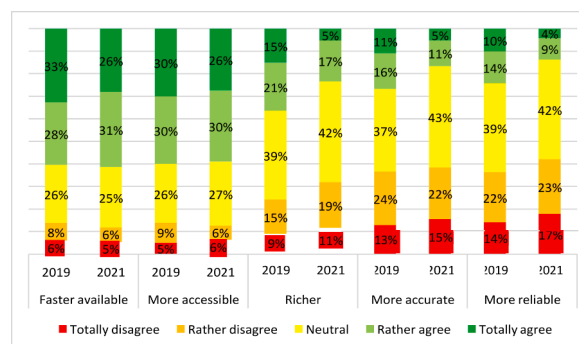
Apart from demographic factors, we also included perceived advantages (see Fig. 4) and disadvantages in the logistic regression (see Table 3) to shed light on reasons for use and non-use of social media in emergencies in the latest 2021 survey. Because some of these (dis-)advantages were highly correlated, only those items with a variance inflation factor below 2.5 [82] were included in the model. This revealed that especially the perceived disadvantage of *information overload* was associated with less social media use in emergencies. On the other hand, the perceived advantage of *quicker availability of information* was associated with more social media use in emergencies.

Open answers partly illustrated the reasoning behind this: regarding the potential information overload in social media, one person stated “In real emergencies, I prefer to rely on radio/TV, because in social media everyone wants to get rid of their own crap and effective help is rarely offered” (P186). Regarding the potential advantages, one person stated that if she were to get into an emergency situation, she “would probably use it to share with loved ones and possibly also to quickly find out about possible safe places” (P332). Others confirmed this view by stating that “During the pandemic, people were always quickly informed about the new measures” (P82) and “When the flood happened, one quickly got information about which areas were affected” (P335). Thus, the overall quicker and easier availability for a large number of people seems to be one of the facilitators for social media use in emergencies.

**Table 3**

Logistic regression for the dependent variable social media use in emergencies (yes/no) in the 2021 sample. Reference categories were age: 18–24 years, gender: male, education: academic degree. The statements refer to perceived advantages and disadvantages of social media in emergencies. Significant results at the level  $p = .05$  are marked with a \*.  $R^2 = 0.15$  (Cragg-Uhler), 0.09 (McFadden), 0.14 (Nagelkerke).

(Intercept)	Estimate	Std. Error	z value	Pr(>  z )
	1.9510	0.7652	2.55	0.0108
age: 25-34	−0.6490	0.4622	−1.40	0.1603
age: 35-44	−0.8250	0.4545	−1.82	0.0695
age: 45-54	−1.3443	0.4420	−3.04	0.0024*
age: 55-64	−1.4255	0.4427	−3.22	0.0013*
age: 65+	−1.8743	0.4441	−4.22	0.0000*
gender: female	−0.3134	0.1604	−1.95	0.0508
education: lower secondary education	−0.0958	0.2380	−0.40	0.6872
education: middle or high school	−0.2851	0.2928	−0.97	0.3303
“Too much information is published in social media (information overload)”	−0.2578	0.1101	−2.34	0.0192*
“False information is published in social media (e.g. fake news)”	−0.0009	0.1196	−0.01	0.9937
“There are many rumors on social media”	0.0689	0.1292	0.53	0.5938
“I have concerns about privacy”	0.0601	0.0769	0.78	0.4343
“Information on social media is available more quickly”	0.2300	0.1001	2.30	0.0216*
“Social media is easier to access”	0.0544	0.1005	0.54	0.5883



**Fig. 4.** Q12: What advantages do you see in social media over other channels?

Apart from the direct effect on social media use in emergencies 2021, further descriptive results shed light on perceived advantages and disadvantages in different years. In terms of specific disadvantages of social media during emergencies, the respondents consider the danger of false rumors as especially grave. In 2021, 76% saw this as a disadvantage, while in 2019, only 54% saw this as a disadvantage. In addition, in both 2019 and 2021, there are more agreements than disagreements on the topics of data privacy, malfunctions in emergencies, and lack of reliability as potentially detrimental aspects of social media in emergencies.

One respondent, for instance, commented that “especially in emergency situations, the power or the Internet often fails and that it is therefore not possible to use social media in such situations” (P237).

However, neutral responses without clear agreement or disagreement are also frequently found. Finally, a relatively clear stance emerges on the issue of whether calling 112 is preferable to using social media: in 2019 and 2021 only few participants would disagree to that while 71% and 78%, respectively, indeed prefer calling 112. Again, the question emerges whether overall, perceived disadvantages of social media use in emergencies have changed over time.

To assess potential differences between 2019 and 2021, answers were cumulated to form a score describing perceived disadvantages. A Wilcoxon rank sum test indicated that perceived disadvantages were significantly higher in 2021 (median = 26) than in 2019 (median = 25) ( $Z = -6.24, p < .001$ ). Thus, although the effect size indicates a rather weak effect ( $r = 0.14$ ), the disadvantages of social media in emergencies are indeed perceived as more serious as time passes.

#### 4.2.5. How has the use of different sources of information in emergencies changed over the years?

One relevant question is to what extent social media use has evolved over the years. As the proliferation of internet-based applications continues to permeate our lives, it might be expected that the use of social media will also increase in emergency situations. Consequently, we tested the overarching null hypothesis, that social media use in emergency situations is independent from the year of the survey (2017, 2019, 2021). The corresponding Pearson's chi-squared test, however, was significant,

$\chi^2(2) = 334.5, p < .001$ , suggesting that social media use in emergencies is in fact dependent on the year of the survey. Table 4 illustrates that while in 2017 social media use and non-use was fairly similarly distributed, especially in 2019 but also in 2021, social media use in crises strongly exceeded non-use. Cramer's  $V = 0.33$  thereby points to a moderate effect size regarding the relationship between year and social media use. Interestingly, social media use in general was independent of the year of the study,  $\chi^2(2) = 3.8, p = .19$ . Thus, the increase in social media use in emergencies does not appear to be due solely to a general increase in social media adoption.

This raises the question as to why this increase occurred and how the assessment of various sources of information in emergencies has changed over the years in detail (see Table 4). In 2017, 46% of respondents said they had not used social media at all in such a situation. In later years, this figure was reduced to 10% (2019) and 26% (2021). There was an increase in the proportion of respondents who used social media to both share and search for information, with 54% of respondents stating this in 2017, 85% in 2019, and 63% in 2021. A potential explanation for the surge in social media usage during emergency situations may be attributed to the upsurge of attacks, such as the 2016 Munich Shooting and the 2016 Berlin truck attack on a Christmas market, which received significant coverage across German media.

In terms of different information sources used, it can be observed that more *traditional* sources of information are partly rated a little less helpful in 2021 than in 2019. While, for example, 58% considered personal conversations, such as contacting emergency services, as quite helpful to very helpful in 2021, this number decreased to 69% in 2019. The value of personal conversations with trusted contacts at the same time remained consistent – in 2019, 67% of the respondents perceived these as quite to very helpful while in 2021, 63% considered these as quite to very helpful.

Changes are also apparent in terms of the use of radio, television, newspapers, and magazines: as recently as 2019, radio was rated as quite helpful to very helpful by 61%, television by 62%. These numbers decreased to 47% (radio) and 45% (television) in 2021. Newspapers and magazines were rated as quite helpful to very helpful by 32% of respondents in 2019 but only by 22% of respondents in 2021. Local announcements, such as loudspeaker announcements, were perceived as quite helpful to very helpful by 49% in 2019, compared to only 35% of respondents in 2021.

#### 4.3. Data sharing practices in emergencies

Also of interest to us is what type of information was shared most frequently by respondents in emergency situations (see Fig. 6). While no corresponding data is available from 2017, in 2019 it was primarily information about weather (56%), as previously about road/traffic conditions (48%), and safety reassurance (43%) that was shared by participants. At the same time, an increase in sharing

**Table 4**

Answer distributions regarding social media use in general and in emergencies. Significant differences were found for social media use in emergencies in 2019 and 2021 compared to 2017.

	Social Media Use			
	in general		in emergencies	
	yes	no	no	yes
2017	1.6%	98.4%	45.7%	54.3%
2019	2.8%	97.2%	10.6%	89.4%
2021	2.1%	97.9%	29.5%	70.5%

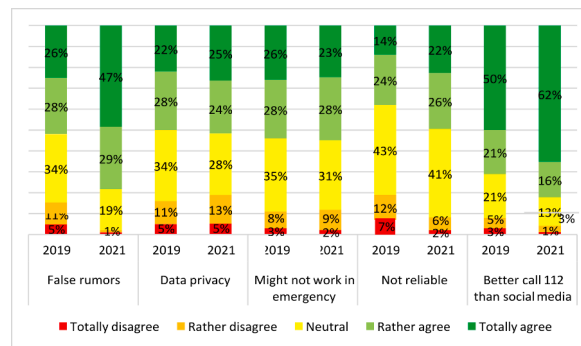


Fig. 5. Q13: What disadvantages do you see in using social media during an emergency situation?

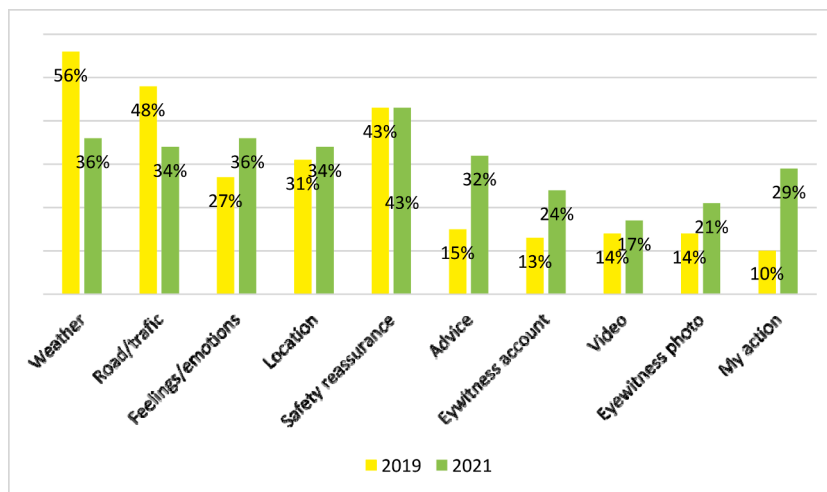


Fig. 6. Q11: What types of information have you shared on social media in emergency situations that have affected you?

one's own feelings and emotions to 36% can be observed in 2021 (as opposed to 27% in 2019), making this type of information one of the most shared in 2021, alongside safety reassurance with the same value from 2019 of 43% and sharing information about the weather, which is shared at a rate of 36%. It can be observed that in 2021 the differences between the various types of information shared are less pronounced than in 2019. A particularly strong increase can be seen in information about one's own actions: while in 2019 only 10% of respondents shared information about this, in

2021 29% of respondents said they shared information of this type. Likewise, more information in the form of advice on how to act was shared in 2021 compared to 2019.

Taken together, the question emerges as to whether social media information sharing during emergencies has changed overall from 2019 to 2021. To assess this, Pearson's Chi-squared test was conducted to evaluate the null hypothesis, that information sharing in social media during emergency situations is independent from the year of the survey (2019, 2021). This test, however, was insignificant,  $\chi^2(1) = 0.61, p = .43$ , suggesting that there is no association between information sharing practices and the year of the survey. Since at the same time social media use in emergencies in general has increased over the years, this suggests that the increased use is manifested more in the consumption of information rather than in the active sharing of information.

#### 4.4. Expectations towards emergency services

Not only the general population, but also public emergency services (ES) such as fire departments, rescue services, and the police use social media in emergency situations. In order to improve this usage, it is relevant to analyze the population's expectations for its use (see Figs. 7 and 8). The majority of respondents expects emergency services to monitor social media regularly, with values ranging from 58% to 62% in 2019 and 2021, respectively. While 53% expected a response on social media from emergency services within an hour in 2019, this dropped to 31% in 2021. At the same time, as many as 32% of respondents contradicted this expectation in 2021. However, it should be noticed that many respondents do not have definite expectations regarding the social media activities of the emergency services.

Overall, there is a modest uptick in the expectations placed on emergency services and their social media use in 2021 compared to 2019. In the current situation, 48% (+8% compared to 2019) expect emergency services to offer as many different social media channels as possible, and 57% (+10% compared to 2019) expect emergency services to use social media not only in emergency situations,

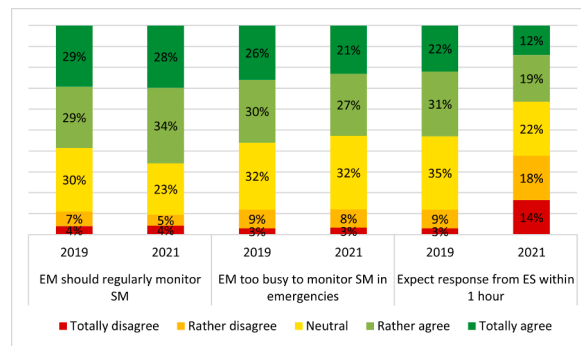


Fig. 7. Q14.2: How should public authorities and emergency services (ES) such as fire departments, rescue services, and police use social media (SM) in emergency situations?

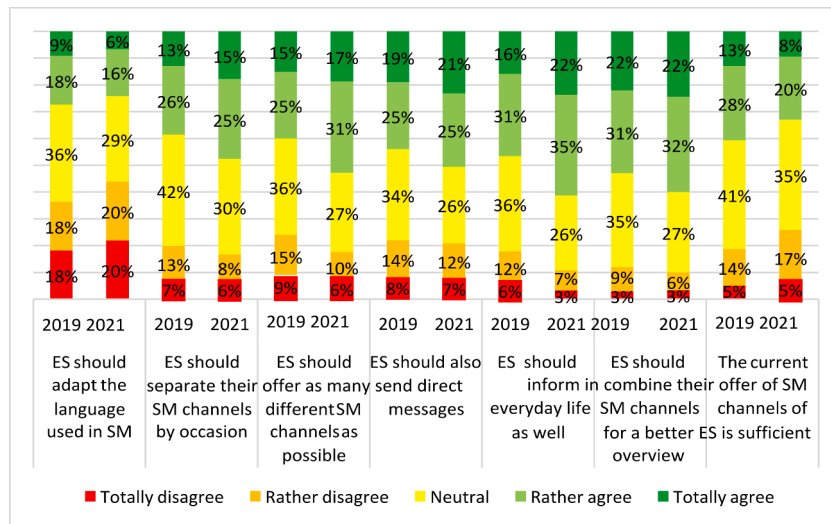


Fig. 8. Q14.1: Should public authorities and emergency services (ES) such as fire departments, rescue services, and police use social media (SM) in emergency situations?

but also in everyday life to inform the population. In addition, the percentage of respondents who are satisfied with the current state of social media offers by emergency services has shrunk, this figure was still at 41% in 2019, while in 2021 it is only at 28%.

In 2019, 44% of respondents said they would welcome the possibility of direct messaging (e.g., via social media chats) with emergency services in emergencies; in 2021, this figure was 46%. While, at the same time, 22% of respondents were opposed to such direct contact in 2019; in 2021, this figure was only 14%. When it comes to the question of whether more colloquial language should be used on social media, opposition is relatively high: in 2019, only 27% favored the proposal and 36% opposed it; in 2021, only 22% favored this proposal, while as many as 40% opposed it. While many respondents are neutral towards the suggestion that emergency services should separate social media channels depending on the occasion, most of the individuals who were interviewed expressed their concurrence with the proposal that emergency services should consolidate their social media channels to enhance the comprehensiveness of their emergency response.

## 5. Discussion

The aim of this study was to analyze the use of and attitudes toward social media in emergency situations in Germany and to examine whether changes can be observed here over the years (2017–2021). In doing so, our study represents a contribution to quantitative and longitudinal research on the use of social media in emergency situations in Germany, which is subject to a state-oriented risk culture. Moreover, the representativeness of the study also takes into account the usage behavior of people who do not themselves turn to social media in emergencies and are therefore often overlooked in such studies. Thus, generalizable statements can be derived due to the representative character of our study.

The core findings of the present study (see Fig. 9) include:

- (1) More *traditional* sources of information (personal/telephone conversations, radio, television) are still preferred over social media in emergencies in 2021.
- (2) Individuals often have no clear expectations of how emergency services should deal with social media. While citizens expect emergency services to continuously monitor social media, at the same time, they acknowledge that they are too busy to monitor them in emergencies.



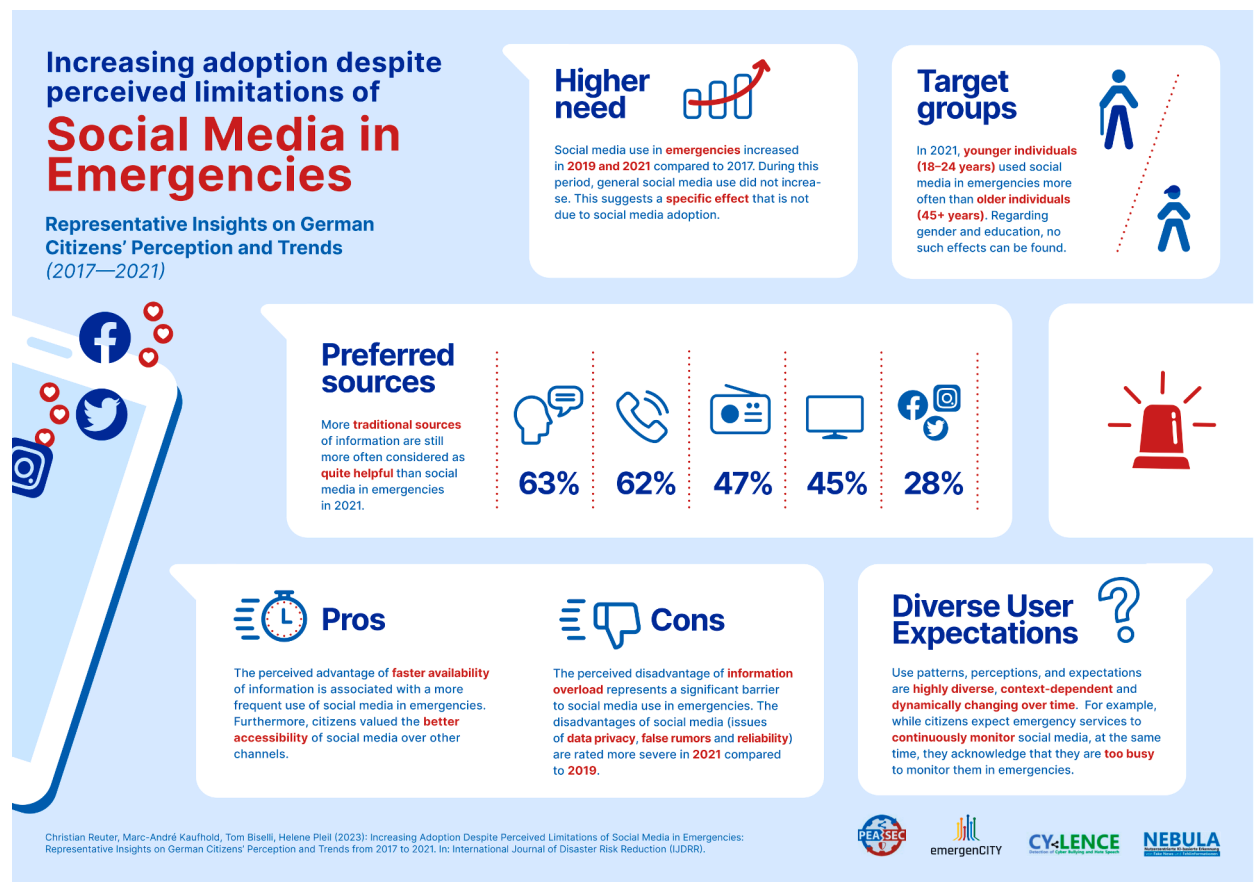


Fig. 9. The core findings of the study.

- (3) Younger individuals (18–24 years) use social media in emergencies more often than older individuals (45+ years) in 2021. Regarding gender and education, no such effects can be found.
- (4) While the disadvantage of *information overload* represents a significant barrier to social media use in emergencies, the advantage *faster availability of information* is associated with a more frequent use of social media in emergencies.
- (5) Social media use in emergencies increased in 2019 and 2021 compared to 2017. During this period, general social media use did not increase, suggesting that this development is not only a side-effect of an increased social media adoption in general but a rather specific effect.
- (6) Between 2019 and 2021, individuals did not share more information during emergencies via social media.
- (7) Perceived disadvantages of social media use in emergencies are rated more severe in 2021 compared to 2019.

#### 5.1. What are German citizens' use patterns, perceptions, and expectations towards social media during emergencies in 2021 (RQ1)?

In general, social media are permeating our daily lives more and more [34,37,38]. This could result in an increased adoption of social media in emergency situations as well. However, regarding the first research question of our study, it appears that while 89% of respondents use a smartphone daily, if not hourly, only WhatsApp has already been used by the majority in emergency situations. This is in line with the observation that personal conversations, for example with emergency services, but also with family members, friends, or neighbors, are still particularly valued. In addition, this result also confirms that in emergencies, WhatsApp is by far the most used social media platform, followed by Facebook. This confirms findings from studies on the general adoption of social media in the German population [37–39], but represents a noteworthy difference from other studies in which Facebook was by far the most used platform in emergencies (cf. [69,70,72]). However, it remains uncertain whether this points to a change in the use and relevance of specific platforms or if other social media platforms were not taken into account in these studies. Nonetheless, it is worth highlighting that in Germany, the overall share of weekly users of WhatsApp increased since 2019, whereas the share for Facebook decreased [37–39]. Generally, more *traditional* media such as TV or radio still remain popular sources of information. This finding is consistent with other quantitative research, for example from the USA or Canada [67–70].

We also evaluated whether demographic differences in terms of age, gender, and education affect social media use in emergencies. Only age proved to be a relevant factor, in the sense that older people over 45 years use social media less in emergencies than younger people aged 18–24. This is in line with previous findings in Refs. [67,70], suggesting that age is a relevant dimension when assessing social media usefulness in emergencies. However, this deviates from other findings that suggest an impact of gender [70,72] and edu-

cation [67] on social media use in emergencies. Whether there are variances related to the presence of children in the household, as was found by other work [67,70,72], was not investigated in our study. In general, Overall, this illustrates the importance of bearing the potential audiences in mind when choosing to disseminate information via social media so as not to exclude certain populations.

Respondents perceive both advantages and disadvantages in the use of social media. Generally, respondents see the biggest advantages in the fact that social media is faster available and more accessible. Reuter and Spielhofer [70] found the same in a cross-country survey conducted in 2015. In the state-oriented risk culture of China, the positive attitude towards social media was even higher, with a majority of users describing it as faster, more accessible, richer in content, more accurate, and more reliable than traditional media [71]. In a large-scale study [68] that also included emergency responders, the advantage that citizens could support the ongoing disaster response by providing information about the current situation became apparent. Major disadvantages of using social media specifically in emergency situations were seen by our respondents, for example, in the sheer volume of information available and the trustworthiness of the information: For example, a large proportion of respondents see the risk of false rumors online. This is also in line with the results of other studies [68,70]. Especially in relation to the COVID-19 pandemic there were many warnings about misinformation in social media, so this topic got not only more media attention but also a lot of research focus (cf. [83–85]).

In terms of expectations and in line with a state-oriented risk culture [75], we saw strong expectations that emergency services should regularly monitor social media (62%), although a considerable portion of participants acknowledged that they might be too busy during emergencies (48%). Furthermore, participants requested that emergency services should not adopt the colloquial language used in social media (40% in contrast to only 22% in favor), i.e., maintain a professional language. However, despite a lack of personnel resources in emergency services [5,86], many participants supported the addition of further services, such as informing the population in everyday life as well (57%), using as many social media channels as possible (48%), and also answering to direct messages (46%). The latter is particularly significant in view of previous research that found that more than one-third of respondents expect a response or help to a social media request within 1 h [67,70]. Such findings also amplify the need for technologies supporting cross-platform monitoring, analysis, and communication of social media in emergencies [61,87].

## 5.2. How did these patterns, perceptions, and expectations regarding social media during emergencies change between 2017 and 2021 (RQ2)?

Significant changes in the use of social media in emergency situations can be identified primarily in user patterns regarding the information that respondents shared in such a situation: in 2017, for example, the most popular information to share was of a more personal nature, such as one's own feelings, emotions, or location. This is in line with a 2012 survey in Canada that revealed widespread intention to share information about one's own safety [69]. In 2017, road or traffic conditions were also popular to share – this remained unchanged for 2019 and in a 2015 cross-country survey [70], along with information about the weather. In 2019, one's own feelings were shared somewhat less, but in terms of oneself, it was still popular to share safety reassurance. In general, the differences in the information shared in 2021 were much less significant than in previous years, and sharing has become more personal again, with safety reassurance and one's own feelings being the focus, along with information about the weather. According to a 2012 survey, these types of information were also most commonly shared among the U.S. population [67].

Whereas previous work has only examined the general use of specific platforms in emergencies [72], we have differentiated between information sharing and searching. We found that certain platforms are used more to share information (WhatsApp, Facebook Messenger), while others are primarily used to search for information (Twitter, Instagram, Facebook, and YouTube). However, to a certain extent this is also related to the design of the platforms.

Interestingly, the amount of information that is shared via social media did not change between 2019 and 2021. The disadvantages of social media in emergencies, on the other hand, were seen as significantly more serious in 2021 than they were in 2019. Furthermore, social media use in emergencies in general did increase in the years 2021 and 2019 compared to 2017. While 46% (2017) of participants stated not to use social media in emergencies, this number decreased considerably to 10% (2019) and 26% (2021). At the same time, no corresponding differences were found for social media use in general. While previous work observed a stagnation in the adoption of social media in the US [34,36], it was found that in Germany, the weekly usage of only some platforms increased between 2019 and 2021 [37–39]. Altogether, this seems to indicate a rather specific effect regarding social media use in emergencies as opposed to a general increase in social media adoption.

Regarding the expectations German citizens have of social media during emergencies, our study shows that the majority of respondents have consistently expected emergency services to monitor social media regularly. Even though over the years there have been variations, this expectation persisted throughout the entire period of the study since 2017. The peak value in our long-term study of 67% of respondents who expect such kind of monitoring of emergency services is comparable with the values of similar quantitative studies in the US (70%) [67], Canada (66%) [69], and across Europe (69%) [70]. However, since these studies were conducted in 2012 and 2015, it would be interesting to be able to compare our study to a more current study. Overall, there is a slight increase in the public's expectations of emergency responders and their social media use, although this is reinforced by a sharp increase in the proportion of those who are dissatisfied with the current state of the social media offerings of emergency services.

Taken together, these changes in attitudes over time indicate that use patterns, perceptions, and expectations regarding social media use during emergencies develop in a dynamic process. Past results cannot necessarily be projected into the future, and the emergence of new types of social media platforms and digital tools could actively affect individuals' willingness to use social media during emergencies.

## 5.3. Implications for practice and theory

While the general social media adoption in the US stagnates but at a high level, the daily use of social media in Germany is still increasing (cf. Table 1), strengthening the role of social media as an important constituent for multi-channel crisis communication. By

providing information of how to prepare for and respond to emergencies in social media, emergency services contribute the potential reduction of disaster risks [5]. However, although citizens still see social media as a faster available and more accessible source than other channels, the already lower perceived accuracy and reliability decreased in the recent survey. Moreover, the increasing fear of false rumors might further reduce the perceived usefulness of social media in emergencies. These fears could be mitigated by providing citizen guidelines [41] and educational tools [88] for the identification and response to fake news, but also algorithms for the detection of misinformation [89] could help emergency services to counter harmful content in their crisis communication strategy and establish trust with citizens. Furthermore, besides using verified social media profiles, the official accounts and published messages could be combined with links to content that was perceived more credible by citizens, such as emergency apps, radio, or television. Since messengers like WhatsApp were the most used social media sources in emergencies, which was also observed by Haunschild et al. [78], the use of official public groups should be explored to increase the reach of emergency services and thus enhance citizens' crisis preparedness and response. To further enhance community resilience, the establishment of public-private partnerships [90] between authorities and social media providers could be an option to establish functionalities for the dissemination of emergency warnings without the need to join a specific messenger group.

Our findings highlight that citizens increasingly expect emergency services to monitor social media, use as many different social media channels as possible, and inform them in everyday life as well. This reinforces the observation that private social media use strongly shapes attitudes and expectations regarding official social media use [25]. However, the number of people expecting a quick response from emergency services was decreasing. These findings emphasize the importance of applying strategies for *information dissemination* (e.g., preparedness education in everyday life as well as alerts, warnings, and advisories during emergencies) and *data monitoring & analysis* (e.g., account monitoring and data analytics for situational awareness), while citizens also seem to acknowledge that a strategy of *conversations & coordinated action* might be too ambitious and resource-intensive in terms of emergency service personnel [91]. Although a previous European survey showed that a considerable number of emergency services already use social media to share information for preparedness (44%) and response (32%), fewer were monitoring social media for enhanced situational awareness (23%), thus indicating a gap between citizen perceptions and emergency services practices [5]. While Germany, on the one hand, uses a modular warning system for disseminating emergency-related content across multiple channels, it remains a challenge to integrate the changing landscape of social media platforms using different APIs for automated crisis communication [92]. On the other hand, tools for monitoring and analyzing social media are often only developed for a single platform (e.g., TweetDeck for Twitter), cost-intensive or remain at the stage of research demonstrators [61]. Unless binding standards for social media interoperability are established, emergency services are still confronted with considerable manual work if they decided to integrate social media into their crisis communication and response strategies.

In terms of the previously proposed state-oriented risk culture in Germany [71], the present results provide some implications, too. One could assume that it is precisely in individualistic risk cultures that the advantages of social media are appreciated in emergencies because they enable a kind of self-organization. Even though no direct comparison between state-oriented and individualistic risk cultures was made in the present study, plenty of disadvantages of social media in emergencies were perceived in the present German sample. While the quicker availability of information was one of the reasons for social media use, especially the potential information overload was a key factor for not using social media. This is in line with emergency services' perception of information overload as one of the most pressing problems, just below the lack of qualified personnel for social media analytics [93]. Together with the general preference for more traditional sources of information, this indicates a preference for established institutions that continue to enjoy a high level of trust and serve as reliable intermediaries of information in emergency situations.

#### 5.4. Limitations and directions for future research

This study deals exclusively with the use of social media in emergency situations in relation to the German population. Here, Germany can be understood as an example of a state-oriented risk culture. This focus represents a limitation of the study, yet it also constitutes a starting point for further research. Studies on other countries, for example, which are also characterized by a different risk culture, would be interesting to enable comparisons. Such a comparison could also reveal learning potentials, among others. Moreover, the results of online surveys might be biased due to possible self-selection of volunteers. Since our study only ensured representativeness for the adult German population with respect to age, gender, education, federal states, and income, it cannot guarantee the representativeness for other factors, such as varying levels of literacy and computing skills, very young or old people, people with a mental disability, homeless people, or migrants with poor German language skills. In addition, our findings are based on individuals' answers but not observed behavior. However, perceptions and expectations are still an important driving force when implementing professional management structures via social media.

A further limitation of this study relates to the fact that not for all relevant items, data was available from all time points (2017, 2019, 2021). Therefore, some of the reported trends only relate to the differences between 2019 and 2021. Future studies covering even longer periods would be exciting, as they may reveal even more changes in attitudes toward social media and their use – especially in view of the fact that the younger generation in particular uses social media even more intensively and has ultimately grown up with them. Comparable quantitative studies also investigated which groups of people are more likely to use social media in emergency situations. This showed that women, younger people, and people who live in a household with children are more positive about such use. This aspect was neglected in our study, but it would of course also be interesting to know whether a change could be observed against this background.

## 6. Conclusion

This study sheds light on German citizens' use patterns, perceptions, and expectations regarding social media during emergencies as well as their changes over time in 2017, 2019, and 2021. The results show that user attitudes cannot be broadly categorized into *positive* or *negative* perception of social media. Instead, use patterns, perceptions, and expectations are highly diverse, context-dependent and dynamically changing over time. Especially relevant changes over time include an increase in social media use during emergencies in the later surveys of 2021 and 2019 compared to 2017. On the other hand, in 2021 compared to 2019, the perceived disadvantages of social media in emergencies were rated as more serious. Taken together, the potential use of social media in emergencies is confirmed by the majority of citizens. However, the specific design of social media platforms and the behavior of emergency services themselves must always take into account the heterogeneity in user expectations in order to build trust and enable participation of all involved actors.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

The data set and codebook of the representative survey data from 2021 are publicly available.

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## Appendix. Survey Questions

Q1: This survey aims to find out citizens' attitudes towards the use of social media and warning apps in emergency situations. We are investigating the resilience of society and technical infrastructures in emergency situations, amongst others. In addition we develop recommendations and concepts for prevention, detection, and response to incidents, including for those responsible at municipal level.

Please confirm that you agree to participate in this survey. (Yes, No)

Q2: How old are you? (18–24; 25–34; 35–44; 45–54; 55–64; 65 + )

Q3: I am ... (male, female, diverse, prefer not to say)

Q4: What is your highest educational qualification? (No qualification; Hauptabschluss; Polytechnische Oberschule; Realschulabschluss; Fachabitur; Abitur; Fachhochschulabschluss; University degree; Other qualification)

Q5: In which federal state do you live? (Baden-Württemberg; Bavaria; Berlin; Brandenburg; Bremen; Hamburg; Hesse; Mecklenburg-Western Pomerania; Lower Saxony; North Rhine-Westphalia; Rhineland-Palatinate; Saarland; Saxony; Saxony-Anhalt; Schleswig-Holstein; Thuringia)

Q6: If you add up all the incomes of your household: In which of the following income groups does your monthly household net income (i.e., household income after taxes) fall? (under 900 EUR; 900 EUR to under 1300 EUR; 1300 EUR to under 1500 EUR; 1500 EUR to under 2000 EUR; 2000 EUR to under 2600 EUR; 2600 EUR to under 3200 EUR; 3200 EUR to under 4500 EUR; 4500 EUR to under 6000 EUR; 6000 EUR and more)

Q7: Please indicate how often you engage in the following activities on average. (Hourly; Daily; At least 1 × per week, but less often than daily; Less often than 1 × per week; Never): *Use a smartphone* (e.g.: *Android, iPhone or Windows*) | *Use Facebook* (except *Messenger*) | *Use Facebook Messenger* | *Use Instagram* | *Use Snapchat* | *Use Telegram* | *Use TikTok* | *Use Twitter* | *Use YouTube* | *Use WhatsApp* | *Read newspapers and magazines* | *Watch TV* | *Listen to the radio* | *Writing post in social media* | *Writing message in messenger*.

Q8: have you ever been affected by an acute emergency situation? (Yes; No; Don't know; Not sure)

Q9: Please indicate how helpful you find the following sources of information in an emergency situation that has affected you. (Not helpful; not very helpful; moderately helpful; quite helpful; very helpful; have not used; not specified): *Newspaper and magazines* | *television* | *radio* | *Personal conversations* (e.g., *with families, friends, and neighbors*) | *Telephone conversations* (e.g., *with families, friends, and neighbors*) | *Contacting emergency medical services, fire department, police, or hospital* | *On-site information outlets* (e.g., *notices, flyers, and loudspeaker announcements*) | *Social media* (e.g., *Facebook, Twitter, Instagram, or YouTube*) | *Other internet outlets* | *An emergency app* (e.g., *KATWARN* or *NINA*)

Q10: Please indicate the extent to which you have used the following social media in an emergency situation that affected you. (To share information; To search for information; To search and share information; No use): *Facebook* (except *Messenger*) | *Facebook Messenger* | *Instagram* | *Snapchat* | *Telegram* | *TikTok* | *Twitter* | *YouTube* | *WhatsApp*.

Q11: Please indicate what types of information you have shared on social media in emergency situations that have affected you. (Yes, but only in private messengers; Yes, also in public networks; No, I did not share): *Weather conditions or warnings* | *Road or traffic conditions* | *Confirmation that you are safe* | *Your feelings or emotions about what happened* | *Your location* | *What steps you took to stay safe* | *An eyewitness account of something you experienced* | *Advice on what steps others should take to stay safe* | *An eyewitness photo* | *A video*.

Have you shared any other type of information in an emergency situation? If yes, please specify (free text).

Q12: Please indicate the extent to which you agree with the following statements. This is about what advantages you see in social media over other channels (e.g., television, radio, or traditional website). (Do not agree at all; Somewhat disagree; Partly agree; Somewhat agree; Fully agree; No response): *Information on social media is more readily available.* | *Social media is easier to access.* | *Social media provide more detailed information.* | *Social media provide more reliable information.* | *Social media provide more accurate information.* | *Social media provides more trustworthy information.*

Do you see any other benefits to using social media in emergency situations? If yes, please specify (free text).

Q13: Please indicate the extent to which you agree with the following statements. This is about disadvantages of using social media during an emergency situation. (Do not agree at all; Somewhat disagree; Partly disagree; Somewhat agree; Totally agree; Not specified): *Information from social media is not reliable.* | *Information from social media is not trustworthy.* | *Too much information is published in social media (information overload).* | *False information is published in social media (e.g., fake news).* | *There are many rumors on social media.* | *I have concerns about privacy.* | *It is better to call 911 (112) than to post messages on social media.* | *Social media may not work properly during an emergency.*

Do you see any other disadvantages in using social media in emergency situations? If yes, please specify (free text).

Q14: Authorities and organizations such as fire departments, rescue services and police also use social media in emergency situations. Please indicate the extent to which you agree with the following statements. (Do not agree at all; Somewhat disagree; Partly disagree; Somewhat agree; Totally agree; Not specified): *Agencies and organizations should continuously monitor and analyze their social media.* | *If I have made a post (e.g., request for help) on social media, I expect a response from authorities within an hour.* | *Authorities and organizations are too busy during an emergency to analyze activities on social media.* | *Authorities and organizations should not only provide information in emergency situations, but also in everyday life.* | *Authorities and organizations should also send direct messages (e.g. Facebook Messenger) in acute emergency situations.* | *The current range of social media channels offered by authorities (e.g., fire department, police) is sufficient.* | *Authorities and organizations should bundle their social media channels for a better overview (e.g., Bavarian police, Hesse police).* | *Authorities and organizations should separate their social media channels by occasion (e.g., Twitter channel in operation and a Twitter channel for general prevention and public relations work).* | *Authorities and organizations should offer as many different social media channels as possible (e.g., Frankfurt Police, Lower Franconia Police, Münster Police, Offenbach Police).* | *Authorities and organizations should adapt their social media channels to the choice of language in social media (e.g., always use the form of address 'Du' and write in 'youth language').*

Q15: Please provide as many additional details as you wish about your experience with social media in emergency situations or what would encourage you to use them in the future (free text).

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