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Toward Persuasive Design for Emergencies: Pointing Citizens in the Right Direction

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Abstract. Recent large-scale emergencies, such as the 2013 Central European flood or the 2015 wildfires in Australia have shown the importance of an appropriate warning as well as instruction of the affected people on-site. Nowadays modern mobile devices are widely spread throughout the population in many parts of the world and apps are available for warning as well as giving advice, which have the advantage to reach citizens individually, i.e. based on their current location. However, disaster communication is prone to many kinds of biases and strong emotions such as fears, making it difficult to point the crowd in the intended direction. It is therefore all the more important that the messages are well chosen and presented to the users. Within this paper, we will apply the persuasive system design model as a method to design persuasive technology to the domain of crisis management by analyzing two of the most important warning service apps in Germany. Based on our analysis we will outline design potentials to make those kinds of apps more persuasive to efficiently addressing the crowd to prevent them from harm and even distribute crowd tasks unidirectionally.

1 Introduction

When dealing with emergencies, a variety of official organizations, which consist of public authorities with security responsibilities, such as emergency services (e.g. police, firefighters) or public administration is usually involved. As another important actor, but with less engagement in prevention or response strategies, citizens are engaged in various ways during emergencies too, such as victims, indirect affected citizens or volunteers (Stallings & Quarantelli, 1985; Wachtendorf & Kendra, 2006).

One typical characteristic of (large-scale) emergencies, especially regarding mitigation, is that decisions have to be made for low-probability, high-consequence events (Meyer, 2006). This causes well-known biases in human decision making like "[…] the tendency to learn by excessively focusing on short-term feedback, […] poor insights into future consequences, […] and poor inter-temporal tradeoffs between short-term costs and long-term benefits" (Meyer, 2006). Emergency warnings, for example, often prove to be false alarms, as impact zones mostly are much smaller than warning zones, reducing beliefs in related warning messages. Misjudgments regarding future consequences, amongst others, are caused by the subjective assessment of the likelihood that i.e. a hazard will occur (Lerner et al., 2003) and the subjective consideration whether taking mitigation actions will probably prevent future losses (Meyer, 2006). Within these considerations, biases like the *availability bias* (mental availability of i.e. losses due to a flood or fire), *representativeness bias* (taking recent history as an implication for long-term likelihoods) (Kahneman & Tversky, 1973), *optimistic bias* (belief that dangerous events will more likely happen to other people than oneself) and *projection bias* (inability to imagine i.e. one's home to be destroyed, leading to refuse to evacuate) (Loewenstein et al., 2003) are well known cognitive dissonances in the application area of (large-scale) emergencies. Further, discrepancies regarding tradeoffs (short-term costs and long-term benefits) underlie biases as well, like the *status quo bias* (default or no action at all are preferred instead of actions with uncertain outcomes) (Samuelson & Zeckhauser, 1988) or the tendency to *procrastinate* mitigation investments against low-probability events. This is also caused by *hyperbolic discounting*, the consideration of current relative benefits versus future events (Loewenstein & Prelec, D., 1992). Meyer (2006) presents even more biases and causes of misconduct in emergency situation which cannot entirely be discussed here. Due to these biases citizens are i.e. usually often not familiar with concepts of risk communication or warning (Helsloot & Beerens, 2009; Lorenz, 2010; Menski & Gardemann, 2008).

Recent emergencies, like the 2013 Central European flood or the 2015 wildfires in Australia have shown the importance of an appropriate warning as well as risk communication to the affected citizens on-site to overcome possible biased actions. As early forms of warning mechanisms, official organizations used sirens or loudspeakers announcements (Lindell & Perry, 1987) in combination with radio or television to reach as many citizens locally as possible. But nowadays modern mobile devices are widely spread throughout the population in many parts of the world. Thus, mobile apps are available for warning as well as giving advice, which have the advantage to reach citizens individually, i.e. based on their current location. As Ludwig et al. (Ludwig et al., 2015) have shown by using mobile apps, individual targeted warnings are possible that are more likely to be noticed. However, as Vihalemm et al. (Vihalemm et al., 2012) have shown, institutionally framed warnings are often perceived not well by the public and that citizens "either seek information from informal information networks or simply take their own response action". Those citizen-initiated actions are not always in line with those of the official organizations. Citizens sometimes enter danger areas or they interfere with the actions of relief forces (Ludwig et al., 2015). This area of tension leads to the discussion about citizen empowerment version activity control during emergencies: Should citizens be allowed to carry out their activities although these are not in line with the emergency services' ones? How to manage citizens' activities without patronizing them and without letting citizens put themselves in danger?

It seems there is a significant need to address civics in a way to overcome biased behavior. Mobile devices, however, could serve as persuasive technologies, who are "any interactive computing system designed to change people's attitudes or behaviors […] without using coercion or deception" (Fogg, 2003). Thus, technologies of this kind could be suitable to address these deeply rooted problems. To build persuasive technologies, Oinas-Kukkonen & Harjumaa (2009) have created the Persuasive System Design Model (PSD model). This model allows analyzing and designing systems to be persuasive with the aim of closing the gap between the targeted and actual behavior or attitude. They first suggest to thoroughly understand the *persuasion context* by examining the intent, thus who the *persuader* is and what *type of change* is to be achieved (behavior or attitude). Further the event has to be examined, more precise in which environment and problem domain the technology will be situated (*use context*), the users' personality like interests, needs or goals (*user context*), what kind of technology is being used (*technology context*). Lastly the *strategy* has to be considered, meaning the content and timing of messages presented to the user, implying a *direct* or *indirect route* of persuasion. After these considerations Oinas-Kukkonen and Harjumaa Oinas-Kukkonen & Harjumaa (2009) propose a taxonomy of design specifications for persuasive system design that could be used to address the above mentioned problems and biases. The 28 different *design principals* are grouped into four categories, namely *primary task support*, *dialogue support*, *social support* and *system credibility support*.

Within this paper, we will contribute with design implications based on the PSD model to pave the way for overcoming biased actions in emergency situations through technology. To do so, we first analyze two mobile warning apps using the PSD model to understand the intentions towards the persuasion context. Secondly, determine currently used design principals as an anchor for our objective to suggest exemplary design implications to specifically expand the design of such apps based on specific biases. We then will outline design implications to make these apps more persuasive.

2 Related Work

Persuasive technology and persuasive system design currently mainly focus application area like health, environmental sustainability or education. Reducing obesity by promoting individual health behaviors (Purpura et al., 2011), addressing smoking or alcohol abuse (Lehto & Oinas-Kukkonen, 2011) or improving responsible gaming (Wohl et al., 2014) aim at closing the gap between actual and targeted behavior or attitude due to the possible gap between short-term satisfaction and long-term consequences regarding diseases like diabetes. Motivating for saving energy (Midden et al., 2008) or fuel efficient driving behavior (Ecker et al., 2010) are approaches to do this in the area of environmental sustainability mainly by giving users feedback about their current behavior and the resulting consequences towards the targeted behavior. In education, related work was conducted regarding i.e. study habits amongst students. This was targeted leveraging personal resource management, personal values towards learning and expectations of learning (Filippou et al., 2015). Little work has been done in the wider context of emergency or hazardous situations regarding persuasive technology so far. Chittaro and Zangrando (Chittaro & Zangrando, 2010) used persuasive virtual experiences to improve awareness for personal fire safety by simulating dangerous situations to trigger attitude change. Further, technology to persuade visitors during major events to avoid overcrowded places (Vries et al., 2014) was conducted but without systematically analyzing these using the persuasive system design model. However, a very similar approach was conducted using the PSD model to analyse mobile warning apps from user comments in popular app stores (Kotthaus et al., 2016).

3 Analysis of KATWARN and NINA using the PSD model

Taking a look at German crisis management, public authorities currently use two mobile apps to warn citizens, namely KATWARN (FOKOS, 2016) and NINA (BBK, 2016). Both apps provide functionality to receive warnings, such as weather, flooding, fires or bomb disposals, partly based on the users' current location. These apps, however, focus on information distribution and general behavioral instructions without deliberately addressing the above mentioned problems. We therefore apply the persuasive system design model (Oinas-Kukkonen & Harjumaa, 2009) to both apps.

Figure 2: Screenshot of NINA showing weather warnings at that time in southern Germany as well as the device's location message on a map.

3.1 Persuasion context

Intent: The persuader of both apps is the user himself, so the intent can be considered as autogenous, because the app is being installed by the user voluntarily. It can be assumed, that the user wants to be aware about warnings in his local area. However, it is the (local) authorities who may want to persuade the users to mind their behavior in certain threatening situations. Thus, also an endogenous intent can be seen. This also implies that the change type of KATWARN can be considered towards behavior change directly by the authorities or indirectly by reliable weather warnings, letting the user consider their behavior. There is no direct or indirect evidence the app aims at changing user's attitude.

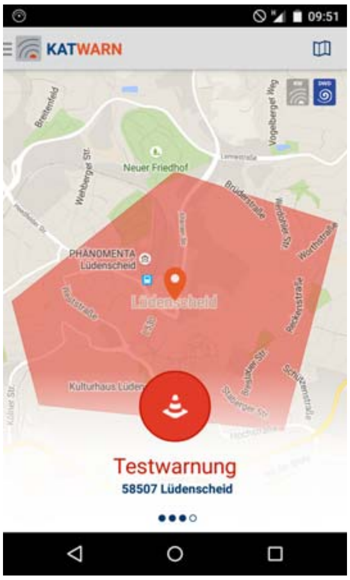

Figure 1: Screenshot of KATWARN showing a test warning message, the location and the affected area on a map.

Event: The use context of both apps will also not be distinguished as the problem domain is identical. All German citizens constitute the target group and the persuasive system in both cases is a mobile smartphone app. Characteristics of the problem domain were mentioned in the instruction and therefore not be repeated. As the app is usually not being distributed, but has to be installed voluntarily, users with an interest of mitigation and preparation towards emergencies might be the majority of the active users. This could enrich information regarding the user context. However, as both apps treat all users as a single audience, no more implications in this matter will be considered. Finally, the technology context of both mobile apps is also obviously the same. Due to their pervasive use, mobile devices have the potential to persuade users in-situ but on the other hand bare the risks of doing this ineffectively by annoying them or technical constraints, like battery life or network coverage.

Strategy: As mentioned before, both apps focus on the direct route, as both send messages with clear suggestions of how to behave in the specific emergencies. NINA additionally provides general behavioral information regarding different kinds of emergencies like storm, fire or flood independently of the warning messages. The timing of the messages is solely depending on the official's source system.

3.2 Design Principals

The system functionality of both apps was analyzed and classified by the PSD taxonomy (Oinas-Kukkonen & Harjumaa, 2009).

Primary Task Support	**KATWARN**	**NINA**
Reduction	-	Instructions based on event
Tunneling	Guide to set up the application	-
Tailoring	-	-
Personalization	Weather warnings based on current / up to seven places	Location based warnings; Emergency con-tacts; alarm sound
Self-Monitoring	-	-
Simulation	-	-
Rehearsal	Test alert	-

Table 1: Primary task support features

Dialogue Support	**KATWARN**	**NINA**
Praise	-	-
Rewards	-	-
Reminders	-	-
Suggestions	Location based suggestions to warnings	Location based suggestions to warnings
Similarity	-	-
Liking	Appropriate design (subjective)	Appropriate design (subjective)
Social Role	-	-

Table 2: Dialogue support features

System Credibility Support	**KATWARN**	**NINA**
Trustworthiness	Blunt messages focusing on the issue	Blunt messages focusing on the issue
Expertise	No dangling info; source of info well known	No dangling info; BBK well known for its expertise
Surface credibility	Seems to merit	Seems to merit
Real-world feel	Organization behind app unclear; feed-back possible	BBK clearly recognizable; no feedback option
Authority	DWD well known in Germany	BBK as governmental representative
Third-party endorsements	-	-
Verifiability	-	-

Table 3: System credibility support features

Social support: Both apps do not provide any functionality regarding social learning, social comparison, normative influence, social facilitation, cooperation, competition or recognition.

4 Conclusion and Outlook

Public authorities are challenged with managing citizens' voluntary activities during emergencies without patronizing them. Current mobile apps lack appropriate options for guiding citizens. One way to address this issue could be the design of persuasive technologies. Considering the findings of our analysis, we conclude that officials' intention to influence civics behavior is relatively poor as the only way to narrow down messages to target groups is either to filter by location or type of event. Especially because there is no channel for the recipients to reply, the distributed messages have to be chosen carefully. Although it is well-known that not every single design principle needs to be addressed (Räisänen et al., 2010), some of the uncovered bare potential to be further exploited. As a next step, we want to implement a prototype to evaluate the effectiveness of the proposed implications within crisis management.

5 References

[1] BBK. (2016). Warn-App NINA. Retrieved January 21, 2016, from http://www.bbk.bund.de/EN/Home/home_node.html

[2] Chittaro, L., & Zangrando, N. (2010). The persuasive power of virtual reality: Effects of simulated human distress on attitudes towards fire safety. In *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)* (Vol. 6137 LNCS, pp. 58–69). doi:10.1007/978-3-642-13226-1_8

[3] Ecker, R., Slawik, B., & Broy, V. (2010). Location Based Challenges on Mobile Devices for a Fuel Efficient Driving Behavior. *… of fifth International Conference on Persuasive …*, 5–8. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.172.5602&rep=rep1&type=pdf

[4] Filippou, J., Cheong, C., & Cheong, F. (2015). Designing Persuasive Systems to Influence Learning: Modelling the Impact of Study Habits on Academic Performance. *PACIS 2015*. Retrieved from http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1100&context=pacis2015

[5] Fogg, B. J. (2003). *Persuasive Technology: Using Computers to Change what We Think and Do*. doi:10.1007/978-3-540-77006-0

[6] FOKOS. (2016). KATWARN - Warn- und Informationssystem für die Bevölkerung. Retrieved January 12, 2016, from http://www.katwarn.de/

[7] Helsloot, I., & Beerens, R. (2009). Citizens' response to a large electrical power out-age in the Netherlands in 2007. *Journal of Contingencies and Crisis Management*, *17*(1), 64–68.

[8] Kahneman, D., & Tversky, A. (1973). On the psychology of prediction. *Psychological Review*, *80*(4), 237–251. doi:10.1037/h0034747

[9] Kotthaus, C., Ludwig, T., & Pipek, V. (2016). Persuasive System Design Analysis of Mobile Warning Apps for Citizens. *Manuscript sumbitted for publication*.

[10] Lehto, T., & Oinas-Kukkonen, H. (2011). Persuasive features in web-based alcohol and smoking interventions: a systematic review of the literature. *Journal of medical Internet research*, *13*(3), e46. doi:10.2196/jmir.1559

[11] Lerner, J. S., Gonzalez, R. M., Small, D. a., & Fischhoff, B. (2003). Effects of fear and anger on perceived risks of terrorism: A national field experiment. *Psychological Science*, *14*(2), 144–150. doi:10.1111/1467-9280.01433

[12] Lindell, M., & Perry, R. (1987). Warning mechanisms in emergency response systems. *International Journal of Mass Emergencies and Disasters*, *5*(2), 137–153. Retrieved from http://www.safetylit.org/citations/index.php?fuseaction=citations.viewdetails{&}citationIds{%}5B{%}5D=citjournalarticle{_}55979{_}38

[13] Loewenstein & Prelec, D., G. (1992). Anomalies in intertemporal choice: Evidence and an interpretation. *The Quarterly Journal of Economics*, *107*(2), 573–597. doi:10.2307/2118482

[14] Loewenstein, G., O'Donoghue, T., & Rabin, M. (2003). Projection Bias in Predicting Future Utility. *The Quarterly Journal of Economics*, *118*(4), 1209–1248. doi:10.1162/003355303322552784

[15] Lorenz, D. F. (2010). Kritische Infrastrukturen aus Sicht der Bevölkerung. *Schriftenreihe Sicherheit Nr. 3*. Berlin: Forschungsforum Öffentliche Sicherheit.

[16] Ludwig, T., Reuter, C., Siebigteroth, T., & Pipek, V. (2015). CrowdMonitor : Mobile Crowd Sensing for Assessing Physical and Digital Activities of Citizens during Emergencies. In *In Proceedings of the Conference on Human Factors in Computing Systems (CHI)*. Seoul, Korea: ACM Press.

[17] Menski, U., & Gardemann, J. (2008). *Auswirkungen des Ausfalls Kritischer Infrastrukturen auf den Ernährungssektor am Beispiel des Stromausfalls im Münsterland im Herbst 2005*. Münster: Fachhochschule Münster.

[18] Meyer, R. J. (2006). *Why we Under Prepare for Hazards*. *On risk and disaster: Lessons from hurricane Katrina*.

[19] Midden, C., Mccalley, T., Ham, J., & Zaalberg, R. (2008). Using persuasive technology to encourage sustainable behavior. *Workshop paper at 6th International Conference on Pervasive Computing*, (1), 83–86. Retrieved from http://alexandria.tue.nl/campusonly/Metis220393.pdf

[20] Oinas-Kukkonen, H., & Harjumaa, M. (2009). Persuasive systems design: Key issues, process model, and system features. *Communications of the Association for Information Systems*, *24*(1), 485–500.

[21] Purpura, S., Schwanda, V., Williams, K., Stubler, W., & Sengers, P. (2011). Fit4life: The design of a persuasive technology promoting healthy behavior and ideal weight. In *Proceedings of the 2011 annual conference on Human factors in computing systems - CHI '11*. doi:10.1145/1978942.1979003

[22] Räisänen, T., Lehto, T., & Oinas-Kukkonen, H. (2010). Practical findings from applying the PSD model for evaluating software design specifications. *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *6137 LNCS*, 185–192. doi:10.1007/978-3-642-13226-1_19

[23] Samuelson, W., & Zeckhauser, R. (1988). Status quo bias in decision making. *Journal of Risk and Uncertainty*, *1*(1), 7–59. doi:10.1007/BF00055564

[24] Stallings, R. A., & Quarantelli, E. L. (1985). Emergent Citizen Groups and Emergency Management. *Public Administration Review*, *45*(Special Issue), 93–100.

[25] Vihalemm, T., Kiisel, M., & Harro-Loit, H. (2012). Citizens' Response Patterns to Warning Messages. *Journal of Contingencies and Crisis Management*, *20*(1), 13–25. doi:10.1111/j.1468-5973.2011.00655.x

[26] Vries, P. de, Galetzka, M., & Gutteling, J. (2014). Persuasion in the Wild: Communication, Technology, and Event Safety. *Persuasive Technology*. Retrieved from http://link.springer.com/chapter/10.1007/978-3-319-07127-5_8

[27] Wachtendorf, T., & Kendra, J. M. (2006). Improvising Disaster in the City of Jazz: Organizational Response to Hurricane Katrina.

[28] Wohl, M. J. A., Parush, A., Kim, H. (Andrew) S., & Warren, K. (2014). Building it better: Applying human–computer interaction and persuasive system design principles to a monetary limit tool improves responsible gambling. *Computers in Human Behavior*, *37*, 124–132. doi:10.1016/j.chb.2014.04.045