CrowdRisk: Exploring Crowdsourcing of Risk Information

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ABSTRACT
This paper describes the outcomes of a preliminary study into the design of a mobile app to crowdsource information related to "risk". For the purpose of this study the notion of risk is defined broadly; however, we predominantly focus on the personal, subjective perception of risk. The study involved building a prototypical mobile app to crowdsource risk and exploring the use of the app as part of an expert workshop. Outcomes show challenges and opportunities with regards to the categorisation of results, the motivation of users, and interaction design of the prototype. The study provides value by giving an initial insight into this design space.

Author Keywords
Risk; crowdsourcing; mobile apps

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION AND RELATED WORK

Crowdsourcing and Risk
Various industries rely on collecting information about risk and conducting risk assessments to make informed decisions about their products and policies. The accuracy of these assessments increases in correlation with the availability, quantity and quality of information. Increased take-up of digital technology, ubiquitous computing, mobile applications, location-based services, social media, open data repositories, and sensor networks have opened up a wide range of new opportunities that allow access to previously unavailable or untapped real-time data sources (Rittenbruch, Foth, Robinson, & Filonik, 2012; Robinson, Rittenbruch, Foth, Filonik, & Viller, 2012). Crowdsourcing approaches that support the collection of risk-related information have the potential to generate time-critical insights into emerging hazards and threats and supports the next generation of consumer-generated data.

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The term "crowdsourcing" was coined to describe the concept of outsourcing and distributing labour to a group of individuals (the 'crowd') as a tool for organisations (Howe, 2006). It quickly evolved into a key business model (Corney et al. 2009) that is still widely utilised today, often in the form of online micro-tasking platforms such as Amazon's Mechanical Turk. More recently proposed definitions of crowdsourcing reflect a shift away from the traditional task-focused and commercially motivated model to one that is more generic with far wider applications. Crowdsourcing can be understood as a participatory activity in which the crowd is asked to voluntarily undertake a task via a flexible open call (Estellés and González, 2012). Emerging conceptualisations of crowdsourcing emphasise a more informal and open approach to collecting citizen-generated data whereby social behaviour and culture can be better observed and understood (Whitaker et al., 2015). The concept continues to evolve, with various sub-types emerging alongside technological and societal developments. A recent proliferation in mobile technology has supported the emergence of participatory sensing, which appropriates data collected by the integrated sensor capabilities of such devices (Ludwig, Reuter, & Pipek, 2016). This has radically transformed crowdsourcing in terms of the quality and scope of the insights it is capable of producing, though the potential to collect ambient data has raised a number of privacy concerns (Egelman, Serge, Raghudeep, & Richard, 2015).

Some of the most successful applications of crowdsourcing have occurred within the field of crisis management, whereby volunteered geographic information (VGI) is visualised in real time on a map and used to inform situation assessment and response (Bailard, Baker, Hindman, Livingston, & Meier, 2012). A similar crowdsourcing approach exists for the reporting and tracking of public issues, whereby citizens submit details of street faults to a central repository for delegation to the responsible authority (e.g. FixMyStreet, FixVegas). Although crowdsourcing apps such as these address specific risks in the physical environment, no single application has been designed to engage the public in exploring and mapping the question of risk more broadly. This study outlined here takes preliminary steps to address this gap in the field through its development of a prototypical app (CrowdRisk) for crowdsourcing risk-related information and perceptions of risk.

RESEARCH DESIGN
Our study is framed around two activities: the development of the CrowdRisk mobile app prototype and an expert workshop that was conducted to evaluate the

app and further explore issues around crowdsourcing risk-related information.

For the app we developed a cross-platform web-technology based crowdsourcing prototype for mobile devices. We kept the prototype purposefully simple to stimulate the creativity of our participants, providing them with a basic idea about the notion of crowdsourcing risk information, but otherwise not trying to limit their thoughts by providing a too specialized interface.

Our approach for designing the prototype app was guided by what we had identified as being two major functions that a crowdsourcing application for risk must perform, namely: 1) providing functionality for users to gather and submit data and 2) motivating and engaging users to participate in the collection. We then conducted an expert workshop with members of the Urban Informatics Research Lab at QUT not only to test how well the prototype incorporated these functions, but also to further explore subjective notions of risk and to what extent information about risk could be crowdsourced. All members of the lab are experienced Interaction Design researchers. We chose the format of an expert workshop to quickly explore underlying challenges to the design of a crowdsourcing app in the context of risk information. This study does not aim to replace a user-centred design process, but instead represents an initial step in our overall research approach.

Prototype

To address the data collection and user motivation features we implemented three basic features:

1. Creation of risk reports and commenting on other reports.
2. Exploration of reports on a mapping interface.
3. Statistics about the contribution made by a user.

Feature 1 addresses the data gathering part whereas features 2 and 3 provide basic instances of a motivation interface. Providing a way to explore reported risks gives incentive to users to participate in the crowdsourcing, as it provides them with value in the gathered data and may lead to an improved understanding of risk in their neighbourhood or local context. The app implements a simple status system showing statistics about the contribution per user to motivate higher levels of contribution which may in turn lead to higher status within the community.

User Interface

We split the user interface into three tabs according to the three basic features (see Figure 1). The Profile page contains statistics related to the use of the app. The Home (Reports) page provides users with a list of recently submitted reports, the content of which they can then evaluate and possibly extend. The Explore page displays a heat map of reports.

Data model

In our prototype each risk report is made up of a geolocation, an image of the associated risk, and a textual description of the risk. For this study, we chose to predetermine common risk categories, “Crime and Security”, “Property”, “Health and Safety”, but added an open category “Other”.[1] Users had to file each report under one of the categories. Each report could further contain any number of comments, which were used to collect open feedback. Reports and comments can only be created by authenticated users. An authenticated user can comment on all reports. The creator of a report can furthermore edit a report at any later stage.

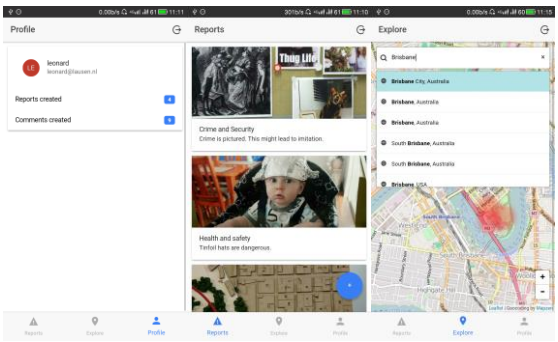

Figure 1. Profile, Home (Reports) and Explore page of the CrowdRisk application.

Technology

We used Ionic 2 based on Apache Cordova and Angular 2 to develop the prototype. The backend runs on NodeJS with ExpressJS and MongoDB as database. The source code is available on GitHub[2].

WORKSHOP

12 members of the Urban Informatics Research Lab participated in the expert workshop in August 2016. The workshop aimed to address the following questions:

- What constitutes risk for different people?
- How to design a risk crowdsourcing application? This includes how to motivate users to participate and which interface considerations have to be made for a crowdsourcing application related to risk.

We presented the CrowdRisk prototype and asked the participants of the expert workshop to peer review the application. The review was conducted in two stages, an initial test of the application, followed by a group discussion. ***App test:*** As part of the review experts were encouraged to explore potential risks in their nearby environment in order to see whether the application was fit for purpose. During a 15-30 minutes’ collection phase participants walked the Urban Informatics Research Lab’s building and the QUT Gardens Point Campus, creating geo-tagged and categorized risk reports consisting of a picture and description of the associated risk. ***Group discussion:*** The expert participants then came together in groups and discussed their experience, reflected on the design and applicability of the prototype and the feasibility of collecting crowdsourced risk information.

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[1] In the discussion section, we will outline how this choice is suboptimal and discuss a tagging system.

[2] https://github.com/leezu/crowd_risk

The peer review resulted in two types of material:

- 44 risk reports gathered within the crowdsourcing app consisting of categories, descriptions, pictures and locations of risk.
- Comments from the group-discussion phase as well as written comments on printouts of the user interface regarding usability, user motivation, report audience, risk definition and application usage patterns.

DISCUSSION OF RESULTS

In the following we analyse this material to answer the two questions raised in the previous section.

Constitution of risk and risk themes

Theme	Count
Property	25
Health	11
Safety	8
Incitement	8
Behaviour	6
Reputation	5

Table 1. 6 most common themes with counts.

Overall, our expert participants felt that the predefined categories were too limiting to capture risk information. Participants instead suggested that risk reports could be linked to one or several properties allowing for different perspectives on the same data. For instance, one example considered the different aspects of safety risk stemming from broken property versus the risk to the reputation of an organisation due to broken property.

We therefore analysed the reports created by the participants for common risk themes, which we list below. In Table 1 we present the counts of the respective themes.

- **Property**: A risk related to some physical object belonging to a certain party, e.g. hazardous items lying around or dangerous furniture.
- **Health**: A risk to the health of people, e.g. unhygienic devices or lack of ergonomic furniture.
- **Safety**: A risk to the safety of people, e.g. low hanging furniture with the risk of people bumping into it.
- **Incitement**: Inciting people to behaviour that will put others or themselves at risk, e.g. unsecured property, animating theft or vandalism.
- **Behaviour**: A risk related to the behaviour of people, e.g. people being focused on playing with their smartphone or people leaving personal valuables unattended.
- **Reputation**: A risk to the reputation of a person or organization, e.g. display of outdated research or information.

Addressee of risk

Reports differed with regards to who is affected by the risk reported. Collected reports included both, those that are only relevant to certain communities as well as those that affect everyone nearby.

An example for a community-related risk was a report of dangerous property design for skateboarders as shown in Figure 2. The image in Figure 2 was contributed by a participant concerned about stopper pins on a metal handrail as they pose a risk to skateboarders using the handrail as a ramp. While the pin might be placed there exactly to prevent the use for skateboarding it does constitute a health risk for the skateboarder.

Figure 2. A stopper pin on handrails constitutes a risk to the skateboarder community.

By comparison, Figure 3 shows a health and safety risk that potentially affects everybody at a particular place.

Figure 3. The drawing pins constitute a risk to everyone nearby the board.

The image in Figure 3 displays scattered drawing pins reported as risky by one participant. The reporter saw this as a risk to people that might hurt themselves.

Visualization of risk

One of our reviewers pointed out that our choice of a heat map for data visualization implies that risks are geographically located and that location is a useful way to identify them. We agree with this feedback and welcome future research on risk visualization or grouping of non-locatable risks.

Group discussion

The group discussion phase revealed aspects regarding *user motivation and usage patterns*, *report creation and organization*, *display of and interaction with reports*, *resolving of reported risks* and *audience of risk reports.*

User motivation and usage patterns

Participants reported two factors relevant to their motivation to use the app prototype and other crowdsourcing apps. First, some participants were motivated by application-internal factors such as gamification and a reputation system. Second, external factors influencing the usage pattern were seen to increase motivation. An external factor could be a risk gathering event organized by an enterprise or local authorities to gather a large amount of risks in a short time comparable to the workshop's collection phase.

It was proposed that a reputation system could be implemented by awarding users points for providing meaningful reports and helping with management tasks related to already existent risk reports. Gamification was suggested as an approach to reward the identification and suggestions for the resolution of risks, at both individual and team levels.

Participant P1 mentioned that two different usage patterns exist for a risk crowdsourcing application. One approach is that the application is used during the day-to-day activities of the user whenever he spots a risk. To enable this usage P1 found it necessary to incentivise the user to report risks e.g. by introducing a reputation and gamification system as discussed previously.

Another approach according to P1 is to organize risk reporting events or awareness days either on a city-wide or organization-wide scale. Then citizen or employees will be encouraged to look out for any risk related information during the event and will gather a large amount of useful data during a short time. Thereby an external incentive can be added through advertisement for the risk-reporting event to the reputation and gamification approaches previously described.

Report creation and organization

Participants suggested that reports should be tagged with appropriate themes instead of being assigned to one discrete category.

The prototype featured a free text description field ("Other" category). Participants suggested that while this was helpful in adding information to risks not featured in the predetermined categories it also required additional user effort. Participants therefore proposed an image annotation feature where risks could be highlighted graphically e.g. using a red arrow or circle on the image associated with the report.

The prototype identified the location of a report with GPS coordinates. Participants mentioned that this made it difficult to determine exact locations inside buildings or office environments. Participants therefore proposed to include further location information, either via textual annotations or by integrating an indoor positioning system.

Display of and interaction with reports

Our experts suggested that different users might be interested in following up on certain reports. It was proposed to give users the ability to follow reports and be notified if new content is added or if they are resolved. In addition, a list of resolved reports should be accessible.

Furthermore, users might wish to explore already existent reports and should therefore be given a way of filtering and ordering reports on the home page according to report themes, locations or date.

Our experts advised that, in addition to comments, users should be enabled to up- or down-vote reports, thereby collecting quantitative data on the report quality that does not have to be extracted from textual comments.

Resolving of reports

Participants suggested the app might include a feature so that users could nominate people or organizations as responsible for fixing reported risk and who might then be contacted automatically via the application or a third party service such as email. Furthermore, a report details page should provide a place to brainstorm about how to resolve the risk. While this could be addressed in the comments, providing dedicated fields to supply this information would will facilitate this process.

Users should also be able to provide a subjective ranking of the severity of a risk, determining the order, priority and time-frame within which issues should be addressed.

Report audience

Participants furthermore discussed the audience of the reports gathered, noting that a user who submits risk-related information will likely be interested to know who has access to their reported information.

In the prototype each user could see every created report. This global visibility can be undesirable if a report encourages exploiting the risk. In such cases it would be preferred to only share reports with a specific party or number of parties. Furthermore, users may, for various reasons, wish to make anonymous reports which are not associated with their user profile.

CONCLUSIONS

This study aimed to provide initial insight into the concepts of crowdsourcing risk-related information. To do so we built a prototypical crowdsourcing app and through an expert workshop explored different perceptions of what constitutes risk and how risk information could be crowdsourced. Our preliminary results show that the concept of risk is multifaceted and that any attempt to gather such information via crowdsourcing needs to take into account a wide range of contextual factors. Our study identified some of these factors and presented some initial design considerations, in particular around: *the annotation and tagging of information*; *support for fine-grained indoor location systems or textual location notes; notifications and follow-ups on reports created or subscribed to; quantitative ways to interact with reports; issues surrounding the resolution of risk reports; and, lastly, issues related to the privacy and visibility of report.*

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