Bridging from Crisis to Everyday Life – An Analysis of User Reviews of the Warning App NINA and the COVID-19 Regulation Apps CoroBuddy and DarfIchDas

Jasmin Haunschild
Christian Reuter
haunschild@peasec.tu-darmstadt.de
reuter@peasec.tu-darmstadt.de
Science and Technology for Peace and Security (PEASEC), Technical University of Darmstadt
Darmstadt, Germany

ABSTRACT

During a dynamic and protracted crisis such as the COVID-19 pandemic, citizens are continuously challenged with making decisions under uncertainty. In addition to evaluating the risk of their behaviors to themselves and others, citizens also have to consider the most current regulation, which often varies federally and locally and by incidence numbers. Few tools help to stay informed about the current rules. The state-run German multi-hazard warning app NINA incorporated a feature for COVID-19, while two apps, DarfIchDas and CoroBuddy, focus only on COVID-19 regulation and are privately run. To investigate users' expectations, perceived advantages, and gaps as well as the developers' challenges, we analyze recent app store reviews of the apps and developers' replies. We show that the warning app and the COVID-19 regulation apps are evaluated on different terms, that the correctness and portrayal of complex rules are the main challenges and that developers and editors are underusing users' potential for crowdsourcing.

CCS CONCEPTS

• **Human-centered computing → Empirical studies in ubiquitous and mobile computing**.

KEYWORDS

crisis informatics, warning apps, information accuracy, user reviews, COVID-19

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1 INTRODUCTION AND RELATED WORK

With its global reach, high embeddedness in daily life, and high conflict between physical safety and other values, the COVID-19 pandemic differs significantly from other crises that are typically studied in crisis informatics, such as natural disasters or more limited health dangers [18, 43, 44]. Interpretations of the virus as an overblown, inevitable, or acute risk have varied by country and over time [5]. Citizens' information needs increased and remained high, particularly as the first measures against COVID-19 were announced [39], but uncertain, contradictory, overly complex, changing, and inaccurate information posed challenges [43]. Information about restrictions was strongly sought out, surpassed only by inquiries about the spread of the virus [10], but Germans were particularly challenged by the differences in regulation across the country [22] since measures are mainly implemented federally in a decentralized manner leading to great local variation [23]. Germans perceived a responsibility to stay informed about current regulations, but held agencies as co-responsible and expected them to provide adequate information [22, 45]. Particularly when perceiving a need to stay informed and lacking an information strategy [47], information overload can occur. This can lead to withdrawal from information seeking [7] and a reduced intention to self-isolate in the pandemic [14].

Crisis informatics [44, 49] has shown the relevance of ICT for communication between agencies and citizens [44] and volunteerism [50]: However, reliability is often a challenge [31, 33]. Emergency apps are one solution that provides information about emergencies from trusted agents, such as research institutes or state agencies. Some mobile applications are specific to one type of emergency, some include warnings only as a supplement to daily information (e.g. extreme weather warnings in weather apps), other apps are built to warn about multiple hazards [54]. While such apps are widely regarded as important (as far as they centralize many relevant warning types in one authoritative app), they are rarely adopted [12, 28]. Usage intention is positively influenced by risk perception, trust, and perception of using warning apps as a subjective norm [15]. An analysis of warning apps revealed that malfunctions and the temporal and spatial relevance of warnings are main concerns [30]. Furthermore, dependability, avoidance of advertisement, resource efficiency, appropriate audio interface for alerting, and avoidance of in-app browsing are usability requirements that are particular to warning apps [52]. Research suggests that even during the COVID-19 crisis, pandemics were infrequently

mentioned as hazards that should be included in a multi-hazard warning app [12]. Such warning apps, like NINA, were largely not perceived as filling the information needs in a study in April 2020 [22]. Studies suggest that warning apps should on the one hand contain all relevant topics, while at the same time notifications that are perceived as irrelevant strongly reduce usability [51]. In light of this tight rope walk of too much and too little information, it is unclear how the inclusion of COVID-19 into a warning app and the specifically designed COVID-19 regulation apps are perceived.

App store reviews, which contain bug reports, feature strengths or shortcomings, user requests, praise, complaints, and/or usage scenarios [19] have been successfully used to gain insights into warning app usability issues [30, 52]. Written by users who are specifically motivated to share their experiences, as a crowdsourced task to identify the best app for a specific purpose [29] or to increase pressure on the developers [40], they are not necessarily representative of the average app's user. At the same time, because a large segment of reviews contains aspects of software requirements, feature requests, and use scenarios, they are used to inform future development of missing features, errors, etc. [16, 34, 41]. Research shows that amateur reviews can be as good as expert reviews for predicting long-term popularity [46].

Some reviews about COVID-19 technology exist but they either portray the very beginning of the pandemic [1, 13, 17, 36], digital technologies generally [27, 56], or health apps [6, 36]. Tools for the general public mainly concern data sharing and contact tracing [13, 56]. While news media and news apps become particularly popular in crises, including during COVID-19 [39], they include debate and discourse and may therefore contribute to information overload when searching for current rules. With this lack of studies on warning and information apps for the protracted COVID-19 crisis with its particular information challenges [43], it has remained unclear whether users' preferences are similar or different to those expressed for multi-hazard warning apps. We therefore ask: *RQ1) What are the similarities and differences between the reviews of COVID-19 regulation apps and the multi-hazard warning app* and *RQ2) what are citizens' perceived challenges, gaps, and advantages.* In addition to the formal state agencies' crisis response, convergent informal activities have been identified which include supporting others [24], sharing local information [18], "voluntweeting" on social media [50], crowdsourcing [37], and crowdmapping [48]. Through expert networks or software development communities [55], volunteers are also involved in creating new online applications, e.g. in the COVID-19 hackathon #WirVsVirus [20]. Challenges for volunteered and technical communities often include shortage of resources and volunteers, but also collaboration with formal organizations [55]. The data revealed that particularly the developers of the volunteered apps were active in responding to the reviews. We therefore ask: *RQ3) What challenges are expressed by the developers of the COVID-19 information apps.*

2 METHOD

To identify apps that show updates of local regulations in the dynamic crisis, we performed a market analysis. In app stores, we searched for the (German) keywords "COVID", "Corona", and "incidence", resulting in 249 apps. We excluded 154 apps not related to the topic (e.g., Snapchat), 11 dedicated only to tracking COVID-19 infection chains (e.g., Corona-Warn-App), 20 for educating and documenting symptoms (e.g. Corona Health), 7 apps only about the vaccine (e.g., STIKO-App), 18 general health apps (e.g., WHO Info), 12 city or agency apps (e.g., Darmstadt) and 13 news apps (e.g., Tagesschau). We then manually screened the description of the 14 remaining apps which all provide regional incidence numbers regarding COVID-19 infections. Only three apps provide the local rules in addition to statistical information. The three apps are the multi-hazard warning app "NINA" [3], which is the most widely used warning app in Germany [28] and run by the Federal Office of Civil Protection and Disaster Assistance, and the privately run COVID-19 regulation apps "DarfIchDas" [26] (which translates to "AmIAllowed"); and "CoroBuddy" [9]. While many of them report current statistical data, such as incidence number, vaccination rates and intensive care availability, we selected only those apps that, similar to warning notifications, map infection events to current local restrictions. NINA (10,000,000+ downloads) was launched in 2015 and introduced COVID-19-related aspects in April 2020 [2]. DarfIchDas (500,000+) was launched in September 2020 and CoroBuddy's (10,000+) first review appeared on March 15, 2021 (abbreviated N, C, and D in the source of quotes). The apps share the portrayal of local regulations aiming to inform about what is currently (not) allowed in different regions and regarding specific areas of life (see Figure 1). Whereas NINA and DarfIchDas list users' favorite regions, CoroBuddy only displays one selected region at once. DarfIchDas allows searching the list of measures with keywords and added an incidence history of the past 14 days during the course of the study. CoroBuddy and NINA represent the threat situation through a color scheme. The warning app NINA is the only one of the three apps to show a map of Germany, with the regions color-coded according to their incidence levels. NINA also sends push notifications about government announcements regarding the COVID-19 pandemic and provides general information about COVID-19 (e.g., basic knowledge, vaccinations, etc.).

To compare these apps, we analyze the praise, and complaints, while mentioned feature aspects, requests and usage scenarios are coded as users' perceived advantages, information challenges, and gaps. Two researchers iteratively discussed and generated a suitable coding scheme, which was built abductively with some categories deduced from previous usability assessments on crisis apps [12, 30, 52] and an analysis of review responses [57], while other codes emerged from the text. Due to the novelty and the speed of the development of updates, the analysis does not show the critiques of the most current versions, but rather users' needs and assessments regarding information in the protracted crisis. Since the three apps are non-commercial in nature, they are also instructive for volunteering and non-profit app development in crises. We coded all reviews from March 15 to May 31, 2021, a time when all three apps were published and which covers the full third wave from its uptake in March, its peak in April, and the decline and end in May, marked by the German Federal Institute of the Ministry of Health's (RKI) downgrading of Germany's risk status from "very high" to "high" on June 01, 2021 [25]. The observed time period includes a shift in German policy with the entering into force of a national law on the protection against Infection ("Bundesnotbremse") on April 24, 2021.

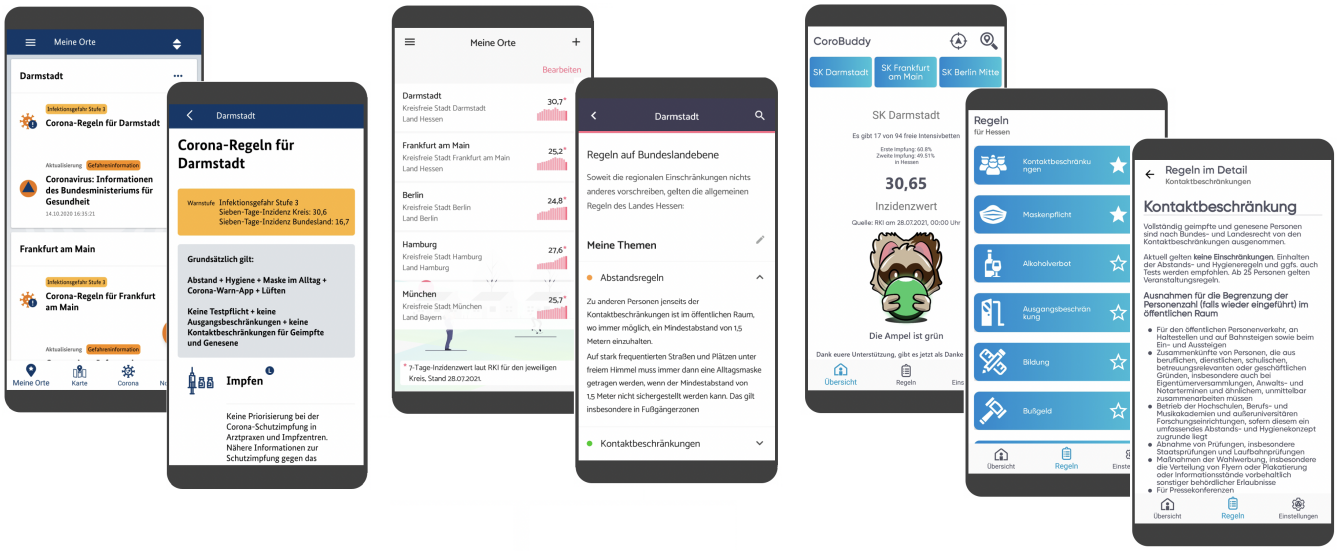

Figure 1: Screenshots of the Warning App NINA (left) and the COVID-19 Regulations Apps DarfIchDas (middle) and CoroBuddy (right), from July 28, 2021. See Online Appendix at https://github.com/HaunschildJ/CSCW2021_UserReviewsCOVID-19Apps for more details

The law for the first time set mandatory minimum measures for regions above an incidence rate of 100, requiring regulatory changes in most areas in Germany. We include reviews from the Google Play Store (N:75, D:402, C:235, total: 712), the Apple App Store (N:21, D:86, C:-; total 107) and the HUAWEI AppGallery (N:12, D:1, C:-; total: 13, the app store source is abbreviated as G, A and H in the given quotes). This results in 234 reviews and 319 coded segments from CoroBuddy (G:235, A:-, H:-), and 438 reviews with 704 coded segments from DarfIchDas (G:402, A:86, H:1). Since NINA warns about a wide range of emergencies and was analyzed previously [30], we filtered the 295 reviews to contain only those related to COVID-19 information with a wide set of keywords surrounding the pandemic, resulting in 106 reviews (G:70, A:21, H:12) and 166 coded segments. This results in a total of 832 reviews and 1164 coded segments.

3 ANALYSIS

In the following, we answer the research questions by analysing first the user reviews and then the developers' replies.

3.1 Analysis of User Reviews

Differences and Similarities (RQ1). **CoroBuddy's** reviews are marked by a great number of general praise and gratitude (94 reviews) for the initiative and the volunteers' efforts. Most praise refers to the clarity of the design which enables a quick overview: "*One look is enough and you are up to date*" [CGa8]. Other reviews reveal personal challenges that the app solves, speaking about the "*jungle of rules*", "*patchwork of rules*" or "*chaos*" (19), and about trouble in keeping an overview (8). Some express that they would have expected state agencies to provide such an overview (5). Complaints relate to the accuracy and lack of updates of rules (51 reviews). The granularity of the information is a challenge (6), with people wishing for municipality or city-level information (instead of county-level information) or not finding rules in the app (5). A traffic light color scale was used to visually express the local severity of the pandemic in the app. However, the state in the application of its federal COVID-19 law, as well as the federal health agency RKI used different traffic light color schemes to denote the severity of the spread of COVID-19. This caused confusion among the users who were often unaware of this duality and thus perceived the information be contradicting other official information (11).

DarfIchDas's evaluations are also marked by wide-spread praise and thanks (198), often mentioning the ease and speed of getting an overview, the good support, and the absence of advertisement. Similar to CoroBuddy, the accuracy and validity of the portrayed rules and data are often questioned (118). A dominant complaint concerned that the rules displayed were too general (22) and that local rules were only available through website links (16) or could not be found at all (14). At the same time, the many details listed required extensive reading: ("*Only the texts of the regulation are reproduced, but not what specifically applies at my location today*" DGb32). After the app was featured on TV, functionality failures were reported due to server overload. 24 comments across both apps address relief for commuters or travelers in general. While for DarfIchDas and CoroBuddy the topics were similar, the reviews for NINA revealed different aspects.

Among the reviews related to COVID-19, **NINA** received significantly less general praise and thanks (16). The appearance of pandemic-related information was sometimes generally contested because it was not seen as an emergency (12). When COVID-19 information was generally approved, it was often regarded as clustering the app with older general information at the top, making it difficult to identify new notifications (16). Some users had trouble

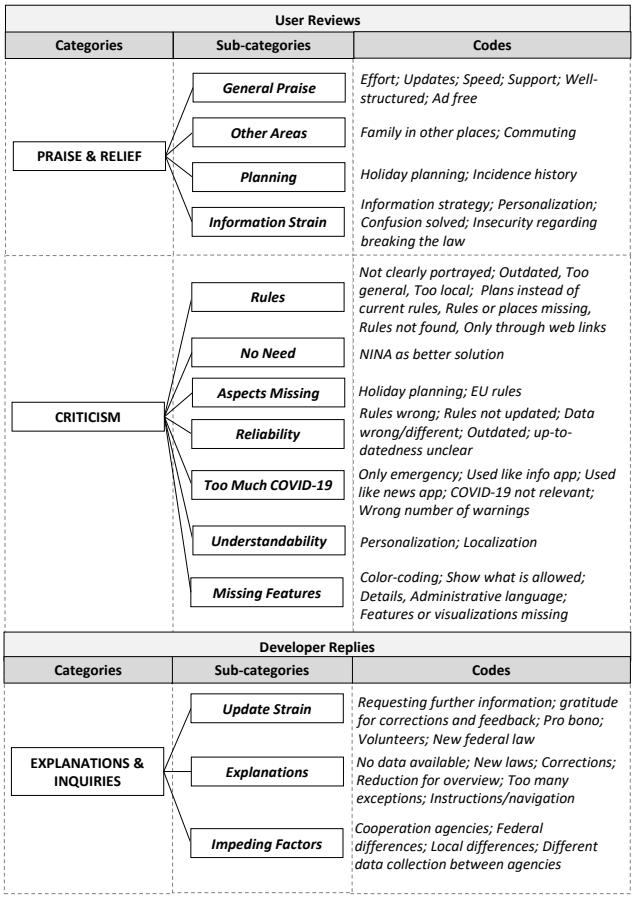

Figure 2: Coding Scheme

setting their often loud alarm sounds so that they would exclude COVID-19 notifications. Functionality issues seemed to be more prevalent for NINA than for the other apps. Across all apps, around 25% of the reviews mentioned problems with the reliability of the portrayed rules and data, showing that this is the most significant challenge. This is especially true for the COVID-19 regulation apps, for which the number increases to almost 50%. Only a few reviews indicated that the COVID-19 regulation apps were performing "*the state's job*" (DG258) while NINA reviews more commonly expressed disappointment or confirmation of low expectations towards state agencies: "*I can't understand how the state app can't manage to update the rules*" (NG44). Few reviews mention the lack of liability and fear of sanctions if the rules are incorrect (5). This suggests that the COVID-19 regulation apps are not regarded as unreliable per se.

Citizens' Perceived Advantages, Challenges, and Gaps (RQ2). The most commonly mentioned use case for the COVID-19 regulation apps was as part of an information strategy to get an overview. Some of the most positive features in this scenario were having "*everything at a glance, a good companion through the chaos of rules*" (CG186), "*without a thousand other unnecessary facts*" (CG88). Some reviews showed that the app helped with a perceived information strain: "*I'm tired of having to find information all the time and that often requires a long search*" (CG18). Specific scenarios that were mentioned included people who are mobile or commuters ("*I am in different regions of the republic several times a week*" (DG132)), have family or other interests in different places ("*I can directly have the districts displayed that are relevant to me*" (DG106)). Similarly, DarfIchDas' personalization feature for saving locations as favorites was often mentioned as helpful and dearly missed before it was included in CoroBuddy. Since the incidence number has come to determine mandatory national measures, incidence trends have become important to enable planning for the future. Some people missed an overview about places where certain activities or vacationing are allowed, possibly extended throughout the European Union or including neighboring countries. Sometimes a map, filter or search function was missed. Dissatisfaction and insecurity are often caused by a perception of wrong or outdated information when the incidence numbers of the apps are not in line with the ones that users find elsewhere. Indeed, primarily due to delays in the process of transferring data from local agencies to the federal one (RKI), these are often not identical, especially in regions with smaller populations [59]. But many are also dissatisfied with finding incorrect rules, stating that if the app is not fully reliable, it is not useful: "*Unfortunately, however, the information on the limitations lags far behind. And precisely this would be absolutely necessary for the now very confusing situation*" (DG220).

3.2 Analysis of Developers' Replies

Developers' and Maintainers' Challenges (RQ3). Supporting previous findings on app store review answers [57], the review responses of DarfIchDas and CoroBuddy often consist of appreciation for the feedback or supportive comments, revealing reviews as a source of motivation for volunteer activity. When users complain about errors or perceived inconsistencies, the COVID-19 regulation app providers often explain the updating strain, pointing particularly to a small team of editors or volunteers. DarfIchDas maintainers also mention the many changes required by the federal law, partly transferring blame to the regulatory freedom of federal states in implementing the law. According to the review answers, these differences impede the rule-based automation of incidence trends and resulting restrictions. DarfIchDas's replies mention a lack of interest in cooperation on the part of agencies. This supports past findings of the difficulties of cooperation between formal and informal agencies [55]. DarfIchDas's review answers often seek further information, especially about the locations that users report as outdated. When a location is named, the answers often contain gratitude and the promise of correction. CoroBuddy, being a very new app, often explained which features have been implemented or will be implemented in the near future to solve the issue mentioned by the users. Only NINA responses provide further contact information and solutions for how to change settings, especially with a view to (de-)activation of GPS or sounds for COVID-19 warnings. While NINA responses focus on mobile phone specifications to understand the reported bugs and direct reviewers to customer support (e.g. "*If this tip does not help, I would be very grateful for a short info. If you have any questions, please do not hesitate to contact me at [e-mail].*", the other two apps often seek to identify places

that are reported to contain wrong information ("*Unfortunately, you did not tell us which place your case refers to, [otherwise] we could have taken a look at it*" (DA14)).

4 DISCUSSION AND CONCLUSION

The analysis of user reviews allows insights into new apps that portray current COVID-19 related regulation information and that have emerged during the protracted COVID-19 crisis, as well as into the integration of such information into an established warning app. In addition, the analysis of developers' responses to the reviews reveals the challenges they are facing. We can derive the following key findings:

- Overviews about the regulations put in place to limit the spread of the COVID-19 pandemic, provided both by private actors and state agencies, have been gratefully received by many users.
- Warnings and prioritized COVID-19 information in warning apps, however, are often regarded as obstructing information about other emergencies.
- Receiving a concise overview over legal requirements with accurate, timely and location-specific information remains a challenge.
- Uncertainty about the quality of the information provided negatively affects users' trust.
- Users' comments about missing or wrong information in the reviews are appropriated by the developers of the COVID-19 regulation apps to improve the accuracy of the apps' content.

From these findings we can derive implications for design that improve transparency, accuracy and reduce the strain on developers. Since the accuracy of the provided information is often contested, developers should include more features that can help users judge the information's reliability. Transparency and trust could be increased by showing the date and time of the latest update, while a feature could allow users to contest or support the correctness of the information and possibly provide reasons and references.

Looking at the requests for further information about reported errors, none of the apps direct users to a formal mode for reporting or correcting errors. Implementing a system for crowdsourcing gaps and updates may be feasible and can build on insights from digital crisis volunteering [8, 42]. For instance, inviting feedback instantly after the use of the tool can attract previously inactive users [35]. Contributions could range from simple tagging of potentially false segments, to correcting them with revisions. Replies to the reviews could include a link for structured input, which has been shown to improve non-expert feedback [58]. Other crises have shown that individuals and emergent online communities can be effective at collecting and analyzing complex information [11, 18].

Cooperation with agencies could to some degree relieve the update strain that results from the local implementations and regulatory differences. Local agencies could be in charge of updating their information, making sure that the information could be fully relied upon. DarfIchDas responses indicated a lack of interest in cooperation on the part of agencies. This should be further explored through interviews with developers, agencies, and also agencies cooperating with NINA, where local agencies are involved in providing information and releasing an alarm. The challenges described by the developers in the responses may indicate a lack of consideration of harmonization and digitalization on the part of German agencies, which are only slowly adapting to digitalization requirements in government [21].

The findings of this study also indicate avenues for future research: The study suggests that usability aspects identified for warning apps, such as dependability and resource efficiency [52] are less relevant for regulation apps. Instead, portraying complex information and reducing administrative text appears to be the bigger challenge. The many reviews that express relief at getting an overview through the apps appear to confirm previous findings, which showed that citizens were more prone to information overload when they felt they needed to keep up with politics for their daily life [47]. A further indicator may be a particularly popular user review which wished for a widget, which would allow to more easily and constantly survey the situation. This would allow staying informed even without opening any app – a feature quite different from the occasional sound and push notifications used in warning apps. Future research should thus explore which features contribute to a sense of being informed without increasing information overload, particularly in dynamic situations.

In light of the different expectations towards regulation apps and warning apps indicated by this study, future work should further explore where the design of tools that inform about regulation can follow guidelines for warning apps [53] and which aspects need to be different. In addition, messenger apps are increasingly used for communication in large anonymous groups and for news delivery [32, 38], including by the German ministry of health which provides WhatsApp and Telegram broadcasting channels on COVID-19 information [4]. Due to their widespread use compared with warning apps, research in human-computer interactions could explore messenger apps as multi-purpose tools for communication in dynamic times.

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