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Designing for networked community resilience

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Abstract

Communities have been described to be at the heart of the preparedness for and the response to disasters. The increasing connectedness has made communities more vulnerable for their dependence on a complex network of critical infrastructures. At the same time, this very connectedness has the potential to enable communities to self-organise, engage, and connect with other communities to improve their resilience. While the pathway to more resilience is promising and has many advocates, the response to crises and disasters, time and again reveals the challenges related to (i) ad-hoc switching from preparedness to response; (ii) ad-hoc connecting professional responders, communities, volunteers, and local authorities; and (iii) designing systems and tools that are tailored such that the feedback from local communities can be taken into account for coordination and planning. Therefore, a paradigm shift is needed in designing crisis and disaster management information systems linking ad-hoc response to longer-term planning, in which networks of communities are at the core of the process. This paper sets out to provide a critical review on community-resilience literature. From there, it develops a research design principles for information systems to improve community resilience.

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1. Introduction

Finding systematic ways to improve resilience has been a concern for governments around the world. Despite the increasing amount of resilience-related research, focus is mainly given to efforts of public authorities and professional responder organizations [1]. Ubiquitous computing, Internet of Things, and crowdsourcing, however, facilitate real-time access to granular information that enable citizens to interact with their environment in new ways. Expectations towards Big Data are high, particularly when it comes to new forms of community engagement for disaster response [2]. But only by turning this deluge of information into verified, processed, and actionable knowledge communities can be empowered to transform increasingly smart or interconnected communities into a resilient society.

From a technology perspective, there are good reasons for optimism: fueled by the increasing pace of technology development and innovation, there is a wide range of tools to support sensemaking, collaboration and coordination for different types of crises and disasters. Still, key challenges, particularly in the response to a disaster, remain collecting, analyzing and providing actionable information to the people who need it. Finding reliable and trusted data that is relevant to support efficient response and coordination in emerging networks remains a challenge, particularly in rapidly evolving situations [3]. Often, the filtering selection of informative content is done manually [4]. Sensemaking, negotiation and coordination hence rely on the intuition and expertise of individuals prone to cognitive and motivational biases [5], and there is a growing risk that citizens and experts remain in their pockets of information instead of collaborating [6].

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One common pitfall is rushing to action before a situation is understood and then failing to revise assumptions as new information is available [5]. As a result, important cues signaling emerging crises or systemic risks are discounted or ignored [7]. Minute planning instead of embracing emergence, further complicates matters. The theory of threat rigidity implies that mapping out a specific way to react to problems discourages organizations from understanding an event, and creating a tailored response [8]. The use of information technology and the social or organizational structures for sensemaking, coordination and planning are hence interdependent. Thus, it is imperative to design systems that take into account practices of local communities, professional responders and decision-makers in industry and public sector.

Information systems and communication technology have been described as instrumental to the process of improving resilience [9]. While there are many guidelines for communities, cities, or even countries to measure resilience [10–12], there are so far no specific requirements and design principles that guide the design and development of information systems to improve the resilience across specific user groups and geographical boundaries. Such systems will aim to harness the power of the knowledge society to support an integrated trans-disciplinary approach that engages and empowers communities within and across different communities to improve their resilience.

Today, there are three major gaps in the resilient information systems that will be outlined in this paper: (i) *temporality*: understanding requirements for resilience across the different phases of a disaster (preparedness, response, recovery); (ii) *plurality and polyvocality*: understanding communities not as isolated and “good-willed” entities, but as interacting and emerging social structures with specific interests and aims; and (iii) *engagement*: designing for governance and coordination structures that enable communities to participate and engage. This paper provides a critical review on the underlying concepts of each of these dimensions, and outlines a research agenda towards developing design principles for resilient information systems.

2. The Vision: Towards a Resilient Community Network

Resilience theories were established for individuals, families, cities, communities, industrial sectors and even for physics and ecological systems [13]. The concept of *community resilience* describes the sustained ability of a community to take collective actions, and to use available resources to self-organize, respond to, withstand, and recover from crises [14]. Norris and colleagues state that community resilience emerges from four main capabilities; Economic Development, Social Capital, Information and Communication, and Community Competence [15].

While most literature focuses on the ability of communities to use available resources to respond to shocks [16–19], resilience also entails that communities are able to adapt to trends as they emerge [20,21]. Both concepts, the ad-hoc agile response to shocks and the long term planning and adaptation thus need to be integrated in the resilience domain – and reflected in the resilience information systems.

Such systems also have the capacity to connect communities. Much work has been done on community and urban resilience [20,22–24], but most approaches consider communities as isolated entities that do not interact with each other. Experience, insights and practice of on-going developments on city resilience are thus not shared [18], and the much needed mutual learning is hampered.

In recent responses to humanitarian crises, information sharing and online support have shown strong potential as lifeline for local affected communities [25,26]. It is one of the main objectives of this research to investigate this potential to facilitate the creation of a remote support network among communities, where affected communities can connect to communities in other places with relevant technical competences and experiences. As such, the concept of community resilience will need to be expanded beyond “*the ability of community members to take meaningful, deliberate, collective action to remedy the impact of a problem*” [15] by establishing a network in which local and remote communities connect and collaborate in their response to sudden crises and in longer term risk management and planning.

One common resilience framework is focused on “4 Es”: Engagement, Education, Empowerment and Encouragement [11]. A community’s capacity to gain trusted information through networked connections (engagement), to process and critically reflect on that information (education and encouragement), and to rapidly respond to emerging problems (empowerment) is more important for resilience than setting up detailed plans, which rarely foresee all contingencies [3,27]. New techniques using crowdsourcing and citizen science have emerged that enable these processes among citizens. Indeed, concerned citizens have initiated grass roots initiatives to address issues of energy, pollution, transportation, water management, or health care [28,29]. The “digital humanitarians”, a global network of online volunteers, have changed the nature of humanitarian response since the 2010 Haiti Earthquake. Overall, the past decade has witnessed a sustained growth in scope and scale of participation of people from outside established organizations [30]. To bring this evolution to maturity, advances are needed in designing resilience in large scale distributed systems.

3. Temporality: the virtuous cycle of sensemaking, coordination and planning

To integrate short and long term considerations, a theoretical framework is proposed for designing resilience by bringing together agile coordination and adaptive scenario-based planning.

In the response to a crisis, citizens, professional responders and decision-makers are confronted with stress and pressure, distorted, lacking and uncertain information. Thus, they are working in conditions that are known to introduce or enforce biases

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