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Abstract. Situated in the diversity and adversity of real-life contexts facing crisis situations, this research aims at boosting the resilience process within communities supported by digital and social technology. In this paper, eight community leaders in different parts of the world are invited to express their issues and wishes regarding the support of technology to face social challenges. Methods and artefacts based on the Organisational Semiotics (OS) and the Socially-Aware computing have been applied to analyse and consolidate this data. By providing both a systemic view of the problem and also leading to the identification of requirements, the analysis evidences some benefits of the OS-based approach to consolidate perspectives from different real-life scenarios towards building a socio-technical solution.

Keywords: Community Resilience, Human-Computer Interaction, Crisis, Organisation Semiotics, Socially-aware Computing.

1 Introduction

Natural catastrophes, man-made emergencies, accidents, or social issues threatening human rights are constant challenges to humans' ability to live in peace and harmony, both individually and as a society.

Coping with crisis situations and recovering from them are complex processes that may involve resources, several stakeholders, logistics and, above all, collaboration. Thus, communication and information awareness are increasingly being required in disaster management or peace-building processes [7]. The availability of digital information has been fostered by the broad adoption of technology and the willingness to share information online. Though, to be effective in supporting individuals and stakeholders' actions, a digital platform for crisis needs to reflect real-world practices of affected populations and the responders both in social and technical terms [3].

Ushahidi *(www.ushahidi.com)* is a platform that provides situational awareness in crises by enabling anyone to share geo-located information in real time. Since the violent process of the Kenyan presidential election in 2007, scenario that originated Ushahidi, this platform has been deployed in more than 159 countries and translated into

more than 35 languages to support communities to recover from hurricanes, flooding, to fight against corruption, among other issues [7]. As an example, the earthquake that devastated Nepal in 2015 generated 2031 geo-located reports on the platform, 1289 of them demanding an action [16]. Fig. 1 (obtained at [16]) illustrates a) a report requesting help with water, food and shelter, and b) aggregated reports represented on the map.

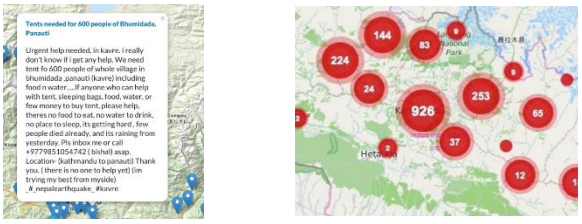

Fig. 1. - Screenshots of the Ushahidi platform
a) report requesting help b) aggregated reports plotted on a map [16]

This research aims at adding new features to Ushahidi for boosting the capacity of the platform to support community resilience. As a globally adopted tool, a socio-technical solution for Ushahidi should be capable of coping with the diversity of contexts without neglecting particularities of each scenario.

As acknowledged in the literature [13][3], involving communities in the platform design improves their purposefulness and usability, also increases the community's awareness and adoption of such tools in times of real crises. The design is then based on the participation of communities to discuss beyond technical features or current usability issues, but to reflect towards establishing a common meaning of community resilience supported by a digital and social tool.

In this paper, the initial steps of this research are reported. Eight community leaders in different contexts have been interviewed expressing their needs and wishes related to technology to support the resilience process. The analysis of this material has been supported by methods and artefacts of the Organisational Semiotics (OS) [11][9] revealing i) the complexity of stakeholders involved; ii) informational needs in technical and social aspects; iii) key elements in a shared understanding of community resilience supported by technology.

By providing both a systemic view of the problem and the stakeholders involved, as well as leading to eliciting socio-technical requirements, this analysis evidences the benefits gained through the application of methods and techniques based on OS approaches to consolidate the diversity of perspectives.

In the next section, works related to community resilience and social platform for crisis are introduced. Then, the research method is described. The OS-based analysis is split into two sections: understanding the problem and socio-technical requirements. In the sequence, the results are discussed by building a situated perspective of community resilience, followed by the conclusion.

2 Related Works

As stated by [20], *community resilience* is an amorphous concept. In the disaster-management literature it has been defined and applied in many different ways, but commonly referring to the ability of a community to cope with emergency situations [19]. Finding systematic ways to boost resilience within communities has been a concern for governments and policymakers worldwide. Situated frameworks maps stakeholders and their roles, stages in the resilience process, tools, and practices. Examples as the United States' one [5], and the United Kingdom's in [15], which centres resilience in planning, response and recovery.

Despite the growing number of crisis-related research, the focus is usually given to responses by authorities instead to empowering citizens [18]. Less attention has been given to bottom-up approaches, especially in the recovering phase [17], justifying the need of local communities not only as information providers but as actors therein [8]. Linnell [8] lists some conditions to promote citizen participation in community resilience, such as managing voluntarism and matching needs/skills/knowledge, reinforcing the culture of collaboration, etc. In line with that, the framework in [4] suggests an approach focused on Engagement, Education, Empowerment and Encouragement (the 4 "Es"). By informing (educating), enhancing social capital (empowerment and encouragement), and connections (engagement), the author recognises social media as a potential tool to boost community resilience collectively.

Such potential has been confirmed in recent crises, so that big players have launched specific services to cope with emergencies. *Twitter Alert* broadcasts and highlights critical information to public when authoritative accounts mark Tweets as alerts. Facebook provides the *Safety Check*, for people in a disaster area to check if they/their friends are safe. And Google, through the *Crisis Map* displays many types of geographic information, such as storm paths, shelters, and power outages from a variety of sources, including official and user-generated content. Beyond these services, Houston et al [6] analysed 15 applications for disaster situations and came up with a set of features for all the phases of an emergency, which includes mental-health support, detecting related events, discussing implications of and responsibilities for events, among others.

Initiatives like that boost resilience by offering psychosocial support, locating missing people, helping users to provide and share information, etc. However, they are not fully driven by community resilience frameworks and guidelines, which can direct the design of features to maximise support for resilience.

Towards this direction, Turoff et al [14] state that the design of resilience information systems must consider the processes that emerge in the field and are influenced by cultural traits. The authors suggest 9 design principles including treating exception as norms, sharing information at the community level, connecting people with authorities and resources, and adaptability in assigning users' roles and profiles.

3 Method

Building on the disaster-management literature, this research understands community

resilience driven by technology as ‘a process of continuously enabling a broad range of actors to acquire a relevant, consistent and coherent understanding of a stressing situation, empower decision makers and trigger community engagement on response and recovery efforts, including long-term mitigation and preparation.’[3].

This particular study aims at finding what sociotechnical requirements should be considered to design a social platform to boost communities’ resilience. The solution is built on real-life experiences in different scenarios. To this end, 8 community leaders were interviewed to understand: i) the meaning of community resilience in their own contexts; ii) how they operate in a disaster situation supported by technology; iii) how a new technology could improve it.

The interviewees were Ushahidi users, potentially collaborating with the co-design of innovative features as the research advances. They were in Nepal, 2 in Nigeria, 2 in Indonesia and 1 in India. For privacy reasons, the identity of the communities and the interviewees have been preserved in this paper.

The social issues they fight against include securing shelter and subsistence after an earthquake, elections monitoring against corruption and violence, sexual harassment and abuse, pursuing human rights, youth empowerment, and environmental issues in urban contexts. Such diversity of actions was pursued to build a comprehensive picture considering multiple possible roles of technology.

The interviews happened by phone lasting approximately 1 hour each. They were semi-structured and recorded for further analysis with the consent of the interviewee. The questions included:

- How is your organisation structured (formal/informal)?
- What is the organisation goal? Who are the users and the beneficiaries?
- Who are the main stakeholders involved to achieve this goal?
- How do you establish connections with key stakeholders?
- When would you consider the project a success?
- Can you exemplify an (big) achievement? Why was it successful?
- What are the major issues you encountered / shortcomings?
- What factors play a role in effective community engagement?
- How do you ensure that the community has adopted your project/tools?
- What is the relationship between information and a resilient community?

The analysis has been grounded on the concepts of the Socially-aware Computing [1] and the Organisational Semiotics [11][12][9]. The Socially-Aware Computing is an approach to design technology informed by sociocultural aspects. It relies on the involvement of stakeholders with a diversity of experiences for understanding the problem from different perspectives, also considering how the new technology is expected to impact the community [1]. The design is seen as a three-layer process considering first the informal aspects of a society (e.g. people’s values, beliefs), then the formal aspects (regulations, rules, procedures), towards the construction of a technical system. The technical layer, on the other hand, impacts back on the external layers towards influencing the society. This understanding suggests that innovation risks to fail if only the technical level is considered and is not compatible with people’s values, beliefs, or current regulations [1].

For translating social aspects into design elements and technical features, the Socially-aware computing is grounded on the Organisational Semiotics, an approach for understating information in a social context [11][12][9], based on semiotics principles by Peirce [10]. The OS artefacts applied in this analysis are part of a set called *Problem Articulation Methods* - PAM, usually helpful in the initial stage of projects when the problem definition is still vague and complex [2]. The artefacts are: i) Stakeholders Identification Diagram [9], which enables a systemic view of the stakeholders' according to their levels of involvement, interest and expectations. ii) Evaluation Frame [2] for revealing issues that worthy attention from the stakeholders' perspective. iii) Semiotic Framework [9] that helps to understand the problem as an information system.

This OS-based approach has been chosen due to its capacity to deal with a diversity of meanings and perspectives, and the adequate support to transform social issues into sociotechnical requirements. The artefacts and results are described in the next sections.

4 Semiotic-based Analysis

4.1 Stakeholders and Their Concerns

The stakeholder analysis evidences the complexity and diversity of actors involved with the socio-technical system, enabling a systemic view of the forces (expectations, concerns) from the interested parties [9]. All the interested parts mentioned by the community leaders during the interviews are represented in the layers of the Stakeholders Identification Diagram (SID) [9] (Figure 2).

Fig. 2. - Stakeholders Identification Diagram

Three main groups of stakeholders were identified: those related to the platform supply, local community members assuming distinct roles, and the responders, organisations that will act upon the information obtained through the platform. They are represented with different colours in the diagram: members of the local community are in orange, platform suppliers in purple, responders in green. Those in black are members of the society exercising different roles.

Some stakeholders are in more than one layer. The interested parts acting upon the society are in the Community layer, they are: volunteers, affected people and local people not directly affected by the crisis. Partners or competitors are placed in the Market one, such as the United Nations, other civil protection authorities, NGOs, international aid agents. Those providing any type of information, like technical support, platform instructor and reporters are in the Source, followed by those contributing more directly with the system in the Contribution layer, interface designer, community leader, analysts, and again the reporters. The stakeholders related to the technical and operational aspects are in the core, in the Operation layer. They are activists, deployers, and the technical leader, which is also in the contribution layer.

Derived from the SID, the Evaluation Frame [2] reveals stakeholders' main concerns towards the information systems, as described in Table 1 below.

Table 1. – Evaluation Frame

Stakeholders	Concerns
Operation level	
Activists or deployers	Create an instance of the platform efficiently
Technical leader	Provide conditions for the platform operation
Contribution level (actors, responsible)	
Technical leader	Provide platform training for the community staff
Community leaders	Engage volunteers and staff (meetings, adverts, etc.) Solve local conflicts to enable actions Assess current situation and vulnerabilities Coordinate actions connecting volunteers with locals
Analysts	Process the information provided by reporters Ensure the reliability of the information provided
Interface designer	Design an attractive and easy to use platform
Source level (customers, providers)	
Reporters	Provide impressions and reports from the field
Platform instructor	Training the technical leaders on the platform
Technical support	Ensure the platform availability
Market level (partners, competitors)	
Responders (UN, civil protection, NGOs)	Identify the most relevant issues Find the necessary information to act upon the issue
Local government	Identify the most relevant issues and find the necessary information to act upon them Establish guidelines on how to act on the emergency Get prepared for next disaster and reconstruction
Community level (viewer, lawmaker)	
Affected people	Get information on the current situation
Volunteers (i.e. donors)	Offer any sort of assistance
Not affected local people	Have the necessary conditions to act as reporters

In the next step of the analysis, the focus on the stakeholders is shifted to the information, as further described.

4.2 Towards socio-technical requirements

The Semiotic Framework [9] has been applied for understanding the way communities deal with information, and also to translate their current practices and wishes into socio-technical requirements. The framework considers how information operates in the six levels of a "semiotic ladder" representing the perspective of the Physical, Empirics, Syntactics, Semantics, Pragmatics, and the Social world. Issues at the three lower layers will answer questions as to how information is structured, used, transmitted, what its properties are, etc. The upper layers are concerned with the use of signs, meaning in the communication, intentions, etc. [9], evidencing the information that is related to the social environment from those that are part of the digital system.

At this stage of the analysis, all the issues pointed out in the interviews were captured, with no filtering; therefore, controversial issues pointed out by different communities are possible. In the same way, some issues may refer to Ushahidi's existing features, beyond needs and wishes.

For being in line with this research aims, Turoff's design principles [14] for a community resilience platform have also been considered in the framework. Issues that were similarly mentioned by different interviewees were grouped and prioritised for further consideration. In total, this analysis revealed 43 issues related to the social environment and 40 to the technical system. In Table 2, the most popular issues are presented as an example of the results.

Table 2. Issues mapped according to the semiotic ladder

Step / Main topics	Examples of issues
Social (12 issues in total) Engagement Trust Social Impact Familiarity with technology	Engaging local government and policymakers with the platform is difficult People should not be afraid of making a report due to conflicts with other stakeholders People are familiar with SMS, social media, WhatsApp, but not necessarily with Ushahidi
Pragmatics (15 issues) Community impact General communication Policymakers and government involvement	Approaching the local government is more effective with organised tasks and groups Complement the platform with physical communication (printed maps, posters, leaflets) Connect producers/consumers, donors/receivers
Semantics (16 issues) Community perception Reliability of information Policymakers perception	Complement the platform with physical meetings within the community on how to solve issues Convincing the community that the platform is meant to help, not to manipulate Check status reports with the community

Understanding the platform Monitoring the crisis	Ensure that every report has a response. Feedback to reporters
Syntactics (18 issues)	Information should be understandable by the community, not only by humanitarian actors Bilingual system to receive reports Representing the reports in a map
Language Information visualisation Users' profiles, Standards Layers of information	
Empirics (10 issues)	For every reported issue collect geographic coordinates, date, anonymity of the reporter, pictures, source, issue
Interoperability Reports fields	
Physical (12 issues)	Building dedicated lines with key stakeholders such as police to respond to reports quickly Allowing information to be accessible offline Voice channel for people unfamiliar with technology to create reports by phone
Offline / mobile access Audio platform Internet access issues Social media channels	

The more than 80 issues collected have been analysed, generating then the socio-technical requirements. In Table 3, some examples of socio-technical requirements are described, followed by the list of stakeholders most benefitted by the features. Possible solutions to the identified concerns in Table 1 also evolved to requirements.

Table 3. Examples of derived socio-technical requirements

Requirements	Most benefited stakeholders
Automatically estimate and inform the degree of reliability of the reports	Analysts and responders
Graphical evidence of the most reported issues	Responders
Offline access to reports	Community members, affected people, responders
Integration with social media (i.e. Facebook)	Reporters
Self-explanatory user interface (no training)	Reporters, community leader
Print maps	Community leader, responders

5 Situating community resilience

Building a situated notion of community resilience supported by technology, key elements that emerged in the analysis were mapped in the three layers informal, formal, and technical, following the metaphor of the 'Semiotic Onion' [11] (Fig. 3). People's beliefs, values and motivations are in the informal level, the elements that regulate the way people act are in the formal one, and the technical aspects are in the core. The three levels constantly influence each other from the moment the technology is conceived until its appropriation [1][11].

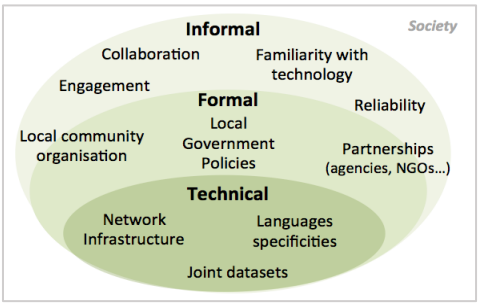

Fig. 3. Community resilience key elements

The main challenges revealed in the informal level are related to engaging local people and policymakers to adopt the technical platform. The lack of familiarity with technology or specifically with the platform were frequently cited as barriers for engagement. Still in the informal level, the platform should be perceived as trustworthy and reliable by all users and stakeholders.

The informal and formal aspects are related to the organisation of the communities, referring to the way they are structured and interact with others, and partnerships between communities, agencies, responders, NGOs, etc. These aspects differ from one scenario to another, and the platform may improve such connections and communication. Also, the platform has to be in line with local government policies, not only to be accepted by them, but also adopted for influencing decision-making.

Technically speaking, the most evidenced problems are network infrastructure, which may be precarious in some disaster situations, the desired integration with other media and communication platforms, such as WhatsApp, voice platforms and Facebook, and, finally, the challenge of dealing with different languages, which may even co-exist in the same scenario.

The analysis evidenced that engaging a community encompasses not only raising awareness of their problems and possible solutions, but also how to use the platform in technical terms.

6 Discussion and Conclusion

Translating real-life constraints of adverse environments into requirements is a crucial step of designing a platform for crisis situations. In the context of this research, is also imperative that any technical solution be adjustable to different realities in social, technical, economics, and cultural terms.

Traditional methods of software engineer may fail in supporting a system designer to build an understanding of the problem dealing with a variety of perspectives, and equality considering requirements from both social and technical angles.

The principles of meaning articulation, participation, and the reciprocal impact between society and the technical solution by the Socially-Aware approach supported building a systemic view of the problem, situating the notion of community resilience. Likewise, methods and artefacts of the Organisational Semiotics provided the necessary

resources for transforming constraints, wishes and needs into socio-technical requirements, evidencing the suitability of this approach to complex contexts as emergency-related platforms.

The analysis suggested that to achieve a real social impact, the introduction of a digital platform to promote community resilience should also consider placing engagement strategies like: i) developing digital literacy; ii) raising the community voice (including on social media) to influence local government decisions; and iii) involve policymakers and responders with the platform.

In terms of socio-technical features, results pointed out, for instance, ways of sharing and presenting information, integration of other communication channels and social media, and the evident need to check the validity of the information, building a trustworthy environment for affected people and responders.

This paper represents an ongoing research that aims at identifying, developing and evaluating new features for Ushahidi for boosting the potential of the platform to support a community resilience process. Next steps of this research include participatory design activities to start translating the requirements into design elements.

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