

Enhancing the usability of a disaster app: exploring the perspectives of the public as users

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ABSTRACT

Limited research has studied how citizens' perspectives as end-users can contribute to improving the usability of disaster apps. This study addresses this gap by exploring end-user insights with the use of a conceptual disaster app in the New Zealand (NZ) context. NZ has multiple public alerting authorities that have various technological options in delivering information to the population's mobile devices; including social media platforms, apps, as well as the Emergency Mobile Alert system. However, during critical events, the multiplicity of information may become overwhelming. A disaster app, conceptualised in the NZ context, aims to aggregate, organise, and deliver information from official sources to the public. After the initial conceptual design, a usability inquiry was administered by interviewing members of the public. Partial results of the inquiry show that the public's perspective has value; in the process of understanding the new user's viewpoint, usability highlights and issues are identified.

Keywords

Usability inquiry, mobile application, disaster, alerts, public perspective

INTRODUCTION

Multiple apps exist to prepare and warn the public for disaster events. These include built-for-purpose disaster apps as well as social media platforms used by authorised agencies. Alerts and warnings can come from multiple sources through various platforms (Wright et al. 2014). However, during critical events, the multiplicity of information may become overwhelming for the user. Information overload can occur when human capacity can no longer process the torrent of data arriving (Stratmann and Boll 2016). To circumvent such difficulties, efforts have been made to create apps that curate emergency information needs. Disaster apps have been developed to have the capability to collate and disseminate information (Bachmann et al. 2015; Tan et al. 2017).

Disaster apps have the potential for improving the public's preparedness and response, but these technologies also pose risks if they are not appropriately designed in the context of its users (Tan et al. 2017). However, only a few studies on disaster apps have addressed the usability of the apps' interfaces (Romano et al. 2016; Tan et al. 2017).

The literature on the usability of technologies for disaster situations usually focus on responders as intended users and not the general public; for example, studies with police (e.g. Kuula et al. 2013) and firefighters (e.g. Prasanna et al. 2013). Only a few studies evaluate disaster technology applications from the perspective of civilians as the targeted users (Tan et al. 2017). Furthermore, most usability studies on mobile apps look into products used in casual environments and not in disaster contexts. For example, on social media apps (e.g. Hoehle et al. 2015), mobile banking apps (e.g. Mohan et al. 2015), and health apps (e.g. Schnall et al. 2016).

Considering these gaps, this research project seeks to explore how the insights of the citizens as users provide valuable perspectives in understanding and enhancing the usability of a disaster app. The research project employs usability inquiry, using interviews with eighteen participants, to investigate the users' perspective on a New Zealand (NZ) based conceptual disaster app.

The paper is structured as follows. The paper starts with a brief background on past studies of usability and disaster apps. Then we introduce the context and rationale behind our NZ based conceptual app. The methodology for the usability inquiry follows. Initial and partial results of the study are then presented. Finally, the paper concludes with the next steps for the research.

DISASTER APP USABILITY

It is important that users can effectively interact with apps; more so during crises, the apps should be usable even when users are under stress (Sarshar et al. 2015). Disaster apps must address the usability challenges of mobile interfaces and also consider the usability issues for safety-critical systems.

Mobile interfaces have their own set of usability challenges; specific issues, among others, include small screen size and the mobility of users (Gomez et al. 2014; Zhang and Adipat 2005). Using mobile apps may require more cognitive load from users; hence, mobile app usability models must consider new dimensions to account for the mobile app context (Harrison et al. 2013). Hoehle and Venkatesh (2015) conducted a prominent study on mobile app usability; they argued extensively for a differentiated mobile app usability model that diverges from software and website models. Analysing past literature on mobile app usability, as well as industry guidelines, Hoehle and Venkatesh (2015) proposed a mobile app usability model that comprised of six factors: app design, app utility, user interface (UI) graphics, UI output, UI input, and UI structure. However, literature that extended from this study has only been implemented on social media apps (e.g. Hoehle et al. 2015).

The lack of usability of crisis-related technological products can lead to compromised safety of its users (Nurse et al. 2012). Individuals can act differently when under pressure (Hiltz et al. 2010). In a review of safety-critical systems literature, supporting the human experience is essential to usability. Five recommendations are highlighted for disaster-related technologies: minimise user memory workload, use simple graphics and structure, avoid information overload, provide contextualised and updated information, and maintain a degree of automation but still keeps the user in the loop (Kwee-Meier et al. 2017). Understanding users and their decision making qualities in stressful conditions are essential when designing technologies for disaster management (Hiltz et al. 2010). User studies are valuable in guiding the design of safety-critical systems (Kwee-Meier et al. 2017).

Usability studies on disaster apps

As it applies to mobile apps and technologies for safety-critical systems, disaster apps should carefully consider usability. A recent study by Tan et al. (2018) tested and re-developed the Hoehle and Venkatesh (2015) model. Using survey responses from 270 actual disaster app users, Tan et al. (2018) proposed a usability-continuance model that fits the disaster app context; five factors were found to affect users' perception on whether to continue or abandon disaster apps: (1) app utility, (2) app dependability, (3) UI output, (4) UI input, and (5) UI graphics.

Before Tan et al.'s (2018) study, only a few papers had evaluated the usability of apps that are built specially for disaster purposes. Sarshar et al. (2015) investigated the usability of two disaster apps, GDACSmobile and SmartRescue; their study highlighted the importance of considering human-computer interaction (HCI) in the design of disaster apps. Furthermore, Sarshar et al. (2015) suggested that to have a deeper understanding of the usability of disaster apps, future research should investigate various usability testing methods.

Moreover, other studies on disaster apps focus on apps' functionalities and only briefly mentions engaging the users to assess usability (Tan et al. 2017). Often, user testing is employed either as a means to prove functional effectiveness or as a step to improve the app's functionality (e.g. Kaufhold et al. 2018; Kolathayar et al. 2018). However, Estuar et al. (2014) argued that engaging users should not just be for assessing functionality; understanding the user experience can help make an app's interface relevant to intended users. Reuter et al. (2017) encouraged the use of participatory methods with users to capture their perspective in the app design.

CONCEPTUALISATION OF A DISASTER APP IN NEW ZEALAND

This paper showcases how gathering user feedback through a usability inquiry can provide valuable insights in enhancing the usability of a disaster app. To begin, we introduce the app under study. This section discusses the rationale behind the conceptualisation of a disaster app in NZ. The disaster app concept is to aggregate the information available from authorised agencies about a crisis or a disaster and deliver it to the public through a simple platform.

In NZ, multiple agencies have the mandate to warn the public on actual or suspected threats, risks, hazards or emergencies (Ministry of Civil Defence and Emergency Management 2017). The Ministry of Civil Defence and Emergency Management (MCDEM) operates the National Warning System, which is the primary channel to communicate national level warnings to local Civil Defence and Emergency Management (CDEM) agencies. The members of sixteen regional CDEM Groups have the responsibility to provide official alerts, including calls to action, to their communities for hazards. Also, monitoring agencies such as GNS Science (geological survey) and the MetService (meteorological agency) also provide public alerting related to their respective hazards (Wright et al. 2014). Moreover, the NZ Police, Fire and Emergency NZ, NZ Transport Agency, Ministry of Health, and Ministry of Primary Industries also provide alerts related to their respective jurisdictions (Ministry of Civil Defence and Emergency Management 2017).

NZ CDEM collectively uses a multi-channel public-alerting approach, to ensure that many people can receive information, with redundancy. There are at least twenty public alerting platforms for these agencies to communicate to the public; these include billboards, radio announcement, cell broadcast, emails, loudspeakers, websites, etc. (Ministry of Civil Defence and Emergency Management, 2018). Multiple technological options exist to deliver alerts to the public through their mobile devices; these include apps, SMS-text message, phone calls, the use of social media platforms, and broadcast messaging (Wright et al., 2014).

Use of social media and apps in public alerting in New Zealand

Many of the NZ public alerting agencies use social media platforms to communicate (Wright et al. 2014). The public can access social media information through websites as well as through respective apps in their mobile devices. Through social media, the agencies communicate not only alerting messages but can also include everyday content such as preparedness advice (Wright et al. 2014).

However, in NZ the use of social media platforms have limitations. Users have to opt-in through individually following various accounts and have to check different streams and sources to receive updates (Wright et al. 2014). The presence of the agencies on popular social media platforms are not consistent. For example, not all NZ public alerting agencies have Facebook or Twitter accounts (Wright et al. 2014). A review of twenty-four alerting authorities on Facebook and Twitter shows that although most have official accounts on both social media platforms, some may have only one or the other, or none at all (Table 1 shows a cross tabulation). Another limitation of social media platforms is the reliance on third-party social media algorithms for providing information (Wright et al. 2014). Social media content does not necessarily come in chronological order (Biersdorfer 2016). Facebook prioritises posts from families and friends rather than organisations (Bromwich and Haag 2018).

Table 1. NZ public alerting agencies' social media presence as of 2018

		Facebook		Total
		Yes	No	
Twitter	Yes	18	2	20
	No	3	1	4
Total		21	3	24

When it comes to the use of mobile apps, three mobile apps are currently available in NZ that are affiliated with public alerting agencies. The GeoNet app is part of the geological hazard monitoring system in NZ; it is an app that allows the public to receive notifications for earthquakes and bulletins on volcanic activity (GeoNet n.d.). The MetService app provides information on weather conditions and forecasts as well as deliver severe weather warnings and watches (MetService n.d.). The Hazard app, developed and distributed by the NZ Red Cross, is a multi-hazard app endorsed and used by multiple CDEM groups (New Zealand Red Cross 2015).

Similar to the limitation of social media channels, mobile apps are opt-in platforms (Wright et al. 2014). Individuals have to consciously choose to download different apps to receive varying details of information on particular hazards that interests them.

With rapid changes in technology and the new media ecosystem, over-alerting can create issues in how the public responds to alerts (National Academies of Sciences Engineering and Medicine 2018a). During a crisis, users can encounter difficulties in making sense of too much data; information overload can occur when human capacity cannot keep up with the torrent of data arriving (Prasanna et al. 2013; Stratmann and Boll 2016). Aside from social media and other technological platforms, public alerting authorities can also push high-priority alerts via the Emergency Mobile Alert (EMA) system.

Emergency mobile alert in New Zealand

NZ had recently adopted the EMA system in 2017; which allows authorised agencies to release alerts via cell broadcast technology (Ministry of Civil Defence and Emergency Management 2017). Other countries have similar systems; for example, the Wireless Emergency Alert (WEA) in the United States of America (Bean et al. 2016), NL-Alert in the Netherlands (Gutteling et al. 2017), and Cell Broadcast Service (CBS) of Taiwan (Chang and Chen 2018).

The emergency alerts, different from text messages, do not cause network congestion as they are distributed through a geo-targeted wireless channel (Bean et al. 2016; Chang and Chen 2018). Moreover, the alert messages delivered to mobile phones are distinct from standard messages; they are uniquely displayed on devices accompanied by distinct tones and vibrations (Bean et al. 2016).

How an individual receives the message can affect how the individual responds to the threat (National Academies of Sciences Engineering and Medicine 2018b). During a crisis, users can encounter issues; anxiety, fatigue, and other stressors can hamper information processing (Stratmann and Boll 2016). The way information is processed, stored, and displayed can affect users (Prasanna et al. 2013). Technology for disasters must be efficiently designed to support the intake of information in stressful conditions.

Multiple studies have looked into the effectiveness of emergency alert messages; including studies on the technical capabilities (e.g. Chang and Chen 2018), on message content and style (e.g. Potter 2018), on citizens' response to messages (Gutteling et al. 2017). However, an understudied area is on how users interact with the alert message. The typical emergency alert message (see Figure 1) is delivered through a pop-up notification mechanism in the users' smartphone (Falcão et al. 2018). The simple message dialogue may be suitable to convey a single message during an unchanging situation, but multiple messages over a complex scenario may require a different manner of presentation to help the users' understand the situation (Iannucci et al. 2016).

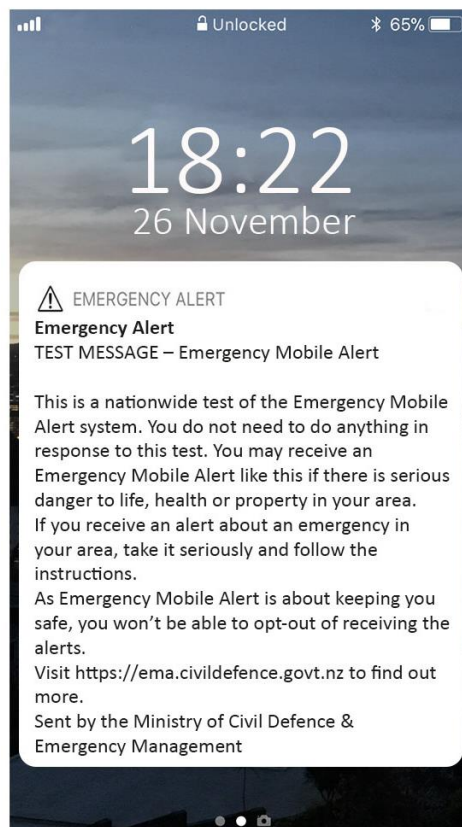


Figure 1. Emergency alert example (Theunissen 2017)

Another interface issue, as encountered in the 2017 test broadcast in NZ, is the disappearance of the alert message when users tap on to the notification on their smartphones (Ministry of Civil Defence and Emergency Management n.d.). Although not identified in academic literature, smartphone users have anecdotally raised interface and retrieval issues for emergency alerts. Table 2 lists some of these anecdotes from users on online forums.

Table 2. Anecdotes on disappearing alert messages

Anecdotes	Forum
Last night I got an emergency alert. I didn't have my glasses on and as I reached for the phone, I lost the message. How can I find that message? Thanks. (2014)	Apple Discussions
I imagine most people push OK in a panic to stop the loud sound, and then are left wondering what it was exactly that was so important. (2014)	Android Stack Exchange
Where are emergency alerts (WEA) stored on the iPhone? One popped up and disappeared before I could read it. (2013)	Apple Discussions

Further research is needed to make the interface more intuitive. As technologies change, so do user behaviour and public response; continued research on human interaction with alert messages is critical (National Academies of Sciences Engineering and Medicine 2018a).

App conceptual design

The app used in this study, currently named ‘NZ Alerts’, aims to address the issues above. The app aggregates information from official sources and authorised alerting agencies into one platform; providing means to find critical information segregated from the noise of multiple media sources and other non-hazard related information. The app will collect, store, and display information that is made public by authorised agencies; these include preparedness information, social media messages, and EMA broadcasts.

The initial expectations for the app are (1) to lessen information overload by consolidating messages from various official social media sources and (2) to address the emergency alert interface issues by collating, storing, and displaying emergency alert messages for users. Also, the app provides preparedness information from reliable sources. The app’s main features are partitioned into three screens (See Figure 2): home screen, prepare screen, and alert screen.

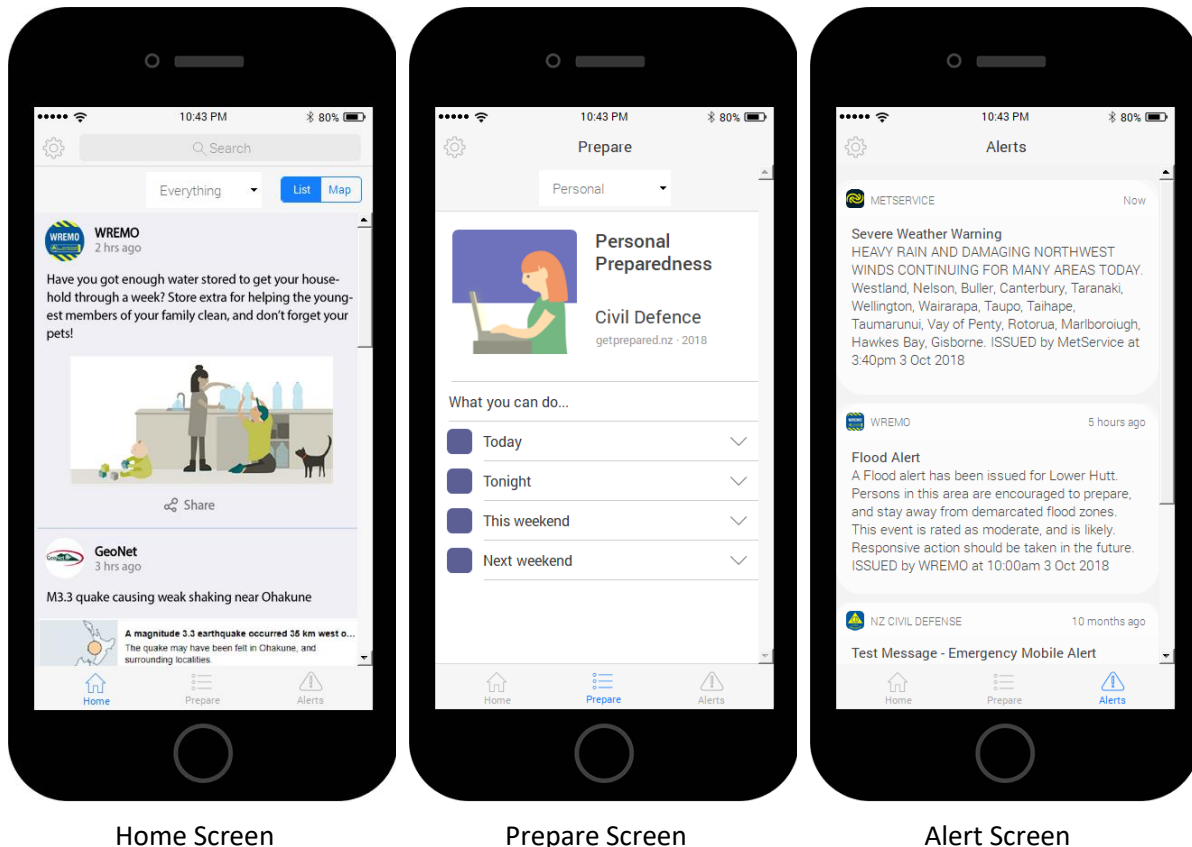


Figure 2. Screenshots of NZ Alerts app

Home screen

The home screen displays a real-time feed, harvesting content from participating authorities' social media channels. By collating information from official sources, it reduces the noise that may be encountered when using social media apps. In social media sites, posts on a users' feed can contain mundane topics that may become noise when seeking information about hazard events; separation of credible and reliable information from trivial ones is needed (Imran et al. 2015).

Prepare screen

Most of the apps in crisis informatics literature focus on the response and recovery stages (Tan et al. 2017). However, there is potential in utilising new media tools to encourage preparedness for a crisis (Veil et al. 2011). In addition to delivering up-to-date information from official agencies, the app will provide credible preparedness information. The prepare screen will be an offline repository of emergency preparedness information which users can access at any time.

Alert screen

The way information is processed, stored, and displayed can affect users' decision-making capabilities during critical scenarios (Prasanna et al. 2013). Users can make errors when under stress which may cause them to dismiss alerts before reading the information. The alert screen will collate, store, and display official emergency alert messages from authorities; allowing users to retrieve the information as needed.

With the combination of the above described three screens, the NZ Alerts app is expected to be a 'one-stop-shop' that aims to provide preparedness and response information on hazard events to the public living in NZ. It is essential that this initial app concept will be aligned with the expectation of the end-users when developed further to form a fully-fledged mobile app. Users can offer perspectives that can diverge or converge from the intended design; providing value in the design practices for disaster technologies (Petersen et al. 2015). The next section discusses the methods employed in this study to gain the users' perspective.

METHODS

The human-centred design is an important aspect in the field of disaster management (Fischer and Klompaker 2012). As part of the user-centred approach taken in this study, inputs from potential users were gathered to obtain their perspective on the NZ Alerts app. A usability inquiry was conducted with the aim of recognising the new users' needs and understanding of the app. Inquiry methods directly involve talking to end-users; techniques include surveys, focus groups, or interviews (Folmer and Bosch 2004; Zapata et al. 2015). For this study, we conducted semi-structured interviews with eighteen participants. Before the recruitment and data collection, the usability inquiry went through an ethical approval process for human participation.

Participant recruitment

The target user for the app is an iPhone user living in NZ, aged eighteen or older; with or without previous experience in using a disaster app. The recruitment strategy was applied in two stages. First, we recruited participants from an earlier disaster app survey. The survey, of which had 562 participants, contained a follow-up question that asked whether the respondents would be willing to be interviewed for a usability study. We invited the willing respondents (n=89) to participate in the usability inquiry; of which nine people volunteered to be interviewed. We then recruited more participants by posting flyers in two university campuses. Another nine individuals participated until the interview data collection reached a saturation point.

Data collection

We first conducted two pilot interviews to refine the questions and the interview flow. All the interviews were conducted in-person only in Wellington, NZ; due to researchers' limitations. The interviews were semi-structured and had three parts (See Table 3). The interviews involved users interacting through each screen of the mock-up interface, and then the interviewer asked core questions and supplementary questions on each part. After interacting through the entire app, the participants were also asked core questions about the overall app in the particular context of a crisis scenario. Each interview took between 40 to 90 minutes.

Table 3. Interview guide core questions

Interview core questions	
1.	Demographic and participant information
2.	Core questions for each screen (after user interacts freely with each screen) <ul style="list-style-type: none"> a. Do you like the look? What comments or issues do you have? b. Do you like the controls? What comments or issues do you have? c. Is it intuitive to navigate around the screen? What comments or issues do you have? d. Do you like how the information is presented? What comments or issues do you have? e. Do you like the words and icons used? What comments or issues do you have?
3.	Core questions for the app <ul style="list-style-type: none"> a. In a crisis scenario, do you think the design of the app is appropriate? b. In a crisis scenario, do you think the app will provide you with the needed information? c. Given that the app may be used during a crisis, would you change how the app looks? d. Given that the app may be used during a crisis, would you add/remove anything? e. What would make you uninstall the app?

Data analysis

We used thematic analysis to examine the eighteen interviews. Thematic analysis is a ‘method for identifying, analysing and reporting patterns (themes) within data’, and a theme ‘represents some level of patterned response or meaning within the data set’ (Braun and Clarke 2006 p. 80). The study followed Braun and Clarke’s (2006) 6-step process. The first step is familiarisation with the data starting with the transcription of the interviews. The second step is generating topics; for this study, we used a theoretical approach by using Tan et al.’s (2018) usability factors as the initial topics: app utility, app dependability, UI graphics, UI output, and UI input. The third step is searching for themes around the initial topics. The fourth step is reviewing themes; this involves refining the themes by collapsing and combining themes as necessary. The fifth step is defining and naming themes. The sixth step is to report the results. We discuss the initial results in the next section.

INITIAL RESULTS AND DISCUSSION

The study is still undergoing the data analysis process. Currently, the study is on step-3, searching for themes. A few themes have already formed (see Table 4). The themes are areas that the interviewees have expressed concern or interest in as they interacted with the app or as they answered the questions from the interview. The themes listed in the table is not yet exhaustive nor is it finalised as the analysis is still ongoing.

Table 4. Initially formed themes

Topics	Initially formed themes
App utility	Relevance of the content Clarity of the purpose of the app Frequency of use
App dependability	Accuracy Error-free operation Trust
UI graphics	Disengaged parts White, empty spaces Colour Simplicity/ complexity
UI output	Familiarity Salience of information Interesting/ boring Use of images and text Length of content
UI input	Auto-complete for search User power/control Settings/ customization Intuitiveness

For this working paper, a short discussion based on the findings so far will focus on some insights gathered around the app's interface output. The users' insights showcase the value of collecting user feedback for the design and development of disaster apps.

User insights on the interface output of the app

Interface output is about how well an app presents content effectively (Hoehle and Venkatesh 2015). Through the usability inquiry, we obtained an understanding of users' views and feelings on how the app presented its content.

The participants confirmed comfort and ease when they found familiarity with the interface. The participants found that similarity of the interface to other apps' helpful in using the NZ Alerts app.

I appreciate that it looks like an app that I am familiar with. [...] It's what I'm used to. Which make me comfortable. [Participant#05]

If people are not used to it, they will find it difficult to use. [Participant#06]

On the other hand, the participants also raised concern, highlighting that too much similarity has its downside also. For example, a few participants questioned whether they needed to scroll far to get relevant news. Scrolling endlessly to retrieve information is an experience they relate to when using Twitter. Furthermore, participants expressed some concern about presenting information in a feed format, especially in the context of use during disasters.

But it can also be a bad thing, as you might need to spend too much time on your phone. Similar to Twitter; if [an organisation] posted something really important. You may have to scroll down really far. [Participant#03]

During a crisis situation, we would be doing a lot of things. There are a lot of notifications – I might miss lots of information that is coming in. [Participant#04]

Interface output helps with information overload, presentation affects how users perceive information to be compelling or salient (Prasanna et al. 2013; Stratmann and Boll 2016). Beyond raising concern on how critical information will be relayed, participants provided suggestions on how to make information more salient; such as using colours, providing time stamps, and pinning posts, among others.

The importance of each post may be different. There could be a generic colour for general things. For alerts, use range of colours, red, orange, yellow. [Participant#01]

I might think the app is out of date. [...] Maybe have your own time stamp that says 'this page has been updated 2 minutes ago'. [Participant#02]

If there is a severe alert, there should be a way [for the post] to remain on the top. Even when you scroll, it remains on top. [Participant#04]

Furthermore, the participants were also able to highlight which elements in the app already helped emphasise critical information.

I like how they have the logos [of the authorities] for each. Really helpful, especially when you are scrolling really quick to look for something. [Participant#15]

NEXT STEPS AND FUTURE WORK

The importance of usability has been emphasised in safety-critical technology research (Kwee-Meier et al. 2017); however, limited comparable literature can be found on public-facing disaster apps. Furthermore, only a small number of academic work have employed user-centred methods in understanding the usability of disaster apps. This study addresses the gaps by highlighting and utilising citizen's feedback to gain insights on usability.

This paper has shown that the intended end-users' perspectives have value to the design and development of the NZ Alerts app. With the partial analysis for a single initial topic (UI output), the insights confirmed some design decisions, supplied particular concerns specific to the disaster context of use, and offered suggestions on improving salience. Through the full analysis of the usability inquiry, more themes will be reviewed and refined; potentially offering a holistic appraisal of the initial app configuration.

The next steps for this study are to complete the analysis of the usability inquiry and to present a comprehensive report of the results. Practical action forward for the NZ Alerts app is to use the results for the next iteration of design and development. Future theoretical work will build on the broader implications of the results; developing a case for a citizen-centric approach in enhancing the usability of disaster apps.

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