Proceedings of the 59th Hawaii International Conference on System Sciences | 2026

From Alerts to Action: Designing Crisis Apps that Enable Self-Help in Storm-Flood Events

Enrico Milutzki
University of Hamburg
enrico.milutzki@uni-hamburg.de

Marten Borchers
University of Hamburg
marten.borchers@uni-hamburg.de

Jan Hummel
University of Hamburg
jan.hummel@studium.uni-hamburg.de

Valeria Magdych
University of Hamburg
valeriia.magdych@studium.uni-hamburg.de

Eva Bittner
University of Hamburg
eva.bittner@uni-hamburg.de

Martin Semmann
University of Hamburg
martin.semmann@uni-hamburg.de

Abstract

This paper explores the design of mobile emergency applications to enhance citizen self-help during storm flood events, addressing critical gaps in current warning systems. Through a comprehensive literature review and the application of the design science research paradigm, we identify 13 socio-technical issues, such as low user motivation, mistrust, information overload, and fragmented community support. We formulated twelve meta-requirements and derived eight actionable design principles. Based on these findings, we developed a prototype and evaluated it through qualitative walk-throughs with ten citizens. Our findings indicate high usability, trust, and perceived helpfulness, validating the layered, credibility-centered, and community-aware approach. The findings suggest that effective storm-flood apps should incorporate straightforward navigation, action-linked alerts, visual hazard communication, step-by-step guidance, and neighborhood networks. This work extends existing crisis communication guidelines, offering practical insights for designing citizen-empowering emergency tools that align with the Sustainable Development Goals for resilient urban communities.

Keywords: Self-Help, Storm Flood, Mobile Apps, Emergency Management, Design Science Research.

1. Introduction

Climate change constitutes one of the most significant challenges of the contemporary era. Global surface temperatures have already increased by about 1.1 °C since pre-industrial times and continue to rise despite ongoing mitigation efforts (IPCC, 2023). As ocean temperatures rise, evaporation rates accelerate, enabling clouds to retain greater quantities of moisture and thereby intensifying precipitation events (Wang et al., 2023). Concurrently, sea levels are rising, and currently, over 100 million individuals reside in areas below present-day sea level, a number projected to exceed 450 million by 2050 (Kulp & Strauss, 2019).

This trend poses substantial risks to human life, critical infrastructure, and ecosystems, underscoring the necessity of achieving the United Nations' Sustainable Development Goals (SDGs), in particular, Goal 11 (sustainable cities and communities) and Goal 13 (climate action), as highlighted by Kulp & Strauss (2019). Recent events, such as the 2021 floods in Germany and those in 2024 in Austria, Spain, and the USA, have highlighted significant deficiencies in disaster preparedness and public warning systems (Center for Disaster Philanthropy, 2024; Lourenço Neves, 2024; Morote et al., 2025). Despite the presence of accurate forecasts and advanced hydrological modeling, warnings often reached residents too late or lacked sufficient clarity. Specifically, 85% of individuals did not anticipate the severity of the floods, and 46% were uncertain about appropriate protective actions to undertake (Thieken et al., 2007). Furthermore, over half the population reported inadequate information regarding personal preparedness strategies, indicating an overdependence on governmental actors and highlighting the urgent need to strengthen community self-efficacy (Fekete et al., 2021). For the purpose of this project, we focus on Germany to prototype a crisis app. Accordingly, relevant mobile warning applications, such as NINA, Katwarn, and FEMA, now represent central components of flood risk communication, providing rapid alerts and crucial response guidance (Reuter et al., 2022; Rossi et al., 2015). However, their adoption remains limited, with only 16% of the German population having utilized an emergency app (Reuter et al., 2022). Challenges such as alert fatigue, limited interactivity, and the absence of features to facilitate actionable self-help persist (Abbasi et al., 2024). This indicates considerable untapped potential to utilize mobile applications to empower citizens to respond proactively before, during, and after flood events (Haunschild et al., 2023; Milutzki & Borchers, 2025). Therefore, we examine the following research question (**RQ**) in this paper.

RQ: How should mobile emergency apps be designed to empower citizens to help themselves during storm flood events?

The paper continues with the Related Work section, in which we describe the foundation of emergency management and specify the stakeholders and their respective actions. Afterward, we describe the method according to the Design Science Research (DSR) paradigm, followed by the section on Awareness of the Problem & Suggestion, in which we identify socio-technical issues, covering both limitations of current app designs and user-related challenges, and derive corresponding meta-requirements that address these issues, from which we then formulate design principles. In the Design & Development section, we used these to develop a prototype, and in the Evaluation & Findings section, we describe the evaluation results. In the Discussion section, we elaborate on our findings in the context of the existing knowledge base, including and highlighting practical and theoretical implications, limitations, and future work. Finally, we summarize our findings in the Conclusion section.

2. Related Work

Emergency management is a governmental responsibility regulated by laws, typically assigned to the Ministry of the Interior and public services such as fire departments and police; in severe cases, the army may also be involved (Federal Ministry of the Interior, 2015). Volunteer organizations and civil society groups support these efforts in warning dissemination, evacuations, and relief (Fekete et al., 2021). This includes informing citizens to increase awareness proactively and, in cases of an emergency, warn, evacuate, and respond by building and securing dams, infrastructure, and citizens (Reuter et al., 2022). These actors must coordinate across approved processes, particularly in chaotic flood situations with many stakeholders (Lourenço Neves, 2024).

2.1. Emergency Management Phases

Emergency management is primarily concerned with the protection of human life and the reduction of harm to property and the environment. Achieving these objectives necessitates a range of capabilities and competencies, which are delineated across the three cyclical phases of emergency management (cf. Figure 1). The first phase, risk mitigation, comprises two guiding principles: prevention and preparedness. Prevention refers to structural measures aimed at reducing risks, such as flood defenses, land-use regulations, and technical standards.

Preparedness emphasizes non-structural measures, including training, awareness campaigns, and contingency planning, which equip stakeholders to respond effectively when hazards materialize (Yousefi Mohammadi et al., 2024). The second phase, response, is guided by the principle of relief and relies primarily on non-structural measures. This includes the activation of emergency plans, issuing alerts, disseminating accurate information, providing immediate medical assistance, coordinating evacuations, and ensuring the continuity of essential services (Boin & Bynander, 2016). The final phase, recovery, emphasizes reconstruction through both structural and non-structural measures. Beyond short-term restoration of essential services, this phase also involves longer-term rebuilding efforts, damage assessments, and strategies to strengthen resilience and "build back better" for future events (Rodrigues et al., 2002).

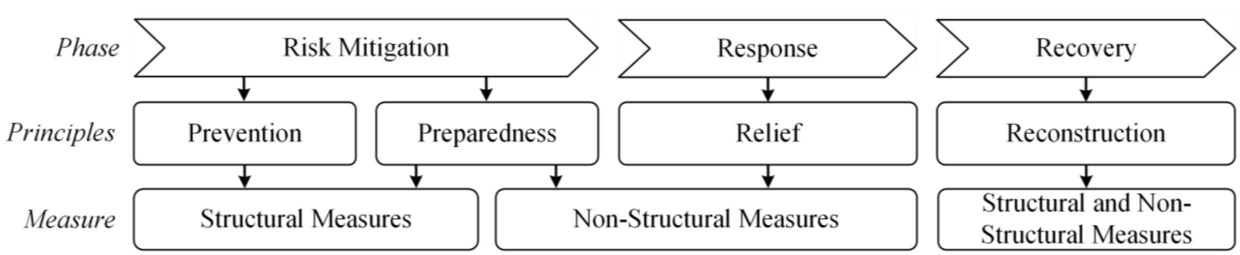

Figure 1. Overview of the Emergency Management Phases, Principles, and Measures as presented by Rodrigues et al. (2002).

2.2. Mobile Emergency Applications

Numerous mobile emergency applications have been developed in recent years; however, several studies indicate that they fail to meet practical requirements and achieve only limited dissemination among the population. Notable examples include Katwarn, introduced by the Fraunhofer Institute in 2013, and NINA, launched by the Federal Office for Civil Protection and Disaster Assistance in 2015, both of which have been the subject of extensive research and analysis (Reuter et al., 2022). Both applications are intended to address a broad range of emergencies and are not specifically tailored to flood scenarios or geographic locations. Furthermore, they offer limited user interaction. Although general recommendations for action are provided, these are not customized to the individual user's context. Additionally, users cannot communicate their circumstances, which limits situational awareness as the perception, comprehension, and projection of critical information, essential for adaptive flood responses (Milutzki & Borchers, 2025). The utilization of users as information sources has been implemented in a mobile application developed by the Federal Emergency Management Agency in the United States (Reuter et al., 2022). This government-issued warning application enables users to request assistance directly through the app or to access support via dedicated hotlines. However, direct real-time interaction between citizens and emergency responders, involving two-way communication and data exchange, is not supported (Borchers et al., 2024). In emergency situations, enabling such interaction is further complicated by the risk of information overload resulting from large volumes of citizen-contributed data (Bawden & Robinson, 2020).

3. Method

To answer the **RQ**, we follow the design science research (DSR) paradigm, a well-established approach known in information systems. DSR is a problem-solving paradigm that generates knowledge by creating IT artifacts and (local) design theories (vom Brocke et al., 2020). In this work, we apply DSR according to Kuechler and Vaishnavi (2008), which involves the five steps as shown in Figure 2 and the following process. The first step, problem awareness, requires the specification of the problem as implied by the **RQ**. In the phase of suggestions, we formulate potential solutions, and in development, these solutions, in terms of design principles, are instantiated into an IT artifact. The subsequent evaluation phase assesses the newly developed IT artifact regarding the design principles derived in the suggestion phase. Finally, the findings are discussed and communicated in the Evaluation & Findings and Discussion sections. One DSR cycle is conducted for this paper. In the first phase, we specify the problem, described as issues in detail based on existing literature (Tan et al., 2017). The prototype was developed in Figma and evaluated with citizens. We conducted ten semi-structured interviews during walk-through sessions, each lasting between 30 and 60 minutes. Participants interacted with the prototype while commenting on usability, clarity, and usefulness. With consent, sessions were recorded, transcribed, and analyzed using Mayring's paraphrasing approach (2014), through iterative

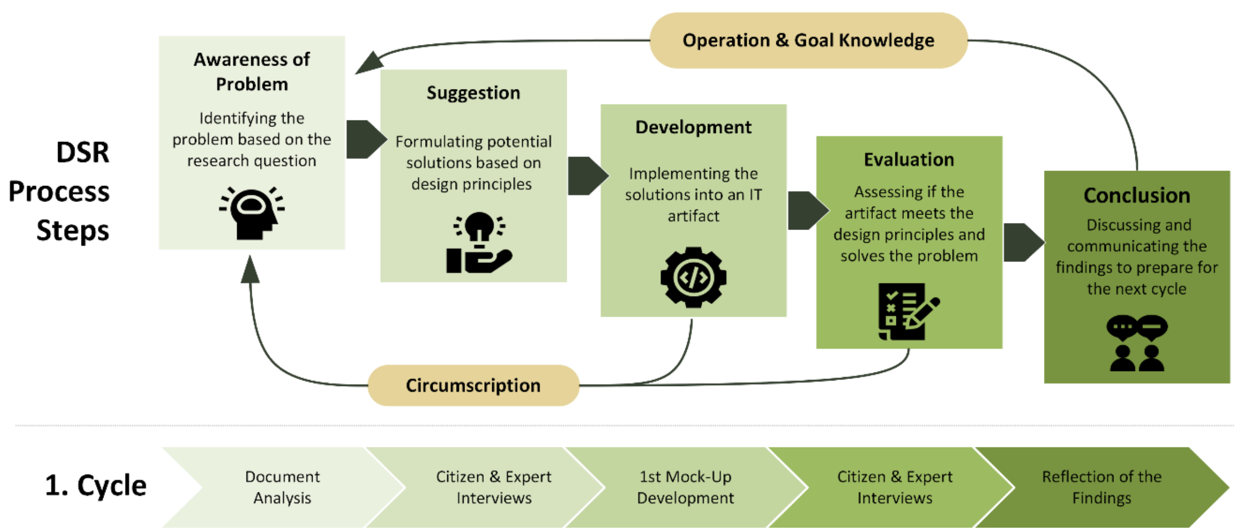

Figure 2. Overview of Design Science Research and the conducted first Cycle based on Kuechler & Vaishnavi (2008)

coding, reduction, and abstraction to derive core themes. Finally, we elaborate and conclude on our findings in the context of the existing literature and knowledge base.

4. Awareness of the Problem & Suggestions

We conducted a systematic literature review following Kitchenham and Charters (2010) to examine the current state of the knowledge base on emergency self-help approaches for citizens in storm floods. First, we searched the two bibliographic databases of ScienceDirect and AIS eLibrary - using the search string: (“self-help” OR “self-efficacy”) AND (“flood") AND (“preparedness” OR “mitigation” OR “response” OR “recovery”) AND (“warning system” OR “app” OR “crisis management”). We targeted recent studies published since 2017 to ensure relevance. We further screened titles and abstracts for relevance, narrowing the pool to 67 studies. Full-text assessment and backward citation tracking further refined the selection to 23 primary sources. From these studies, we extracted data on self-help mechanisms, flood phases (preparedness, response, recovery), and mobile app-based crisis system features, forming the basis for our problem space and meta-requirements. Applying Mayring's qualitative content-analysis procedure (2014), the coded material was iteratively condensed and subjected to continuous reliability checks, which ultimately revealed three overarching clusters of Knowledge Transfer & User Acceptance, Information Design & Communication and Socio-Psychological Support, from which we systematically further identified issues (**ISS**). These issues were then abstracted into meta-requirements (**MR**) and translated into design principles (**DP**) as shown in Figure 3.

4.1. Knowledge & Acceptance

An intuitive interface (**MR1**) directly reduces the twin obstacles of low motivation (**ISS3**) and alert fatigue (**ISS4**). By minimizing cognitive load, clear navigation turns push messages into actionable help rather than a nuisance, curbing the impulse to ignore or uninstall the app, which **DP1** partly addresses by clarifying navigation (Haunschild et al., 2023). Addressing **ISS2**, **ISS3**, and **ISS4**, credible and trustworthy communication (**MR2**) strengthens the retreat effect by making alerts relevant so they are no longer dismissed as spam (Kaufhold et al., 2020; Xiong & Li, 2024). In addition, visible learning progress (**MR3**) can sustain engagement if citizens track their already accomplished knowledge, and its perceived usefulness can raise their willingness to prepare further (Gammoh et al., 2023; Haunschild et al., 2023). Regular, repeating interaction (**MR4**) provides spaced micro-learning that steadily raises baseline knowledge without overwhelming users, thereby bridging the fundamental gaps in risk awareness (**ISS1**) and practical skills (**ISS5**) (Kerstholt et al., 2017; Sakurai & Shaw, 2022). **MR1**, **MR2**, **MR3,** and **MR4** are derived into **DP2**, which aims to reduce cognitive load and increase user acceptance by implementing structured, modular content. Positively framed and evidence-based impulses (**MR5**) underline real success stories and the tangible impact of precautions, translating readiness into concrete protective action while avoiding a scolding tone (Fischer et al., 2019; Fox-Rogers et al., 2016). Additionally, engaging and appealing content (**MR6**), such as badges, progress bars, and scenario simulations, can make the entire learning process more enjoyable. This further offsets notification fatigue and reinforces motivation (Arakawa et al., 2023; Haunschild et al., 2023), leading to **DP3**.

Altogether, these **MR1** to **MR6** and **DP1** to **DP3** specify how the IT artifact, e.g., mobile emergency apps, should be designed to motivate citizens to learn and to empower them, enhancing their self-help capabilities (Borchers et al., 2025; Reuter et al., 2017).

4.2. Information Design & Communication

To represent raw data as useful guidance addressing **ISS6**, the app should translate technical flood metrics into intuitive visuals. Therefore, **MR7** calls for an interactive map and additional figures to enable citizens to grasp the threat immediately (Schumann et al., 2018). Building on this, **MR8** links every alert to a specific, context-relevant action, replacing one-way hazard bulletins (**ISS7**) with clear, doable recommendations, an approach proven to raise protective behavior (Wachinger et al., 2013). Yet relevance alone is not enough. Warnings should also reach people early and in straightforward language. **MR9**, therefore, insists on timely, locally framed messages, simultaneously countering communication gaps (**ISS7**) and limiting the space in which rumors can spread (**ISS8**) (Gammoh et al., 2023; Kaufhold et al., 2020; Rollason et al., 2018), leading to **DP4** and **DP5** (cf. Figure 3). Finally, since citizens react more intensely to sources, they trust (**ISS8**), **DP6** addresses **MR10** by safeguarding credibility. This is achieved by routing content through verified channels, clearly citing authorities, and inviting user feedback. These measures have been shown to reduce misinformation and rebuild confidence following past failures (Haunschild et al., 2023; Kerstholt et al., 2017).

Together, **MR7** to **MR10** and **DP4** to **DP6** highlight the demand and design of visually appealing, location-based, and instruction-based mobile emergency applications.

4.3. Socio-Psychological Aspects

MR11 addresses the entire range of social disparities identified in **ISS9** to **ISS13**. Since age, rather than property, education, or income, now predicts mitigation behavior in industrialized countries, older residents, who often live alone in large cities, are especially vulnerable (**ISS9**) (Fox-Rogers et al., 2016). At the same time, public resources (**ISS10**) remain finite (Lichterman, 2000), urban neighborhoods (**ISS11**) lack tight social ties (Sakurai & Shaw, 2022), and generic, one-way alerts foster a sense of being overlooked (**ISS12**) (Reuter et al., 2017). This weak collective fabric contributes to a broader tendency to shift all responsibility to the state. (**ISS13**) (Gammoh et al., 2023; Reuter et al., 2017). Therefore, **MR11** requires the app to facilitate the nurturing of local networks, from sharing "safe/need-aid" statuses to sending friend invitations so that citizens can become each other's first line of support. Empirical work shows that such grassroots ties facilitate information exchange and enable spontaneous evacuation help (Karunarathne & Lee, 2020; Xiong & Li, 2024). Emotional attachment to a place further boosts preparedness (Fischer et al., 2019; Kerstholt et al., 2017), while interactive features like neighborhood chats or map-based volunteer matching transform would-be "victims" into active resources (Lichterman, 2000). Complementing this, **MR12** focuses on the individual's capacity to act despite strained authorities (again addressing **ISS10** to **ISS13**). Research clearly links a strong sense of efficacy to higher flood readiness (Gammoh et al., 2023). Hence, the app must provide tools like step-by-step guidance, progress feedback, and co-created checklists. These tools must let users see and feel what they can accomplish on their own. Close collaboration between scientific providers and end-users is crucial to produce truly usable solutions (Schumann et al., 2018). Strengthening users' sense of self-efficacy and community support turns passive recipients into confident actors who can organize help, improvise protective measures, and sustain recovery even when formal services are overstretched (Ntontis et al.,

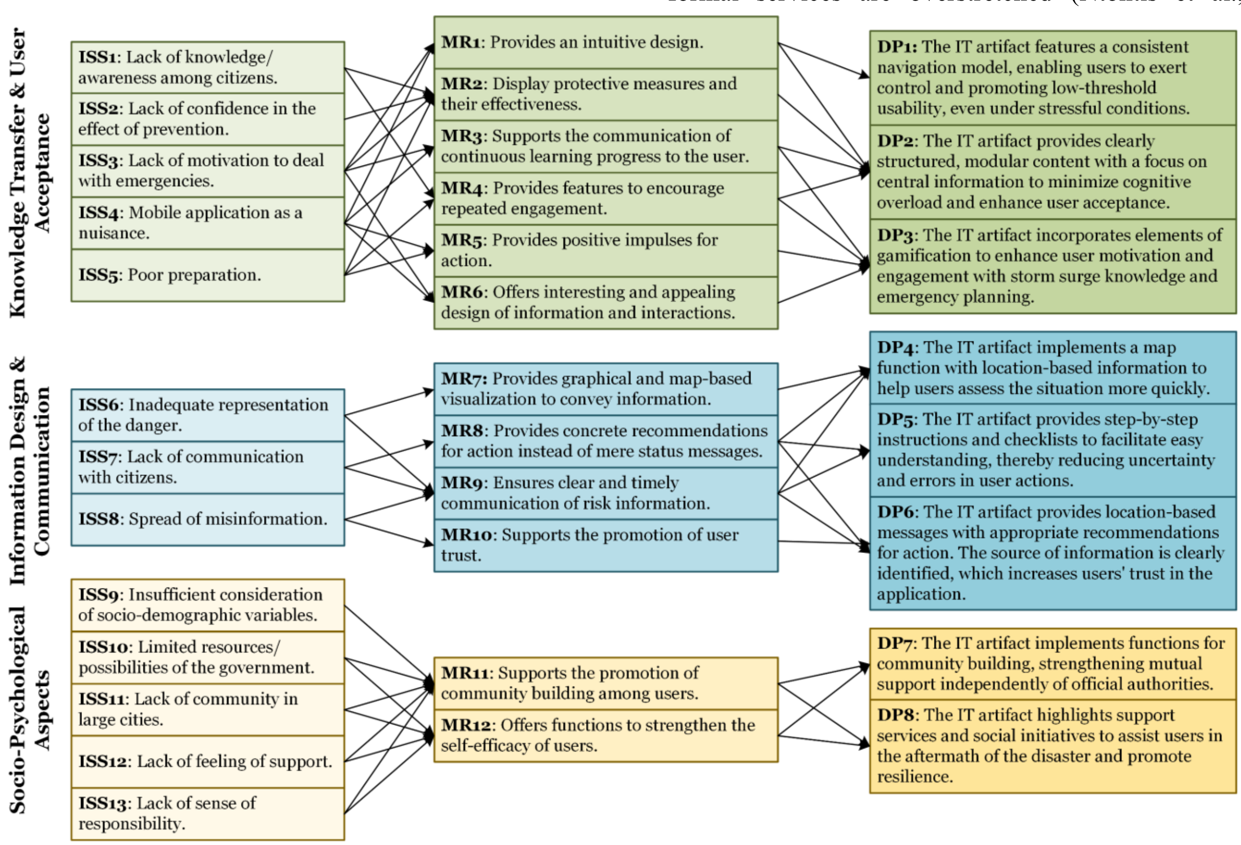

Figure 3. Overview of the identified Issues (ISS), the formulated Meta-Requirements (MR), and the derived Design Principles (DP).

2020). **MR11** and **MR12** are addressing this, leading to **DP7** and **DP8**. Together, **DP7** and **DP8** foster stronger neighborhood bonds with heightened personal agency, transforming a fragmented, state-dependent population into a resilient community capable of collective and self-directed responses before, during, and after storm flood events.

5. Design & Development

The instantiation of the design principles is achieved by developing a Figma mock-up, which serves as a demonstrator. Figma enables the creation of a (mobile) web app that participants can explore interactively and, therefore, receive an authentic impression of the solution (Borchers et al., 2023). The prototype, as shown in Figure 4, was created in two stages: first, low-fidelity paper sketches, and second, a high-fidelity click model in Figma. This process embedded the eight design principles (**DP1** to **DP8**) that follow from the meta-requirements. A concise style guide ensured visual consistency and usability (Norman, 2013). Navigation followed a pyramid pattern with phase-specific top-level tabs and context-sensitive functions (**DP1**, **DP2**).

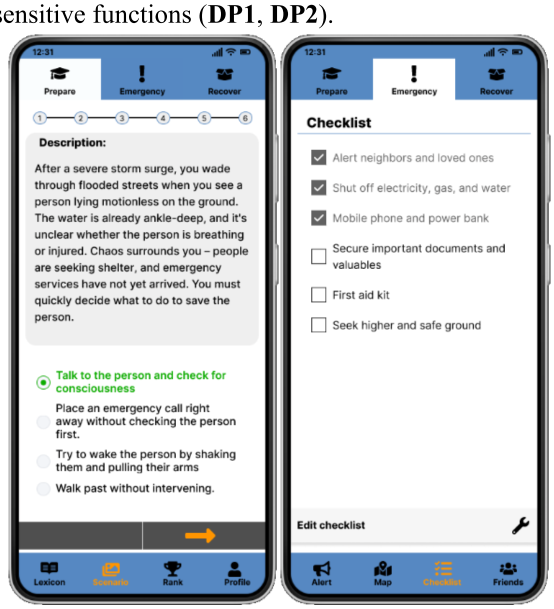

Figure 4. Overview of the prototype showing the scenario (left) and the checklist (right).

Risk Mitigation and Preparation Phase: To operationalize **MR3** and **MR4** and to address **DP1**, the learning rubric provides a searchable lexicon for quick lookups and a scenario where citizens can play interactive emergencies, as shown in Figure 4 (left). Correct answers unlock badges and experience points, turning repetition into motivation and therefore addressing **DP3**. All modules retain the minimalist grid so that, if opened in a crisis, content can still be scanned without overloading to accomplish **DP2**.

Emergency Response Phase: The phase begins with a localized alert feed that pairs every warning with a one-sentence action cue, exactly the pairing demanded by **MR8** and addressed in **DP6**. To fulfill **DP4**, a full-screen map merges official reports with citizens' reports. Visualize dangerous areas with polygons and offer a "Navigate" function for evacuations that avoids flooded segments and blocked roads. A structured checklist derived from government guidelines offers tick-off tasks such as "switch off basement power" and greys out completed items, satisfying **DP5** and giving visual proof of progress (cf. Figure 4, right). The friends pane lets residents toggle the states *Safe*, *Need Aid*, and *Busy*, which adds their status to the map, and opens a neighborhood chat to support a micro-network for citizens addressing **DP7**.

Recovery Phase: The recovery phase offers rebuild guidance with step-by-step debris evacuation instructions, paperwork, and contact information for government assistance organizations. It also provides an aid centers directory with a progress bar that shows the status of each request, translating abstract bureaucracy into transparent tasks and thereby addressing **DP8**. A feedback area invites reflective diaries and improvement suggestions, reinforcing self-efficacy and closing the design loop.

Across all three phases, user-generated hazard reports undergo a lightweight credibility filter that combines automatic plausibility checks and peer voting, meeting **MR9** and **MR10** by curbing misinformation without compromising speed. In this way, every screen embodies at least one design principle, turning the prototype from a one-way warning channel into a platform that empowers citizens to help themselves.

6. Evaluation & Findings

The prototype was evaluated in a qualitative study that mirrored the three storm-flood phases addressed by the design, as described in Section 2.1. Ten citizens (C1 to C10; four women and six men) were recruited, with an emphasis on individuals aged 20 to 30 years. Two participants in their fifties were added to reveal age-related usability issues. All participants received access to the executable Figma prototype and were asked to complete three provided tasks, which address the "Risk Mitigation and Preparation Phase," "Emergency Response Phase," and "Recovery Phase" (cf. Section 6). The ensuing semi-structured interviews followed Helfferich's guideline technique (2019) and were documented and analyzed according to Mayring (2014). Considering the participants, only one had previously installed a mobile emergency app before, echoing the generally low adoption noted by Kaufhold et al. (2020) and Reuter (2017). All ten participants stated that the prototype would enhance their ability to respond to a storm flood. Nine interviewees rated the pyramid navigation as “very intuitive” or “intuitive”; five described the interface as “very clear,” and four as “clear,” with no negative comments. These judgments confirm that the combination of **DP1** (clear orientation) and **DP2** (information reduction) achieves its goal of maintaining low cognitive demands during stress. **DP3** incorporates the demand for gamification elements, which was positively evaluated by six out of ten participants. Overall, they described it as motivating to engage with the content regularly, knowing that the evaluation represents one single interaction with limited time. However, the ranking function was mentioned, as it enables competitive comparison with friends. At the same time, two participants criticized the ranking function, as it was perceived as less valuable in an ongoing emergency and only provided value before and after the event. The interactive map, including the highlighted hazard areas and location-based recommendations (**DP4** and **DP6**), were described as “the fastest way to see what’s going on.” However, several participants asked for distance filters or a clearer definition of “nearby” to avoid information overload. Government-derived checklists (**DP5**) were praised for turning advice into “tick-off essentials when no time is left” and for guiding recovery tasks in the *Rebuild* rubric. **DP6** addresses location-based messages and recommendations of high trust. The participants confirmed this approach and highlighted the possibility of only receiving warnings and messages if they are currently in an area of high risk. This reduced unnecessary information flow and additionally supported the situation-dependent checklist. Two-thirds of the participants welcomed the *Safe* and *Need-Aid* toggle and neighborhood chat (**DP7**) as a quick way to check on relatives and coordinate help. However, some doubted that all neighbors would install the app and highlighted privacy concerns, particularly regarding health and location data, as others could also abuse this information for malicious purposes. The government organization request tracker and progress bar (**DP8**) were perceived as “extremely helpful” for post-event organizations, underlining the value of including the recovery phase. Participants suggested (i) attaching photos to user reports to raise credibility, (ii) splitting the three-state status toggle into separate buttons for faster access, (iii) adding an SOS button with first-aid guidance if professional help is delayed, and (iv) implementing proximity filters for alerts and news. Overall, the interviews provide strong qualitative support for all eight design principles while highlighting concrete refinements for the next DSR cycle.

7. Discussion

In this study, we examine the **RQ, "**How should mobile emergency apps be designed to empower citizens to help themselves during storm flood events?" due to the increased risks of storm surges caused by climate change (Wang et al., 2023). In doing so, we identified 13 issues and twelve meta-requirements and derived eight design principles (cf. Section 4). These principles address socio-technical gaps that current emergency apps, such as NINA or Katwarn, do not systematically cover. The instantiation of these with a web prototype and its evaluation approved our implementation and further highlighted different areas of action.

In answering the **RQ,** we first want to highlight the three key areas extracted of *Knowledge Transfer & User Acceptance*, *Information Design & Communication*, and *Socio-Psychological Aspects*. These expand the current state of knowledge about mobile emergency apps, which, as described in Section 2.2, primarily focus on communicating information. However, the classification highlights the need for motivating factors. Installing an app in an emergency is too late, as evidenced by the low penetration of such applications, as described in the literature. Instead, efforts should be increased to do this in advance. We are aware of the challenge, as this means that citizens must install a mobile application on their smartphones, which, in the best-case scenario, they never have to use. While **DP1** and **DP2** focus on the intuitive communication of information and usability, **DP3** was refined to emphasize context-sensitive gamification elements. This, in combination with the implemented learning contents, as described in Section 5, provides a reason and motivation for citizens to install an emergency app before, as it is more than just a one-directional communication channel. Even if **DP1** to **DP3** are approved, we see the highest potential in this key area in **DP3**, which directly addresses the risk mitigation phase of the emergency management framework in terms of citizens' awareness, a major problem (Reuter et al., 2022). The second key area, Information Design & Communication, is crucial in the response phase of an emergency. The map function can provide orientation (**DP4**), and the step-by-step instructions can guide citizens, especially in critical situations with much pressure (**DP5**). **DP6** was refined to support individualized insights through user-controllable proximity filters, thereby reducing information overload and clarifying what is considered “nearby”. All three are extending existing approaches and are upgrading them into an information platform with bidirectional communication, information, and data flow (Bräker et al., 2022). This can be a strength for future solutions and offers great potential. As described in the literature, many crises are also accompanied by significant information deficits, as there is a lack of local resources and digital data channels to complete the picture of the situation (Borchers et al., 2025). An emergency app for citizens can serve as a platform here, as it can also provide location data, images, and videos for crisis-relevant stakeholders and organizations, thereby supporting their decision-making (Bräker et al., 2022). Nevertheless, we would like to emphasize that this also requires effective and efficient integration of the mobile emergency app with the IT systems of the responsible actors. In addition, data must be filtered and evaluated as automatically as possible to cope with a potential flood of data in the event of a high level of distribution of mobile solutions for citizens, which is desirable (Rollason et al., 2018). **DP7** and **DP8** also address social and community aspects, with **DP7** refined to include privacy-preserving mechanisms. This, too, deviates from existing approaches and underscores the platform concept. However, greater emphasis is placed here on social structures and neighborhoods. Local assistance can thus alleviate the burden on emergency-relevant actors (Krüger & Albris, 2021) by promoting citizens to active risk managers of their own environment (Kerstholt et al., 2017; Schumann et al., 2018), and the evaluation suggests that this aspect should be further considered, aligning with the socio-psychological literature on collective efficacy (Gammoh et al., 2023) and addressing all three phases of the emergency management framework (cf. Section 2.1). With the derived design principles and their assignment in the context of the emergency management phases, we extend the existing design knowledge for crisis mobile applications (Rodrigues et al., 2002). Specifically, we advance the situational awareness framework by detailing actionable interaction patterns, such as distance-filtered hazard cards. Moreover, the study demonstrates how socio-demographic challenges can be addressed through in-app community scaffolding mechanisms. For practitioners, our findings provide design principles for designing intuitive emergency applications with a comprehensive feature set that encompasses the entire emergency management cycle. However, limitations include the small sample size and the non-stressful evaluation with a demonstrator rather than a fully executable solution, which restricts generalizability. Future work should test an executable prototype with larger, more diverse groups, including experienced citizens, and address accessibility. In addition, further extensions such as gamification and community features warrant examination. (Haunschild et al., 2023). In doing so, technical possibilities and restrictions are also of high value, especially in connection with emergency-relevant actors and their IT systems, to which connections are necessary to enhance a platform-oriented approach with bidirectional communication channels (Bräker et al., 2022).

8. Conclusion

This study examined how mobile emergency apps can be designed to promote self-help, shifting citizens from passive recipients of flood alerts to active protectors of their own safety. From a literature-derived problem analysis, we formulated twelve meta-requirements, translated them into eight design principles, and embodied them in an emergency phase-oriented prototype. Walk-through interviews confirmed the value of each principle: clear navigation, action-linked warnings, hazard visualization, step-by-step tasks, and neighborhood support all proved intuitive and useful. Thus, the work extends existing guidance with a coherent, credibility-centered, and community-aware blueprint for storm-flood crisis apps. The results outline a practical route toward citizen self-empowerment, directly supporting the resilience goals in SDGs 11 and 13.

9. Acknowledgment

We want to express our sincere gratitude to the Federal Ministry of Research, Technology and Space (Bundesministerium für Forschung, Technologie und Raumfahrt) for supporting the project RESCUE-MATE. The project examines innovative approaches to support civic engagement in urban crisis scenarios. The funding of RESCUE-MATE, with grant number 13N16836, enabled us to carry out this research.

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