

# KATWARN, NINA, OR FEMA? MULTI-METHOD STUDY ON DISTRIBUTION, USE, AND PUBLIC VIEWS ON CRISIS APPS

*Research paper*

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## Abstract

*Crises, such as thunderstorms and an increasing number of (recognised) terroristic attacks in 2015, 2016, and 2017, do not only lead to extensive monetary damage, but also threaten human lives and influence citizens' perceptions of safety and security. In such situations, the population demands information about the damage and safe behaviour. Although some apps are available to provide this information, the number of users seems relatively low. Focussing on Germany, this study aims to research (1) the distribution of crisis apps in the population, (2) the kinds of crisis apps currently used, as well as (3) needed core functionalities of warning apps. This multi-method study analyses crisis apps by investigating their utilisation quantitatively in a snowball-based survey in Europe (n=1,034) and in a representative survey in Germany (n=1,369). Based on this, the German warning apps Katwarn and NINA and the US-American app FEMA are evaluated qualitatively (n=22). The results revealed requirements which informed the implementation of a warning app prototype. The prototype combines the identified advantages of the apps evaluated in the study, containing warnings and all-clear, recommendations for action, functions to contact friends and helpers. The contributions of this work are findings on the distribution of crisis apps in Europe and Germany (both 16%), the kinds of crisis apps used (mostly weather and warning apps), and empirically based requirements for warning apps which can be integrated in further developments of existing apps and a prototype for such an app.*

*Keywords: civil protection, crisis management, crisis apps, warning apps*

## 1 Introduction

In Europe and all over the world, many crises occurred in recent years, especially natural disasters such as storms and floods which resulted in financial damages and had long- or short-term effects on the lives of many people. Some databases (e.g. EM-DAT and NatCatSERVICE) and studies indicate that over the last decades the frequency and intensity of natural disasters has increased (Berz, 1999; Münchener Rückversicherungs-Gesellschaft, 2015). Not only the consequences of natural disasters demonstrate the relevance of civil protection (Kaufhold & Reuter, 2016), but also the increasing number of man-made disasters, such as terroristic attacks in Europe (Giuliani, 2016; Reuter, Pätsch, et al., 2017). An example of a natural disaster in the German-speaking area is the storm on June 7, 2016. In Baden-Wuerttemberg, for example, up to 30 litres rain fell per square metre in half an hour. Roadblocks, flooded houses and streets as well as fires due to flashes were the consequences. Also in Hamburg, many people had to suffer: On June 7, 2016, a tornado caused harms like those in Baden-Wuerttemberg. Previous crises such as the Central European flood in 2013 or the hurricane Kyrill in 2007 also show that damages caused by storms can be devastating. Besides social media, which meanwhile play an important role in informing the population (Reuter & Spielhofer, 2016), mobile crisis apps can potentially support the people in such situations. While using the term *crisis apps*, we refer to mobile apps providing specific functionality needed during crises, emergencies, or disasters. Ideally, damages from emergencies or crises are minimised or prevented at all. The implementation of preventive measures, as research suggests, requires a sense of danger and thus situational warnings must be delivered urgently (Geenen, 2009; Volgger et al., 2006). Therefore, besides the general investigation of crisis apps, we set a specific focus on *warning apps*, which are mobile crisis apps focusing on warning functionality.

The aim of this work is to investigate mobile apps supporting the population in crisis situations. We aim to research: *RQ1: What is the distribution of crisis apps in the population? RQ2: What kinds of crisis apps are currently used? RQ3: What are core functionalities of warning apps needed by the population?*

With our research we want to contribute to IS research, especially for crisis response and management, but also to sociological catastrophic theory (Clausen & Dombrowsky, 1983). From this view point natural disasters, accidents, or infrastructure damages are not the actual catastrophes, but their effects on or consequences for social life. Historically, all societies have continually developed new solutions for the handling of such disturbances or interruptions of their daily lives, on the basis of their respective knowledge and their technologies. These solutions include above all the institutionalisation, e.g. fire brigade, rescue or disaster relief organisations, but also technical solutions, such as information systems, especially crisis apps. Their distribution, the use of different types of apps and functionality needs to be researched in order to make contributions to empirical and design oriented IS research in this area.

In our study, we focus on the situation in Europe, especially in Germany. Of course, some of these findings might also be true for other regions. Based on background and related work (section 2), the results of our multi-method study existing of both a quantitative study in Europe (n=1,034) and a representative quantitative study in Germany (n=1,369), investigating the usage and spread of crisis apps, are presented. Referring to RQ1, we found that apps are just used by 16% of the population. Addressing RQ2, we found that warning apps represent the most common app category for emergencies (section 3). Concerning RQ3, a qualitative study with 22 participants investigates functions and requirements using the example of the warning apps NINA, Katwarn, and FEMA (section 4). After evaluating the results, design implications are discussed and a prototype app is presented (section 5). Finally, conclusions are drawn (section 6).

## 2 Background and Related Work

Over the past years, Germany, compared to other regions in the world, was rarely haunted by crises. However, in some cases, storms and floods lead to multi-billion losses. Due to the climate change, the dense settlement, and high economic concentration, natural phenomena cause more and more natural

disasters (Bittner et al., 2009). Although floods cause the worst damages worldwide (Uhlemann et al., 2010), in Germany intense storms are responsible for 61% of all damages (Münchener Rückversicherungs-Gesellschaft, 2016).

Some studies indicate that the prevention of crises is not taken very seriously by German citizens (Sulzberger & Glattbrugg, 2014): Most people have not experienced a crisis yet and do not know how to deal with disaster situations. Citizens assume that the state is responsible for a working crisis protection. Only victims which were affected several times have a different perspective (Bundesverwaltungsamt, 2006). In a US-representative sample, it was found that fear influences the implementation of prevention measures; anger effects the opposite (Lerner et al., 2003). Accordingly, existing concepts for risk communication are largely unknown to the population (Helsloot & Beerens, 2009; Lorenz, 2010; Menski & Gardemann, 2008). Memories about events, where people were only affected slightly or shortly, often fade, whereby no preventions for self-protection are made (Holenstein & Küng, 2008; Menski & Gardemann, 2008). However, due to the relative low probability, e.g. of power failures, in Western Europe the overall preparations are not optimal (Birkmann et al., 2010). The German Federal Ministry of the Interior (Bundesministerium des Inneren, 2009) calls this fact *vulnerability paradox*: In the dimension in which the supply performance of a country is less accident-sensitive, the effect of an accident is even stronger. In general, the perception might result in the (low) usage of crisis apps (hypothesis 1).

Information is especially relevant in insecure situations, whereby the needs for information differ in diverse phases (Reuter et al., 2013). Before the crisis, information for sensitisation and crisis preparation are necessary. However, for the implementation of preventive measures, a sense of danger is required (Geenen, 2009). Therefore, warnings have to be delivered urgently (Geenen, 2009; Volgger et al., 2006). This comprises information about existing and potential hazards, their probabilities, and possible consequences. The information transfer can happen in different ways, but a simple solution is “instructing information”, i.e. plans and instructions with best practices for emergencies (Coombs, 2009). Predictable crises have to be communicated on every available channel as early as possible, offering a time frame for the population preferably big enough to make individual preparations (Volgger et al., 2006). Although there are many possibilities with social media and apps, warnings of disasters are mainly distributed through mass media (TV, radio), whereas during the Cold War sirens existed. Nowadays, it is also possible to use multichannel warning systems, where, for example, SMS, email, and RSS feeds can be combined (Klafft, 2013). Sirens might lead to faster reactions, but they do not provide information concerning the event and the following procedure.

During a crisis, consistent and transparent information supply for the public is necessary (Nilges et al., 2009). This includes the need for orientation information for affected people to assess the situation as best as possible, especially weather conditions and weather warnings (Nilges et al., 2009). If communication is still possible, it often fails due to information transfer. For example, callers are often forwarded to unspecific recorded messages if hotlines are overloaded, whereby affected persons quickly feel they are “not taken seriously” (Reuter, 2014). The same thing happens if they are confronted with standardised, unspecific information (Holenstein & Küng, 2008). Another need of the people is to inform others about their safety as well as to hear about others’ current situation (Wade, 2012). Furthermore, problems with the underlying technical infrastructure might lead to further problems (Aldunate & Ochoa, 2006; Reuter, Ludwig, et al., 2017). In the course of communication between citizens, information is also distributed, discussed, and interpreted, showing that the contact with our fellows relevantly co-determines our behaviour during a crisis situation (Kaufhold & Reuter, 2016; Reuter et al., 2015). Besides the communication between citizens, the contact to infrastructure operators and authorities is often requested, but not always successful due to the amount of enquiries (Nilges et al., 2009).

Assessing and improving “warning messages delivered over mobile devices entails difficult theoretical and practical problems that need to be addressed” (Bean et al., 2015). Accordingly, a lack of understanding of the way these messages are interpreted could lead to problems. Requirements for

warning apps contain *basic information*, e.g. recommendations for action, *site-specific information*, e.g. the expected duration of a local power breakdown or contact addresses of the neighbourhood and *configuration-specific information*, e.g. for individuals with special needs (Reuter, 2014). Moreover, the localisation for transmitting site-specific information in real time, the individualisation, the display of emergency numbers, the enabling for feedback, and last but not least current contents are mentioned as requirements for the successful usage of an app in crisis situations (Karl et al., 2015). Based on a study on the feedback to warning apps, users mainly criticise the functionality and stability (Kotthaus et al., 2016) and the population does not seem to be motivated to inform itself proactively (Reuter, 2014).

Based on the information needs during a crisis, we think that warning apps are the kind of crisis app with the greatest relevance (hypothesis 2). Therefore, our study draws on the following issues: The spread of crisis apps, desired functionalities, and usage motivations are to be investigated by means of concrete applications. In order to study these issues, we follow a multi-method approach based on a quantitative empirical study (section 3) and a qualitative study (section 4).

### 3 Quantitative Empirical Study: Crisis Apps

#### 3.1 Methodology: Quantitative Online-Surveys in Europe and Germany

The surveys aimed to identify the attitude of citizens concerning the usage of social media and crisis apps. We conducted two surveys: one snowball-based survey across Europe (n=1,034) and one representative survey in Germany (n=1,369). In order to provide both a view on the European level as well as a detailed view on Germany (where the qualitative study will focus on), we decided – although the surveys have been conducted at different points in time and using different methods – to present both results.

Parts of the first *European snowball-based survey* about social media are already published (Reuter & Spielhofer, 2016). In February 2015, project partners sent a link for an online-survey in English, Polish, Italian, German, and Slovene to friends, colleagues, professional and social contacts, and displayed it on own channels, e.g. on social media and on websites (pyramid scheme). The sample cannot be considered completely representative for residents in Europe. However, answers of 1,034 participants (including 195 who work professionally or voluntarily for an emergency service – these were excluded from the main analysis) from 30 countries were received with the highest percentage from Poland (306), Slovenia (169), Germany (164), the United Kingdom (146), Italy (72), Greece (43), and Norway (39). The genders were distributed equally and different age groups participated in the study (4% under 21, 33% bet. 21-29, 31% bet. 30-39, 19% bet. 40-49, 8% bet. 50-59, 4% 60 and older), although a focus on persons up to 40 can be determined.

In addition to that survey, we conducted a *second representative survey in Germany* in November 2016 with 1,369 participants within a panel of GapFish (Berlin). GapFish is an ISO-certificated panel provider. They guarantee panel quality, data quality and security as well as survey quality through various (segmentation) measurements for each survey within their panel of 180,000 active participants. Thus, this second survey was fully representative for the German population in terms of gender and age (Table 1) and a good (nearly representative) distribution was achieved in terms of region, education, and income. For the quantitative analysis of the surveys, data were extracted and analysed by means of SPSS (IBM 2014). For the qualitative coding of the used apps, excel was applied. In the following, we will refer to the first survey and will also compare it with the second.

Age Group	Male	Female	Total
18-24	4.87%	4.66%	9.53%
25-34	7.48%	7.31%	14.80%
35-44	7.89%	7.78%	15.67%
45-54	10.20%	10.01%	20.21%
55-64	7.74%	8.02%	15.76%
65+	10.50%	13.54%	24.03%
Total	48.69%	51.31%	100.00%

Table 1. Distribution of age and gender

### 3.2 Results and Discussion: Little Distribution, Warning Apps Partly Known

**Distribution.** Most participants (77%) stated that they have never downloaded a smartphone app for crises or emergencies before, 7% were not sure, and only 16% said that they have downloaded this kind of app before (Figure 1). Surprisingly, the representative survey in Germany showed the same results: 16% have used an app, 79% haven't, and 5% are not sure. Our expectation was that the representative study would outline lower numbers based on the selection bias of the first survey, spread out of a project on social media in emergencies which seemed to attract people who are interested in crisis protection – however, it did not influence the likelihood to install such an app.

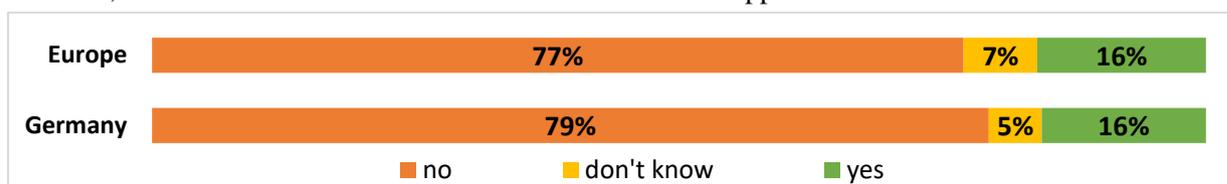


Figure 1. Participants with already downloaded crisis apps (Europe and Germany)

**App Categories.** In the non-representative study, 208 persons answered the open question regarding which types of crisis apps they would have downloaded. Here, categories or app names were possible. The most frequent category included warning apps (49), followed by weather apps (28), and first aid apps (16). Some participants also mentioned emergency apps (14), news apps (11), and earthquake apps (10) (Table 2). Concerning the different apps in the various countries, the app *Regionalny System Ostrzegania* is remarkable which was mentioned 21 times from Polish participants. Furthermore, *Katwarn* was named 13 times by German participants of the European survey. Both are warning apps and freely available for the whole population. No other apps were mentioned by more than five people.

The representative survey explicitly asked for different kinds of apps; of those who use apps weather apps (69%), followed by warning apps (42%), first aid apps (28%), and emergency-call apps (16%) were referred to. Addressing concrete applications, 6% of the representative sample from Germany stated to use *Katwarn* (37% of the app users), 4% to use *NINA* (25% of the app users).

Category	#	Category	#	Category	#	Category	#
Warning app	49	Earthquake app	10	Lifesaver app	5	Fire app	3
Weather app	28	Traffic (jam) app	8	Dangerous substance app	4	Lightning app	3
First aid app	16	Location app	5	Twitter app	4	Other	15
Emergency app	14	Red Cross app	5	Safety app	4		
News app	11	Map app	5	Power breakdown app	3		

Table 2. Crisis app categories and frequency of mentions (Europe)

**Future Use.** While only a relatively small percentage of participants has downloaded an app before, most participants (60%) said that they would probably download an app with the option to share information with and receive information from emergency services in relevant situations. Only 21% stated they would probably not do that (Figure 2). However, it is unsure which value can be assigned to this non-binding avowal.

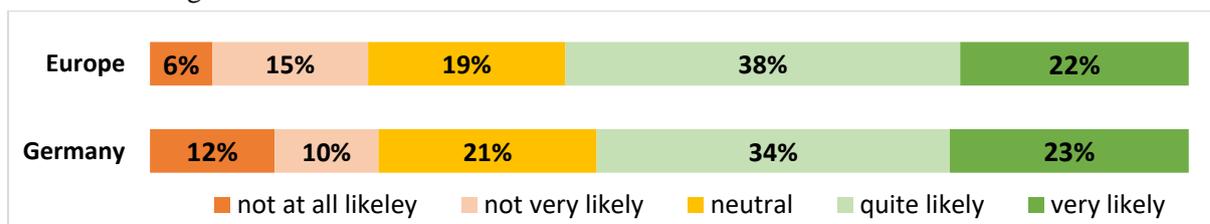


Figure 2. Future usage of apps for information exchange (Europe and Germany)

**Characteristics of App-Users.** There were also differences between app users and non-users: The percentage of non-smartphone-users is comprehensibly higher among the non-app-users (16% vs. 2%, Q7). Also, the representative study found that app-users use their smartphone at least on a daily basis (98%) and more often than non-app-users (76%). Mostly used channels do not differ between app and non-app-users though. Not the most mentioned media (TV news, online news, local radio), but social media (55% vs. 38%), websites (42% vs. 28%), and text messages (29% vs. 14%, Q10) are all more often used by app users. App users have already used social media more often to share information in an emergency (38% vs. 24%), but most app and non-app-users have not done this yet (53% vs. 70%, Q17). Here, it is interesting that Facebook (64% vs. 60%) and YouTube (28% vs. 30%) are used equally frequent, while Twitter (23% vs. 10%) and Instagram (16% vs. 7%, Q8) are used more often by app users. This might be caused by the broadcasting character of both Twitter (short news) and Instagram (picture with tags, quickly created, and meaningful). Facebook (restricted area on wall, cross-channel notification with mobile device more difficult) and YouTube (media usage in the app in the foreground, limited empire due to video-bounded comments) are different. The representative study states that app-users use Facebook (71% vs. 49%), Twitter (17% vs. 7%), or other social media (52% vs. 28%) such as Instagram or YouTube more often at least daily.

Also, the perceived relevance of social media usage by public safety authorities and organisations is much higher for app users (47% vs. 27%, Q9). The representative survey confirms that app users agree more that emergency services should monitor social media (83% vs. 64%), expect an answer within one hour (60% vs. 46%), but also that emergency services are too busy to monitor social media (51% vs. 42%). Already existing in social media integrated applications, such as Twitter Alerts (7% vs. 2%) and Facebook Safety Checks (15% vs. 4%), are in each case more known by app users than by non-app-users – but still rather unknown.

As clarified, warning apps are the most mentioned category of crisis apps, although only 16% of the 1,034 participants in Europe (Q11) and 16% of the 1,369 representative participants in Germany have already downloaded a crisis app and only a quarter of those who answered the open question relating to the type of the app, stated warning apps. Nevertheless, this category of app seems to play the most important role in many situations, justifying a qualitative study about this topic.

## **4 Qualitative Empirical Study: Evaluation of Warning Apps**

### **4.1 Methodology: Qualitative Evaluation in Germany**

In the qualitative empirical study, warning apps – the most mentioned category in the quantitative study – were investigated by interviewing 22 persons (P1-P22) between the age of 19 and 32 (8 males, 14 females). Due to the high relevance of apps for younger people, this group has been investigated in more detail. The empirical work was conducted in semi-structured interviews to be able to react to the answers of the interlocutors and to have a common theme to achieve comparability between the interviews. The sessions took between 25 and 45 minutes. The interview guideline comprised two parts. In the first part of each session, the participants were supposed to answer a questionnaire, where previous experiences with crisis apps were questioned. Furthermore, the participants were asked, why they do (not) use the app and to what extent they are afraid of crises. After pointing out the topic, the participants were asked if they now could imagine using such an app and which structure or which functionalities this app should contain. In the second part of the session, each person was asked to imagine the scenario of a flood disaster and to evaluate the widely-spread apps NINA, Katwarn, and FEMA offline with the use of guideline questions and screenshots of the three apps. The questions are presented in the following:

#### **Questions in Part I: Apps in Crisis**

- Do you have already experience with apps related to disaster prevention or warning?
- If yes, what Apps do you know? How does this app work? How did you get to download this app? Why do you use it? (What motivation did you have for it?) What did you like about it? What not? Were you missing functions or information?

- If not, why not (No interest? No sense of danger?)? Do you feel threatened by natural catastrophes? If you were brought to the subject now by us, would you use such an app? What would the app have to do to use it? How should the app be built? Would you have an idea how it might look? What features should the app have? What information do you need? What information do you expect in the app? Would you use the app to inform yourself about something, even if there is no danger? Should the app send notifications to remember? What would help you to improve your current situation?

### Questions in Part 2: Apps in Detail

- Scenario: Imagine you are in a storm or flood disaster. After you get to safety, you'll find out about an app on the smartphone. You can see the apps NINA, KATWARN, FEMA.
- After each app, the following questions are asked: What are the functions you remember? What did you like about the app? Where do you want extensions?
- Questions about the conclusion: Which app did you like the most and why? Which functions did you find helpful / good or unnecessary / bad? Which functions are missing?

The reasons for choosing these apps are based on the fact that NINA and Katwarn are the most popular disaster related apps in Germany and FEMA is a well-known US crisis related app. *Katwarn* ([www.katwarn.de/](http://www.katwarn.de/)) warns its users of crises either by knowing their GPS-coordinates or by letting the users indicate a region they would like to be informed about. For testing purposes, a test alarm can be set to see how the app works. *NINA* ([http://www.bbk.bund.de/DE/NINA/Warn-App\\_NINA.html](http://www.bbk.bund.de/DE/NINA/Warn-App_NINA.html)) warns of crises and offers recommendations for action and general tips (BBK, 2015). Affected people can inform contact points and tell them to what extent they are affected by the crisis or not (in terms of an all-clear signal). This app also uses GPS-coordinates or WLAN-coordinates. *FEMA app* (<https://www.fema.gov/mobile-app>) is the US-American equivalent to NINA and also provides disaster warnings and recommendations for action and enables the call for help (Department of Homeland Security (DoHS), 2015). Users can also upload pictures and short messages to inform others about their situation (Goncalves et al., 2014). Moreover, information, such as emergency boxes or possible meeting points, can be saved.

Interviews were audio-recorded and transcribed for further analysis. In our subsequent qualitative content analysis, we employed “open” coding (Strauss & Corbin, 1998), i.e. gathering data into approximate categories to reflect the issues raised by respondents based on repeated readings of the data and its organisation into “similar” statements. Two coders analysed and discursively grouped the results in terms of motivation to use warning apps (section 4.2), existing and missing functionality of warning apps (section 4.3), and a comparative evaluation of Nina, Katwarn, and FEMA (section 4.4).

## 4.2 Results I – Weak Motivation Due to Low Probability

Except for one person, every participant was very inexperienced with crisis apps. The most frequent answer to the reason was that they “*have never been affected yet*”. The answer to the question about the feeling of a danger by natural disasters was similar. Almost every questioned person said that they have never experienced a natural disaster and that they take such a situation for improbable: “*I do not feel threatened in Germany. Furthermore, I would then rely on the national and local institutions*” (P10). Regarding the future, at least three participants stated that they would not exclude a (natural) disaster completely, for instance heatwaves, storms, and floods were mentioned as possible crises. Also, after getting to know that such apps exist, many participants cannot imagine using them – at least not in their current situation. Mentioned reasons for this were that they rather prefer other media (this corresponds with the results from the quantitative study), that the danger has not been as big yet, or that they do not know if they would have the time to use the app whilst a crisis. However, some participants can imagine that such an app is especially meaningful if they are in a crisis. In this case, they would like to “*ask for help*” and “*organise help*”. Four of the interviewed participants would install the app from the outset “*to be informed beforehand*”. These answers show that the motivation to use a crisis related app is

dependent on how much a participant feels threatened by crises. The functionality is another important factor to motivate the people. Another suggestion was to make such an app obligatory or to create a standard installation on the smartphones as especially working persons are not permanently up to date with other media.

As many of the interviewed participants live in areas rarely threatened by crises, twelve participants answered that they would not use such an app if there is no danger. Six participants were not sure and four would use the app. Those participants who do not use the app said that they could imagine installing such an app if they lived in another region or if they were sensitised for that. Then, it is also important that the app *“does not overwhelm the user with information”*. Furthermore, they could imagine this app to be useful in this situation to call for and to organise help. The participants who would inform themselves about the app from the outset justified that it is meaningful to know how the app is structured to *“better and faster react”* in an emergency.

#### 4.3 Results II – Informing, Warning, and Helping as Functionality

Concerning the range of functions, many interviewed participants especially required tips for behaviour and a direct and early warning. Tips for behaviour were mentioned by 13 participants and should contain *“gradual instructions”*. Also, checklists or rather listings of things which could be useful in a crisis were needed. Information about central contact points and emergency numbers were expected as well. It should be possible to inform not only rescue services but also contact persons. Warnings should be *“as precise as possible concerning the point of arrival”* and displayed on a map. Furthermore, the app should inform users via push messages about crises in places which have been set before. In case of an evacuation, users should receive information about protection zones. Another important point that was mentioned for the app was *“offering, organising, and searching”* of help and that the app should also *“work without internet”*. Locating the current position is important as well to keep messages updated. It should be possible to determine if the positioning is used or not. The last requirement of a participant was that the app *“communicates calm”*. Neutral information, the latest status, and possible expectations were rated as helpful for users to improve their situation in a crisis by knowing how help can be found and what must be done. Also, calming was mentioned as an important aspect. The participants thought that in such a situation it is important to *“first not panic”* in order to be able to subsequently act better.

#### 4.4 Results III – Comparative Evaluation of NINA, Katwarn, and FEMA

The comparative evaluation of NINA, Katwarn, and FEMA (Figure 3) revealed user feedback on the features of warning messages, prevention and emergency tips, emergency contacts and general numbers, settings, menu and design, checklists, meeting places, and highlighted missing features and comprises an overall assessment of the warning apps.

**Warning messages.** Regarding warning messages, there are different visions. On the one hand, participants expressed that you get *“desensitised”* by too many warning messages and therefore you should only receive messages if you are personally affected (P9). On the other hand, other participants consider it to be justified if the app reacts from time to time: *“Then, you are aware or think about what to do if something happens in your area”* (P8). It is preferable to be able to adjust the settings regarding the cases for which you want to receive push notifications. The app should not send too many warning messages, as this is annoying so that you *“throw the thing down”* (P8). In NINA, warnings are displayed in a list. Many participants considered this as confusing: It displays *“too many information at first sight”* and it is unclear what each information is about. However, Katwarn uses a map that, according to the interviewed people, allows a better access. As for the participants, a map should be aligned to the own position, crises should be marked by red points and a zoom function should be offered. Moreover, the participants would like to be informed about some more dangers, independent of natural disasters. These contain gas and chemistry accidents, bomb disposals, and terroristic attacks. These are crises which occur more often than natural disasters in the region of the participants. Especially terror is a current and

important topic pursuant to one of the interviewed people. Also, the option to start a test warning is desired to note how the app behaves whilst a crisis.

**Prevention and emergency tips.** NINA and FEMA offer, unlike Katwarn, tips for the preparation for and the behaviour whilst and after (latter only by FEMA) crises. All in all, 15 out of 22 interviewed persons considered NINA's emergency tips as very helpful and as a meaningful function. What also should be kept in mind is that recommendations for action are supposed to be short and precise. The subdivision of the tips in before, whilst, and after the crisis was rated as very positive.

**Emergency contacts and general numbers.** 15 participants found it useful to be able to contact a pre-prepared contact list with the app NINA, however, seven did not. FEMA's list of regional phone numbers was considered as very positive, as you can also offer and get help, in case emergency numbers are overloaded.

**Settings.** The settings should offer options for privacy (positioning service) and the configuration of tones and push notifications. Privacy is considered as very important by part of the interviewed people. Also, it should be possible to choose the severity, e.g. of a storm, from where on you want to be warned. Furthermore, some participants want to choose which crises they are warned about, "*as you are not affected by every crisis*" (P16).

**Menu and design.** All the three apps were predominantly rated as clear and meaningful in displaying the information. Concerning the appearance of the app, NINA was partly ascribed a "*certain seriousness*", Katwarn was called "*somehow boring and sterile*" (it "*could be designed optically better*"), and FEMA was characterised as "*old-fashioned, too interlaced, and not intuitive*" due to its subdivision in four different coloured areas (however, others considered this as clear).

**Checklist.** FEMA app contains some more functions which have not been mentioned in this section yet. For example, a checklist of things which are needed in an emergency can be created. This was rather evaluated sceptically: "*I do think about my most important medicals. I will already have packed them up, before the list is even open*" (P11).

**Meeting Places.** With FEMA, you can also define Meeting Places, where you come together in case of a crisis. *Recovery Centre* and *Shelter* indicate meeting places or contact points for help. The function *Disaster Reporter* allows the users to upload photos of the crisis. The opinions about this feature are mixed: A positive aspect was that the user can become active and that the sharing of pictures resembles a community. Other participants call this function "*tasteless*" or "*morbid*". They think that affected people should not be encouraged to take pictures but to seek shelter. Furthermore, spreading pictures can create panic or crisis tourism. Some people regard the *Disaster Reporter* as neutral and unnecessary as there are enough pictures in the press and they are afraid of floods, especially in populous areas.

**Missing functions.** For NINA, a display on the map was required, showing where helpers are needed or how they are organised. Further, a chat function was required. For Katwarn, more information about the current crisis, a possibility for the consultation with others, and an emergency button were needed. For FEMA, it was requested to be able to contact other people, to quickly find suitable information with a search function, to offer each other and to receive help, location-based information, and a map view. The possibility to share danger areas with other people or to forward them to friends and family, was considered as missing for all the three apps. Besides this, setting options were requested to indicate in which part of the house or rather in which type of flat one lives. Last point was the wish for the organisation of regional help via telephone.

**Overall assessment.** About three quarter of the participants liked the app FEMA most. Reasons for this were the wide range of variegated setting possibilities, the checklist, the Meeting Points, and the information. Generally, FEMA was mentioned as "*most sophisticated*", as most diverse, and as the app with the most options. A few appointed Katwarn as the best app since they especially liked the map view and the clarity. The included test alarm was considered as meaningful, letting the user know how this alarm would look and sound like. An app like Katwarn with "*some more settings and more previous information*" would be optimal. A point of critique concerning Katwarn was that the app all in all seems

like a “signalling app, reporting that something happened”, but it does not offer important assistance. One person mentioned NINA to be the best app, especially because of its clarity. Both, previous information and information whilst a crisis are well displayed and in case of an emergency, this app is easy to handle even without being prepared.

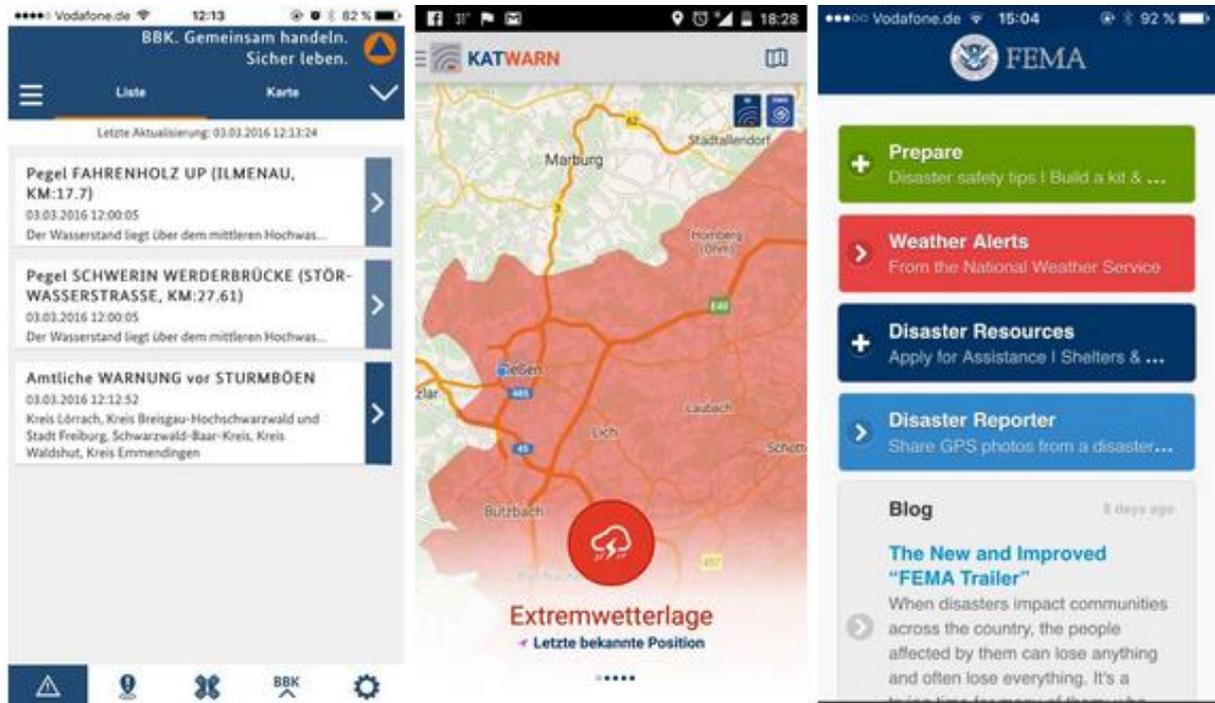


Figure 3. The apps NINA, Katwarn, and FEMA. Left: Warning messages in a list (NINA). Centre: Warning messages for extreme weather conditions (Katwarn). Right: Homepage with interlaced menus (FEMA).

## 5 Synopsis of Requirements and Prototype of a Warning App

As the evaluation showed, each app has certain advantages and disadvantages as well as different functions. A warning app should ideally combine the strengths of all the three apps and simultaneously offer a motivation to use the app. Corresponding main functions of the app should be: seeing warning messages, reading recommendations for action, sending warnings and all-clears, chatting and organising helpers as well as editing settings (Figure 4). Below, the functionality of such an app is discussed (Table 3). To provide rather clear recommendation, the functionalities are presented in descriptions and in the form of a prototype.

Functionality	Description
Warning messages	Overview about current and upcoming crises in a map view
Recommendations for action	Information on how people should behave before, whilst, and after a crisis with detailed explanations and pictures
Warning and all-clear	Inform private persons or official contact points via call or SMS
Chat and organisation	Exchange with others as well as with relief organisations via chat and map of current helpers
Settings	Individual settings of crisis types, site, tone etc.
Emergency contacts	Setting personal contacts relevant during crises

Table 3. Main functions



Figure 4. Warning messages (A), storm warnings (B), recommendations for action (C), checklists (D), instructions (E), warning and all-clears (F), settings (G), emergency contacts (H) (from top left to bottom right)

**Warning messages (A, B in Figure 4).** As soon as the app is started, a map opens which – analogue to Katwarn – centres the own position in case of an active positioning function and displays warning messages. If no warning message is available, a check in a green circle with the description “No warning” is shown. However, in case of a warning, the affected area is marked red and a warning symbol appears at the lower edge with the label of the warning type. With the blue plus top left, additional places can be added (e.g. work or resident of relatives). Tapping the storm symbol, details about the warning are offered. A contained prediction shows how the situation develops and provides first tips for behaviour. A button gives more recommendations concerning the warning type.

**Recommendations for action (C, D, E).** Recommendations for the crisis types storms, floods, bomb disposals, gas or chemistry accidents, and terrorism are written down. Those were divided into “before”, “while”, and “after”, as this was also very well received in the evaluation of NINA and FEMA. Some

tips for behaviour have own subpages with instructions. After tapping on the instruction “seal windows, doors, and discharge outlets” for example, you are led to an instruction with pictures and videos.

**Warning and all-clear (F).** The interviewees requested to give the all-clear or to warn their contacts in a crisis, strongly inspired by NINA. This corresponds with the quantitative study, whereby app users share information in hazardous situations more often. When these contacts are connected in the settings, they can be easily informed via SMS. The text can be prefabricated, like in NINA, and then enriched with more details in the crisis so that (if requested) coordinates can be transmitted as well. Besides the own contacts, regional emergency services can also be contacted via telephone.

**Chat and organisation.** A function that has not been included in the previous apps yet, is the exchange with others as well as the coordination of helpers. Therefore, a chat function is available, by which groceries and assistance can be exchanged. Helpers must know where and how they can help. Nevertheless, the coordination of helpers is too extensive to be examined in this work.

**Settings (G, H).** It is possible to adjust how the app should react in which situation. For storms for example, it is possible to choose if push messages shall be sent and if or rather which tone shall be used. It is also possible to specify from which severity one wants to be informed and if warning messages should be displayed for more locations besides the own position. Personal settings can be regulated, e.g. if one wants to transmit the own position in a crisis or not. Furthermore, emergency contacts can be chosen which can be contacted in case of a crisis; e.g. family members might want to be informed via SMS. Here, a standard text for warnings and all-clears can be defined. Also, contacts from the telephone book of the smartphone can be called.

## 6 Summary, Conclusion, and Future Work

The aim of this paper was to get insights into usage behaviour and motivation of the population concerning crisis apps and to develop concrete design suggestions of such an app. We aimed to research: *RQ1: What is the distribution of crisis apps in the population? RQ2: What kinds of crisis apps are currently used? RQ3: What are core functionalities of warning apps needed by the population?*

**RQ1:** Based on two quantitative studies – snowball-based in Europe (n=1,034) (Reuter & Spielhofer, 2016) and representative in Germany (n=1,369) – we found a low interest in installing a crisis app (16%) which confirms our first hypothesis (contribution 1). Furthermore, we found and discussed differences among crisis app users and non-app users, e.g. that app users agree more that emergency services should monitor social media (83% vs. 64%).

**RQ2:** We also researched what kinds of crisis apps are currently used. Both quantitative studies indicate that warning apps have the highest relevance (contribution 2). However, in the representative study weather apps were mentioned even more often (69%) than warning apps (42%), which might be since they have an even higher relevance in daily life – and referring to RQ1 – the motivation for crisis specific apps is rather low.

**RQ3:** Finally, the functionality of warning apps was evaluated with 22 participants, using the existing apps Katwarn, NINA, and FEMA, to study functions needed by the population. Based on the quantitative and qualitative studies presented in this article, requirements for warning apps were discussed and transferred into a prototype which serves as a suggestion for improvement (contribution 3). Core functionalities were the display of crisis warnings on a map and the service of details, predictions, and tips for behaviour in the context of the crisis. Moreover, the app should offer short recommendations for action before, during, and after the crisis by also providing pictures. Another request was to be able to quickly inform relief organisations and friends about the personal status. It was also demanded to coordinate help. An important point for the design of crisis apps is that many users only want to be warned if the crisis takes place at a personally relevant place. Too many warnings could lead to a desensitisation of warnings or an uninstallation of the app. What also should be considered is that not every user agrees with the permanent location detection of the app. Therefore, the app should enable the adaption to the individual wishes of the persons – among other things concerning privacy. Prospective

investigations to this topic should light the coordination of helpers. Furthermore, the designed concept of this study should be evaluated comparing it to existing crisis apps.

In future work, it is necessary to expand the exchange and organisation of helpers (Kaufhold & Reuter, 2016; Ludwig et al., 2017; Reuter et al., 2013). For this, it would be useful to observe the helper's behaviour in a crisis. Yet, this function should be included in any case in a crisis app and if possible it should be integrated in one and the same application to avoid the usage of various apps. To extend the scientific contribution of the process, further investigations could be driven by scientific guidelines of the design science paradigm (Hevner et al., 2004) and thus consist of an evaluation and iteratively improvement of the concept as well as a comparison between the concept and diverse existing apps. In doing so, the participants could compare directly whether there are other functions missing or some features are not needed at all. Moreover, design aspects could be analysed whereas the participants would be able to decide how the app's individual functions should look like. In this context, it would also be possible to interview other people than the rather young participants who participated in our qualitative study, which is a current limitation. To evaluate the app's real usage, it would have to be applied in a crisis. This would allow us to find out how people use a crisis app and which features are especially important. These features should attract higher interest, other ones may be removed from the app. Finally, it should be investigated if further crises should be added to the app, for example pursuant to the region where the app is used. Natural disasters such as earthquakes or extreme heat could be further crises even if they do not occur in Germany very often. Templates for different types of crisis could be possible. However, they only should be added if a usage in other countries is considered. Traffic accidents also count as crises as affected people also need help and do not always know how to behave.

If all the results which are suggested in the investigations are integrated in the existing concept, we hope to increase the usage and the motivation of people, regardless whether they are at risk or not. Still, further research is required in terms of promoting, e.g. by raising awareness of such apps before crises, and motivating, e.g. by providing functionality that is of use in everyday life, the use of specific crisis apps. In terms of promotion, the support of all stakeholders, especially emergency services, is required and strategies for implementation must be examined. For motivational issues, a participatory prototype development approach, besides specific interviews and surveys on the topic of usage motivation, under stronger guidance of existing motivational theories as well as related to sociological catastrophic theory (see section 1) could also initiate the identification of features and requirements to improve motivation on a qualitative and quantitative level.

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