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New Media Technologies in Crisis and Disaster Management

Socio-technical Factors of Community Engagement in Response Efforts

DISSERTATION

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Kurzfassung

Die Beteiligung informeller Helfer, welche keinerlei Zugehörigkeit zu etablierten Organisationen aufweisen, ist ein wesentlicher Bestandteil des Krisen- und Katastrophenmanagements. Diese Wesentlichkeit ergibt sich aus der Unvermeidbarkeit der Emergenz informeller Hilfsbemühungen, sowie aus deren Wichtigkeit für effektive Hilfe. Emergente Hilfsbemühungen seitens der Zivilbevölkerung stehen den formalisierten Prozessen etablierter Organisationen gegenüber, welche eine vordefinierte Rolle im Katastropheneinsatz verfolgen. Während informelle Freiwillige durch die unmittelbare Wahrnehmung von Defiziten motiviert sind und folglich eine dynamische und adaptive Organisationsstruktur aufweisen, agieren etablierte Organisationen durch geübte, bewährte und starre Prozess- und Kommandostrukturen. Etablierte Organisationen sind teilweise bestrebt, spontane Hilfsbemühungen der Bevölkerung zu integrieren. Jedoch entspricht das Bild von Freiwilligkeit, welches diesem Integrationsversuch zugrunde liegt, nicht immer dem hochgradig emergenten Verhalten, welches der wissenschaftliche Literaturkorpus beschreibt. Zusätzlich fördert der Fortschritt von Informations- und Kommunikationstechnologie emergentes Verhalten, indem er Bürgerinnen und Bürgern weitreichende und weitgehend verzögerungsfreie Organisationsmittel zur Verfügung stellt. Aufgrund dieser technologischen Entwicklung, und grundlegender Unterschiede in der Organisationsform, erweist sich die Kooperation zwischen emergenten Hilfsbemühungen und etablierten Organisationen als komplexes sozio-technisches Problem. Die vorliegende Dissertation erörtert etwaige technologische Unterstützung, um dieses Problem zu mindern. Letztendlich postuliere ich mit dieser Dissertation ein theoretisches Bezugssystem für die Interaktion zwischen etablierten Organisationen und emergenten Hilfsbemühungen der Zivilgesellschaft. Aus den, in diesem Bezugssystem beschriebenen, sozio-technischen Faktoren werden Folgerungen für den Entwurf zukünftiger rechnergestützter Informationssysteme zur verbesserten Kooperation zwischen Bürgern und Bürgerinnen und etablierten Organisationen hergeleitet. Dadurch werden Lücken im bestehenden Literaturkorpus zu rechnergestützten kooperativen Informationssystemen gefüllt.

Abstract

The emergence of informal volunteers, helpers not affiliated with established emergency organisations, is integral to disaster response. It is integral both in the sense of being crucial for immediate help, and in the sense of being inevitable. The spontaneous and highly flexible nature of informal volunteers stands in stark contrast to the formalised, well-defined procedures of established emergency organisations. Where informal volunteers are motived by the perception of immediate needs for action, and employ fluent organisational structures that adapt quickly, established organisations operate through rigid procedures and command structures that have been trained, tried, and tested. Established organisations try to accommodate informal volunteers' readiness to help, by integrating them. However, they often operate on notions of volunteering that diverge from the highly emergent behaviour observed in recent events. The advance of contemporary information and communication technology supports highly emergent behaviour, in that it affords informal volunteers rapid and far-reaching means for self-organisation. Through a confluence of organisational differences and technological developments, the cooperation between emergency organisations and informal volunteers becomes a complex socio-technical problem. In the present thesis, I discuss computational support for overcoming this problem. My thesis builds an arc that spans multiple types of volunteering: from a formalised manner of participation that relies on the integration of citizens into established emergency organisations, to highly emergent, self-determined modes of engagement that lead to an independent response by informal volunteers.

At the beginning of my PhD research, I investigated the digitalisation of an existing volunteer platform, concluding with the empirical examination of a prototype in the field. By comparing the insights of this research with reports of emergence in 2015, I derived the need for new modes of computer-supported interaction between emergency organisations and informal volunteers. Ultimately, I provide a theoretical framing for the interaction between established organisations and highly emergent efforts of civil society. In the present work, this theoretical framing is presented in the form of socio-technical dynamics of interaction. I use this theoretical frame to derive implications for the design of computer-supported cooperative work between emergency organisations and informal volunteers. This contribution addresses a gap in existing crisis and disaster research, in respect of socio-technical factors that inhibit the cooperation between heterogeneous actors and the role that technology can play in overcoming them.

Contents

CHAPTER 1

Context & State of the Art: Crisis and Disaster Research

I understand my own work as contribution to the field of *Computer Supported Cooperative Work* (CSCW). I consider CSCW itself to be under no commission to define what constitutes a crisis or a disaster. CSCW aims to understand the nature of cooperative work and how to support it through the design of computational systems [SB92]. For a research field thus defined, a disaster, as well as the crises it brings, are constituted whenever potential users of the system perceive such events. I argue that, because crises and disasters are socially constructed (cf. [Tie07]), we should look at such events as being represented not by any physical phenomenon and its effects. Rather, CSCW should look at crises and disasters as being constituted by the articulation work that needs to happen, so that the actors of relief efforts can resolve the distributed nature of their work. By this postulation, it appears reasonable and natural that much of the theoretical foundation described in the following chapter is rooted in the social sciences, as well as the management and political sciences, to a lesser extent. Only the last section of this chapter will be dedicated primarily to the influence of information systems and communication technologies. If that appears out of place in a thesis indited in the context of informatics, then it is only because I have not yet made my case that many of the challenges to cooperation in this field are of socio-technical nature.

1.1 Introduction

Complex work in large-scale, heterogeneous environments offers some particular challenges for CSCW [FSKC06]. Hardly anywhere does a large-scale, heterogeneous environment manifest more plainly than in crises and disasters; between emergency organisations and informal helpers. In *Crisis and Disaster Management* (CDM), emergency organisations are deployed to conduct sustainable, large-scale relief efforts in affected areas; by means

of formalised procedures and strict hierarchical command structures, they marshal large amounts of goods and professional, trained personnel. Such *established emergency organisations* are contrasted by emergent, loosely structured efforts of civil society that occur in response to the same event, often from within the affected populace. Citizens come to help in any way they can, forming a heterogeneous group of *informal volunteers*, with the motivation to contribute their time and efforts, yet bringing little preconception about the nature of formalised disaster relief procedures. Their organisation is rapid, dynamic and flexible; it is characterised by emergent problem solving and usually exhibits high adaptability. The organisational cultures of established organisations and informal volunteers are inherently at odds [HR04, DM03, adH04, WMH15]. The crux lies in that both actors are necessary for effective relief efforts to take place [Dyn94b, Qua94, HR04]. Adding to a fundamental difference in organisational culture, the increasing pervasiveness of *Information and Communication Technology* (ICT) appears to have had an influence on the relation between emergency organisations and civil society. Informal volunteer efforts have attained increased visibility and outreach, whereby they are able to rapidly orchestrate efforts [PL07]. Citizens use online social media to organise as digital volunteers [SP11, SP13] or for intersubjective sense-making [VPL+08]. Formal relief organisations try to accommodate this use of new technology: at first employing it as a one-way channel for information distribution and then shifting towards interactive, two-way communication [PL07, HS16].
Recent publications remark on citizens using ICT to form *emergent groups* in the physical world that have not existed prior to a disaster event [KR16, LBY16, SWFB18, TM17]. The impact of the migration crisis in Europe has lead to the formation and sustained work of emergent groups [KLMH18, SRAT19, ZLKS17]. Some cases attained high visibility and seemingly worked independently of established emergency organisations.

Over the course of my work, I have realised the necessity to involve emergent groups and highly spontaneous volunteers in the overall relief efforts; and that such involvement is hard to achieve with traditional notions of volunteering in mind. This is not in itself a revelation and has been postulated by several other authors [DM03, WMH15, Qua94, TM17]; it appears that I have merely retraced some steps towards this conclusion through my own work. While there is an understanding that emergent phenomena should be included in crisis response, the corpus of CSCW literature omits explicit conceptualisation of the socio-technical factors at work in the interaction between established emergency organisations and informal volunteers, as well as emergent groups. Consequentially, there is a lack of design recommendations that are founded on a scientific[1] theoretical framework. In my work, I address this gap in literature: by contrasting diverse forms of interaction between emergency organisations and civil society, by presenting a theoretical framing for the socio-technical factors at work in these interactions, and by offering design implications that are derived directly from this theoretical framing.

[1] In the sense of allowing critical examination and falsification [Pop97].

1.2 Event Terminology and Historical Perspectives

The social sciences are considered to be the origin of disaster research [Kre84]. However, crisises and disasters now occupy researchers from a broad spectrum of fields: from the political sciences, from management and economics, from psychology, from sociology and from anthropology [CH16]; but also from engineering and informatics – the present work being among the latter. Being thus inherently multi-disciplinary in nature, it is hardly surprising that there is no universally accepted definition of crises or disasters [Qua87, SAM03, Per07]. Indeed, the search for a definition of crises and disasters as concepts has been ongoing for decades (cf. [Kre84, Qua87]) and 'may create considerable frustration' [Per07].

Disaster

The meaning of the term *disaster* has changed historically, in that the perceived source of disasters has shifted. Disasters where first seen as acts of the stars or God(s); this is given in the name itself, which derives from the Latin words 'dis' and 'astro', analogous to 'from the stars' [Qua87, Jac11]. Later, disasters came to be seen as the result of natural causes, i.e., as being caused by events in our natural environment [Per07, p. 4]. Carr, for example, distinguished disasters by 'the character of the precipitating event [...] and the scope of the resulting cultural collapse' [Car32, p. 209]. For Carr, a disaster was apparently caused by a singular event in the environment, but also inevitably linked to, if not defined by, the social change it entails. Three decades later, an often cited definition was given by Charles E. Fritz [Fri61], who states the following:

> [a disaster is] an event, concentrated in time and space, in which society, or a relatively self-sufficient sub-division of society, undergoes severe danger and incurs such losses to its members and physical appurtenances that the social structure is disrupted and the fulfilment of some of the essential functions of the society is prevented. (in [Tie14, p. 428])

Kreps, in a later work [Kre84], succinctly points out the four core properties of this definition: a disaster is (1) an event that can be distinguished in time and space, that has (2) an impact on (3) social units; these social units then (4) respond. However, he adds that social order and disasters exert mutual influence: the former may influence the effects of the latter by means of preparedness and mitigation, while vice versa we may observe disruption of the established order. Kreps amends the definition of Fritz such:

> Thus, disaster are: events, observable in time and space, in which societies or their larger subunits (e.g. communities, regions) incur physical damages and losses and/or disruption of their routine functioning. Both the causes and consequences of these events are related to the social structures and processes of societies or their subunits. [Kre84, p. 312]

A few years after Kreps, Quarantelli postulates that, from the perspective of social sciences, references to physical phenomena should not at all factor into the definition of a disaster; and that characteristics of a disaster should be conceptualised as part of social change [Qua87, p. 22f.]. His criticism of event-based perspectives has been reiterated or stated in similar manner by other authors (cf. [Per07, p. 10ff.]). Thus, disasters are more recently seen as stemming from vulnerabilities in society itself [Jac11]. Tierney notes that disaster research has become more open to social constructionist perspectives [Tie07, p. 506]. Challenges to the centrality of singular events in disaster research argue that the separation between social context and the events that occur therein ignore 'human ingredients of natural hazards' [Hew84, p. viii]. Hewitt writes of a 'disaster archipelago' that encloses natural hazards, cuts them off from anthropological relations [Hew84, p. 12] and, in doing so, fails to recognise how disasters are rooted in the cultural context that they occur in [Hew84, p. 29]; or are even characteristics thereof. Tierney notes that such perspectives could move disaster research towards recognising decisions of influential institutions as the factor that makes disasters inevitable, through lack of sustainable practices [Tie07, p. 510].

In summary, two fundamental ideas are reflected by the majority of disaster literature [Per07, p. 12]: (1) that disasters are inherently social phenomena, where the disaster is constituted by societal coping patterns and (2) that disasters are rooted in social structures by way of vulnerability to certain sources. Consequentially, it appears prudent to study the social change occurring in the context of disaster conditions [Per07, p. 7]. I will also follow this conception of disaster research. I will concern myself not with the precipitating events, if they are indeed identifiable, but instead concentrate on the social behaviour that they elicit.

Catastrophe

The term *catastrophe*, while present alongside 'disaster' in some early publications, such as that of Carr [Car32] or Fritz and Mathewson [FM57], is largely absent in more recent literature. It is sometimes used synonym with 'disaster' (see, e.g., [MJH07, VW10, Ale02, PL03b]). If at all, literature appears to distinguish between catastrophes and disasters by the magnitude of the precipitating event. Yet no quantitative indicators or thresholds have been defined to make this distinction [Ale02, p. 2]. Boin and McConnell see catastrophes 'at the furthest end of the scale in terms of language we use to describe threatening events and their (potential) consequences' [BM07, p. 52]. Voss and Wagner mention that 'aggregation of small-scale failures might lead to bigger-scale disasters or even to catastrophes' [VW10, p. 661][2]. Drabek and McEntire similarly speak of 'large catastrophes' as opposed to disasters [DM03, p. 107f.]. Quarantelli has argued that the line between a catastrophe and a disaster is drawn by the appearance of new organisations and their involvement in the response efforts: 'If new groups instead of old organizations became involved, there was a catastrophe' [Qua87, p. 25].

[2]Their discussion on the merits and criticisms of scaling systems for disasters and catastrophes [VW10, p. 658f.] may also be of interest to curious the reader.

Another popular application of 'catastrophe' is to use it as term for the precipitating events that lead to disasters (e.g., [Car32, RK97, HPS+08, BBKG10, CH16, HLA18]). Talking about catastrophes in this function as precipitating events, Coleman states that they need the confluence of three events: (1) a natural phenomenon with sufficient energy, (2) an environment that focuses the energy and (3) a concentration of people or assets in the vicinity of the occurrence [Col06, p. 4f.]. Inversely to its English pendant, *Katastrophe* is the more popular term in German language publications to describe adverse environmental phenomena. *Desaster* was only later adopted in the form of an anglicism [Jac11, p. 16]. The definition of *Katastrophe*, however, is equally as non-uniform as that of its English counterparts [Jac11, p. 73f.]. When using literature published in German language, I will take the liberty of simplifying, by equating 'Katastrophe' and 'disaster'. Consequentially, the following terms shall be used synonym for the remainder of this paper: disaster, catastrophe, *Katastrophe* and *Desaster*.

Crisis

A crisis can be defined as any situation that requires the making of appropriate choices of action to avoid negative repercussions [Wil57]. While 'crisis' and 'disaster' are often used interchangeably in the English language, they have been pointed out to be not the same: Shaluf *et al.*, from an economic, organisationally oriented perspective, surmise that a crisis is 'a situation in which important decisions have to be made in a short time', as opposed to a disaster, 'where management procedures must be maintained' [SAM03, p. 29]. That is to say, crises may result from a disaster; they require immediate, short term and critical decisions under time pressure [RK97, p. 280], while a disaster involves planning and management over an extended period of time. Characteristics of a crisis are threat, time pressure and unexpectedness [Her63, p. 64]. Crises cannot be dealt with in a routine manner [tRK93, RK97]. Pearson and Clair quote Turner [Tur76] in equating a crisis with the cultural collapse of socially constructed relationships [PC98, p. 63]. In their chapter on an integrative approach to communication research in crises, Auer, Schwarz and Seeger view a crisis as 'the ultimate moment of a continuous cumulative process of perceived organizational [...], individual [...], relational [...], or natural [...] failures or changes' [ASS16, p. 67]. Per their definition, a crisis is the culmination of failed precautions and safety measures, of conflicts and disregard for social values and of shifting environmental factors such as tectonic movement or climate change. The noteworthy aspect of this conceptualisation is that it is not limited to the occurrence of the causal event; but also the failure of any precautions and preparations taken against it. Taking this thought further, it appears that criticism levelled at the perception of disasters as events disassociated from their social context can also be extended to the crises that they incur.

The common theme among literature appears to be that a crisis – if authors treat it as a term distinct from disasters, catastrophes and emergencies – is a discrete occurrence within a larger disaster context that requires immediate decision. Such is the meaning that I will ascribe to 'crisis' for the remainder of this work.

Emergency

The distinction between *emergency*, crisis, and disaster appears hazy in most literature, if there is a differentiation at all. I have found two primary dimensions of distinction: (1) the applicability of routine procedures and organisational structures and (2) the magnitude of the precipitating event and its impact. Quarantelli [Qua87, p. 25] treats emergencies as distinct from disasters and catastrophes. He argues that, if existing emergency organisations can deal with an incident using their routine structures, then said incident was an emergency. Alexander [Ale02, p. 1], on the other hand, defines an emergency as follows:

> [A]n emergency is defined as an exceptional event that exceeds the capacity of normal resources and organization to cope with it. [Ale02, p. 1]

He outlines four levels of emergencies, distinguished by the resources they require and the severity of their impact; ranging from a car crash, to incidents that affect the whole municipality, to incidents that must be addressed by regional resources, to events of a national or international magnitude. As such, the term emergency appears to encompass, for him, disasters and catastrophes, depending on the level of the emergency. Tierny also appears to distinguish by magnitude of event impact, differentiating 'smaller emergencies and large catastrophes' [Tie07, p. 507], while providing no relation of these terms to disasters.

In the present work, I will use emergency to mean an incident as per the understanding of Quarantelli; that is, an occurrence that can be dealt with by means of routine procedures and which does not exceed the capabilities of the responsible emergency organisation.

1.3 Crisis and Disaster Management

Efforts to mitigate the effects of crises and disaster – by reducing risks and hazards, by increasing the resilience of society as well as infrastructure, and by coping with the effects of such events – are summarised in the concept of *Crisis and Disaster Management* (CDM). Lettieri, Masella and Radaelli define disaster management as 'the body of policy and administrative decisions, the operational activities, the actors and technologies that pertain to the various stages of a disaster at all levels' [LMR09, p. 117]. Jachs, referring to the Austrian standard ÖNORM S2304, defines the German equivalent *Katastrophenmanagement* as 'comprising the entirety of aligned measures for disaster mitigation, disaster preparedness, disaster response and disaster recovery' [Jac11, p. 75]. The later definition also implicitly defines the phases of CDM. The conception of phases (also 'stages') can be traced back to Carr [Jac11, p. 44], who formulated a sequence pattern of phases experienced by a community over the course of a disaster [Car32]. Carr distinguished between (1) a preliminary phase during which 'the forces which are to cause the ultimate collapse are getting under way', (2) a dislocation and disorganisation phase characterised by the 'collapse of cultural protections that constitutes the disaster

proper', and (3) a readjustment and reorganisation phase in which a part of the affected community 'remains on its feet, fighting back'. The conceptualisation of disasters as a cultural collapse is later taken up by Turner, who provides a model of organisational development in six stages [Tur76]. He starts out from a notionally normal point (Stage I) where 'matters can be assumed to be reasonably normal' [Tur76, p. 381]. In Stage II, there happens an accumulation of events that are at odds with the cultural assumptions and beliefs held in Stage I; however, these events are yet unnoticed. In Stage III, a precipitating event of immediate characteristics draws attention, making the incubating events noticeable. Stage IV is characterised by the consequences of a cultural collapse of the norms and beliefs held during Stage I. In Stage V, the post collapse situation leads to ad hoc adjustments for the sake of rescue operations. Lastly, Stage VI sees the adjustment of beliefs and norms that were held during Stage I; to incorporate experience gained during the disaster.

In more recent literature, CDM has been divided into four time-oriented phases: response, recovery, preparedness and mitigation (cf. [Jac11, DM03, FPF16, LMR09, Qua00]). Lettieri *et al.* call these the four 'canonical' phases of CDM [LMR09, p. 126f.]. *Mitigation* means efforts to reduce risk and vulnerability of social and environmental systems [FPF16, LMR09]. These efforts can be divided into structural measures, such as engineering for safety, and non-structural measures, such as land-use planning and legislation [Ale02, p. 5]. Mitigation includes the outlining of response procedures, planning a crisis response system, and the training of personnel expected to become responders [Jen11, p. xiv]. Perry and Lindell hold planning, training, and written plans as the critical components of mitigation [PL03a, p. 337]. *Preparation* is characterised by measures in expectation of a future disruption; with the aim to enable crisis managers to conduct effective response efforts to reduce the impact of an event once it is forecast or imminent [FPF16, LMR09, Ale02]. Measures taken during the preparation phase include evacuation or immediate structural measures like building flood barriers from sandbags [Ale02, p. 5]. The *response* phase starts immediately with the onset of the event and concerns actions taken during the impact and the immediate aftermath [Ale02, p. 5]. In the response phase, responders aim to manage and control the effects of the disaster or of the precipitating event; to prevent as much loss and damage as possible [FPF16, LMR09]. Lettieri *et al.* point out that the bulk of research regarding crises and disasters is concerned with the response phase [LMR09]. *Recovery*, lastly, aims to return the incident area to previous or improved conditions [LMR09] through restoration and rehabilitation [FPF16]. Immediate measures include restoring service and repairing infrastructure [Ale02, p. 5]. However, the purpose of CDM, when this cycle of disaster phases comes around, should be more than returning a system to its pre-incident *status quo*. Rather, it should be seen as the evolving process of a social system and its existing policies [CSJD01, p. 146f.]. To go into the operational intricacies of managing vulnerability and hazards, or dealing with the impact of crises and disasters, is far beyond the scope of the present work[3]. A succinct summary of issues in CDM is done by Quarantelli (in [Jac11, p. 59]), who states that organisations in CDM

[3]For a comprehensive primer on this topic, the reader may refer to, e.g., the work of Alexander [Ale02]. For disaster management in the Austrian context, Jachs has also provided an introduction [Jac11].

repeatedly have been facing three core problems: (1) shortcomings in the information flow between emergency organisations, as well as between those organisations and the public; (2) difficulties in decision making due to overload and overstressing of management and; (3) discord in coordination due to unclear scopes and responsibilities. It is these challenges of CDM that we will turn to in the coming sections.

1.4 Civil Society in Crises and Disasters

At the time that I write this work, the role of civil society in crises and disasters has been the subject of research for nigh on a century. The earliest known scientific publication that discusses the role of citizens in disaster response is the doctoral thesis of one Samuel H. Prince [Pri20]. Indeed, Prince's thesis is not only the first description of civil society response in a modern academic work; it is also considered to be the beginning of disaster sociology [Jac11] and the first systematic study of a disaster in general [Per07]. As such, it has had a large impact on the research field [DM03, p. 97]. The subject matter of Prince's work was the Halifax harbour explosion of 1917 – a maritime disaster that resulted from the collision of two ships. One of the two ships carried highly explosive cargo, intended for the European theatre of World War II. The ensuing explosion obliterated the northern end of the city, killing 2000 persons and injuring 9000 [Sca97]. Prince describes in his work the efforts to deal with the immediate aftermath of the incident and the efforts expedited to re-establish social order. He writes as follows about 'the first few hours which are of special interest to the sociologist':

> The soldiers were foremost in the work of rescue, of warning, of protection, of transportation and of food distribution. But the earliest leadership that could be called social, arising from the public itself, was that on the part of those who had no family ties, much of the earliest work being done by visitors in the city. [From those with families] in a short while however many came forward to join in the activities of relief. As already said those with no social, family or property ties were among the first to begin relief work. But many of these started early simply because they were present where need arose. Many indeed of the uninjured folk at a distance seemed unable to realize the terribleness of the immediate need in the stricken area. In fact, owing to the collapse of communication they did not for an appreciable time discover that there was an area more stricken than their own, and devoted themselves to cleaning up glass and the like. [Pri20, p. 61]

This rather large section of text is given here in its entirety and almost unabridged because it is an excellent showcase of important factors in civil society's response to crises and disasters. First of all, it shows that the afflicted populace itself will be at the forefront of relief efforts. While the highly structured, organised and trained army 'first recovers conciousness' [Pri20, p. 59], leadership and immediate response activities were carried out by citizens. Secondly, citizens were motivated by, and reacted to, individually perceived

needs. Thirdly, for a lack of information, the overall situational picture was unknown to many, leading to sub-optimal distribution of efforts. Thus, Prince already captures three critical aspects that affect the response of civil society to crises and disasters. I will clarify their meaning for CDM over the course of the following pages.

Another influental publication on the behaviour of citizens was written by Fritz and Williams [FW57], almost four decades after that of Prince. They describe how, contrary to prevalent perception, people will generally not panic or exhibit anti-social behaviour in the event of a crisis or disaster. Neither will they resort to looting or exploiting community conflict in the aftermath. The authors write off such allegations as 'a product of ignorance, inaccurate observation and fertile imagination' [FW57, p. 42]. Behaviour that is perceived as irrational or chaotic by the outside observer is not caused by panic; but rather by disorganisation and uncoordinated activity due to a lack of training and information [FW57, p. 45]. However, Fritz and Williams postulate that assumptions of wilfully disruptive behaviour or irrational panic do subtly influence the actions of those tasked with managing crises and disasters; they caution against overly focusing on such behaviour. To my knowledge, their publication is the first to address this.

Since these early works, the resourcefulness of civil society in times of disasters and the resulting crises has been pointed out repeatedly by a multitude of publications; as have been called out and refuted the claims that citizens behave irrational or malicious in the face of crises [Kre84, DM03, HR04, adH04]. Authors continue to agree that the general populace is rarely prone to panic and that there are no common occurrences of looting. Neither do citizens fall victim to 'disaster shock'; on the contrary, the affected people themselves often become the first responders [HR04, DM03, adH04, TM17]. Based on the given corpus of literature, it seems reasonable to assume that the participation of civil society is a certainty in crises and disasters and that it plays an important role in the overall effectiveness of response and relief efforts.

Volunteering and Emergence

To further discuss the involvement of civil society in CDM, it is necessary to introduce two concepts that are inextricably linked to it: 'volunteering' and 'emergence'. As with other terms that have been introduced thus far, *volunteering* suffers from a lack of theoretical consensus: what volunteering encompasses and how it should be conceptualised is unclear in the face of the wide variety of activities that are associated with the term, across multiple disciplines and cultures [HCH10]. Traditionally, a *volunteer* is considered to be someone who gives their time to an emergency or health organisation, to help others through this service, without being coerced to do so. This definition of volunteering is popular, e.g., in the public health sector, where the perception of volunteering often includes that they give their time 'to a formally structured organisation' [HDSC14, p. 1]. Whittaker, McLennan and Handmer [WMH15, p. 361] note that such formal, operational definitions of volunteering are also widely adopted in emergency organisations. Such perception places the volunteer firmly within the bounds of a formal emergency management system. In this traditional notion, a volunteer acts in accordance with the

procedures and norms of the organisation he is affiliated with. This form of volunteerism has historically played a large role in Central Europe and Scandinavia. In Switzerland and Austria, the level of participation in voluntary or charitable organisations exceeds 50% of the population and reaches as much as 67% in Norway [PH10]. Whittaker *et al.* find that most agencies retain these formal definitions of 'volunteer' [WMH15]. However, Hustinx and Lammertyn state the following: 'recently, there has been a growing conviction that the nature of [formal] volunteering is undergoing radical change' [HL03]. They conclude that there is a trend towards more transitory, detached, and self-centred involvement that contradicts intuitive understandings of who a volunteer is. For example, Hyde *et al.* [HDSC14] describe the phenomenon of episodic volunteering in the public health sector, where volunteers are increasingly preferring flexible, short-term and once-off opportunities. Similarly, a study on volunteering in the European Union concluded that there is not a decline in volunteers, but that the nature of voluntary engagement shifts, resulting in 'a mismatch between the needs of voluntary organisations and the aspirations of the new generations of volunteers' [Mat10, p. 12].

Consequential to these observations, there is an increasing awareness about non-traditional forms of volunteering: persons who are offering assistance to those in need, yet are unaffiliated with the established emergency management and response system. Volunteers who contribute outside the formalised response and relief procedures have been referred to as 'spontaneous' (e.g., [SCTK14, TM17, SRAT19]), 'unaffiliated' (e.g., [BTTA07]), 'emergent' (e.g., [WMH15]) or 'informal' (*ibidem*). In German language literature, the term 'Ungebundene Helfer*innen' was defined by the German Red Cross in a manner that roughly corresponds[4] to 'unaffiliated volunteer' [SBW+14, p. 17]. The above terms are often used to describe roughly the same demographic of volunteers, but are not congruent. Spontaneous volunteers, for example, are understood as contributing on impulse [WMH15] while unaffiliated volunteers are defined merely by the characteristic of contributing while not being associated with an emergency organisation [BTTA07, p. 2]. These two understandings have some overlap, but a volunteer can be spontaneous and affiliated at the same time if they are a trained, associated member of an emergency organisation that is at the incident site by chance; or unaffiliated and not spontaneous, by contributing after considerable planning (cf. 'emergent volunteer' below). To differentiate between volunteers with such a fine edge is not the purpose of this work. For the present thesis, it is sufficient to state that I will use the terms *informal volunteer* and *informal volunteerism* after the definition of Whittaker *et al.* [WMH15, p. 362]:

> [I]nformal volunteerism refers to the activities of people who work outside of formal emergency and disaster management arrangements to help others who are at risk or are affected by emergencies and disasters. Such volunteerism may take place before, during or after an event. Informal volunteers may participate as individuals or as part of a group, on a short or longer-term

[4] The noteworthy distinction is that 'Ungebundene Helfer*innen' is restricted to those that are not affected by the disaster, which is at odds with most other definitions (e.g., those curated by Drabek and McEntire [DM03] or Whittaker *et al.*[WMH15]).

> basis, regularly or irregularly, and in situ or ex situ. Their participation may be spontaneous and unplanned, or deliberate and carefully planned. [WMH15, p. 362]

This is one of the broadest definitions for informal volunteers, but it serves the purpose of this work quite well: it differentiates based primarily on the basis of individuals or groups not being part of 'formal arrangements'; rather than differentiating by the date, manner, or quantity of participation. By means of *argumentum e contrario*, I will use the terms *formal volunteer* and *formal volunteerism* to mean the traditional forms of volunteering, whereby a volunteer freely contributes their time within an established emergency organisation. The concept of formal volunteerism means a strong identification and long-lasting membership with an established organisation; which is at odds with the reflexive, self-determined styles of volunteering that have been purported by literature [HL03]. However, these developments do not necessarily have to be understood in terms of a de-construction of volunteering. Hustinx argues that, rather than speaking of a growing independence of volunteers, these trends should be interpreted as changing interdependence between volunteers and their organisational and institutional environment [Hus10, p. 3].

Informal volunteerism is a result of *emergence*. Emergence, in crises and disasters, relates primarily to self-determined volunteer activity and the adaptation of organisational structures. Emergence is most likely when perceived demands are not met, or when traditional forms of organisation are considered inappropriate and a community thus feels it necessary to respond to the situation [DM03, p. 99]. *Emergent volunteerism* describes 'new forms of volunteering that occur in response to unmet needs, whether perceived or real' [WMH15, p. 362]. Emergent volunteerism is characterised by innovation and improvisation to cope with the unforseen conditions and problems in crises or disaster situations (*ibidem*). That is to say, emergent volunteerism likely entails informal volunteerism, as being a result of unmet needs implies that emergency response organisations are either not aware of, or not able to cover them. Whittaker *et al.* argue that an emergent volunteer is not the same as a spontaneous volunteer, as the former may become active in prevention and preparedness, deliberately, with foresight and planning [WMH15, p. 362]. A collective of emergent volunteers that develops new relations and tasks before, during or after the onset of a disaster or crisis is considered an *emergent group*; such emergent groups exhibit new functions and structure in response to a crisis and disaster situation [DQ76, DM03, TM17]. Informal volunteers have repeatedly been reported to self-organise in the sense of emergent groups [KR16, LBY16, SWFB18, TM17]. Analogous to emergent volunteers, emergent groups will form when people perceive urgent reason for collective action to address needs that are not being met. Like emergent volunteerism itself, group emergence is most likely to occur when people believe that existing emergency organisations are unable to cope with a problem [TM17, p. 446]. This underlines the generally informal character of group emergence at its early stage. However, emergent groups have the potential to become institutionalised over the course of their existence, if they are sustainable [Qua84]. Activities of emergent groups include

search and rescue, damage assessment or coordination [DM03, p. 99]. Apart from this group emergence, Drabek consolidates multiple other forms of spontaneous adaptation under the umbrella term of *emergent phenomena* [DM03, p. 100f.]:

- Quasi emergence: minor alterations to an organisation's structure.
- Structural emergence: organisations forming new structures through social links, while upholding their regular activity.
- Task emergence: groups accepting new tasks but retaining their original structures.
- Emergence with latent knowledge: group emergence where members share the characteristic of being trained in emergency response.
- Interstitial groups: an emergent group formed between other organisations to facilitate coordination.

Information Seeking and Rumours

Issues relating to information scarcity and quality have been documented since early in disaster research. In 1938, LaPiere noted:

> In those times of social crisis when significant events are transpiring and when the normal channels of communication are disrupted, [...] rumors become a substitute for knowledge. Heightened interest in and lessened means of ascertaining distant events make for many rumor stories. [LaP38, p. 182]
>
> [People] become dependent for their knowledge of what is happening outside their immediate range of observation upon the rumors which sweep helter-skelter up and down the land. [LaP38, p. 182]

LaPiere refers to an even earlier work by Prasad [Pra35] to show how much people depend on rumours during natural disasters. Prasad theorised that anxiety plays a central role in rumour generation and transmission; as does uncertainty about the situation – these assumptions have since been corroborated in the field of psychology and sociology (cf. [BD02, p. 52f.]). Rumours are not necessarily a negative occurrence in crisis and disaster situations; they may rather be a vehicle for *intersubjective sense-making* and collective problem solving among the populace. Shibutani, in an influental work on the generation and dissemination of rumours, considered rumours to be a pooling of resources [BD02, p. 53], an improvised form of information seeking and exchanging [OAR13, p. 409], a collective transaction from which definitions about the current situation emerge [AT01]. Shibutani considered rumours not as inaccurate messages, but as a form of supplementing official channels and mainstream media to satisfy knowledge needs that are not met in the absence of relevant information [AT01, OAR13]. This view on rumouring in the context of crises and disasters has since been corroborated by multiple publications about

information seeking (cf. [OAR13, p. 409]). Building also on Shibutani, among other authors, Oh, Agrawal and Rao define rumouring thus:

> Rumoring is defined as a collective and collaborative transaction in which community members offer, evaluate, and interpret information to reach a common understanding of uncertain situations, to alleviate social tension, and to solve collective crisis problems. [OAR13, p. 409]

The reason why I went into the nature of rumours so explicitly is that rumourmongering, according to the given perspective, highlights the active information seeking of civil society as important aspect of crisis and disaster situations. Depending on the viewpoint taken, rumours are either a result of, or a vehicle for, this seeking of crucial information that cannot be obtained through official broadcast channels. Through information seeking, affected persons try to adapt their understanding of an altered world [SPS08, p. 134]. Information seeking needs include inquiries about what to do, about the situation of relatives and loved ones, as well as the existence and severity of reported threats [adH04]. People will seek information from multiple sources while relying primarily on their own social network to calculate their personal response measures [PL07, p. 729]. Apart from improving one's own behaviour and outcome, such individual information-seeking is undertaken to cognitively overcome what has happened [SBME18, p. 6].

Informal Convergence and Other Problematic Aspects

One central peculiarity of the involvement of civil society in crises and disasters is the phenomenon of *convergence*: the informal movement of persons, goods and information towards the disaster area [FW57, DM03, Dyn94b]. Literature suggets that 'convergence on emergency and disaster sites is inevitable' [WMH15, p. 364] and 'an almost universal aspect of disasters' [adH03, p. 464]. It has first been described under this moniker by Fritz and Mathewson in 1957 [FM57]. The term 'mass assault' is sometimes evoked to express this mobilisation towards the incident site in a more graphic manner [FW57, DM03, adH04, HR04, Dyn94b, LF03]. As this phrasing more aptly conveys, convergence can be overwhelming for the responders on site. Convergence can take three forms, according to Fritz and Mathewson [FM57, p. 4]. *Personal convergence* means the physical movement of persons towards the disaster site. Such an influx of persons with unknown background and training complicates the situation for emergency organisations. Lack of training poses a threat to the health of responders and the need to coordinate and keep track of a large amount of informal volunteers is a serious logistical challenge [DM03, CWB03]. Further, the movement of persons itself can cause traffic congestions [FW57, CWB03, DM03]. *Material convergence* describes the deluge of supplies that is the result of spontaneous, unsolicited donations. Excessive commodity donations can become a logistical issue if relief organisations are not prepared for the large volumes of items brought to them [adH04, DM03]. Lastly, *informational convergence* is the overload of communication facilities and information centres by inquiries and offers of assistance.

This is related to the information seeking behaviour as described in the previous section, which leads to information convergence on sources in the impacted area [adH04]. This can lead to information overload and put further strain on emergency organisations [DM03]. Oh *et al.* surmise that such informational convergence and rumouring, in the sense of improvised crisis communication, are interlocking problems resulting from the unpredictable, unfamiliar and unplanned circumstances in crises and disasters [OAR13, p. 409]. Informational convergence can also transition into physical convergence if the sought information is not found through telephone calls or online research [adH04].

Dynes seeks to explain the mass influx of informal volunteers through the concept of *situational altruism*. He places situational altruism between individual altruism, where persons give time or money or energy to a good cause; and collective altruism, which represents the institutionalised welfare state. Situational altruism occurs when helping needs are created suddenly and individual altruism needs to be expanded while collective altruism has to be supplemented [Dyn94b]. Dynes postulates that 'the normal resources which are enhanced through situational altruism in the emergency period are more than sufficient' – yet efficient response is hampered by problematic aspects created through situational altruism [Dyn94b, p. 12f.]. In addition to convergence, Dynes describes the following problematic aspects of situational altruism, i.e., informal volunteerism and uncoordinated donations:

Victimisation An over-abundance of commodity donations means that dependency of real victims is increased and that the local economy experiences a prolonged depression due to a flooded market; thus creating more victims. High availability of commodity donations also means that they will be given out freely, which grants 'victim status' to the receiver where it may not be appropriate in comparison to 'real' victims. Further, if there are too many helpers in the affected area, this may create an artificial need for more victims.

Loss of Autonomy Response organisations may feel threatened by new tasks, personnel or coordinative relationships. As a result, they can start resisting volunteers and outside help in an effort to maintain their independence. If they feel that they cannot achieve this, or dominate emergency response, they will withdraw from coordination.

Mixed Motivation The openness of participation that situational altruism entails can enable participation of parties with motives other than simple concern for victims – i.e., for their own gain in one way or another. Such actors are unwilling or unable to coordinate with experienced response groups and work on the margins of the emergency system, complicating it.

Coordination Situational altruism increases coordination effort beyond what is anticipated by conventional disaster planning. Segmental coordination, within sub-groups of the overall response efforts, exacerbates this issue.

1.5 Command and Control

The informal volunteers and emergent groups of civil society are contrasted by formal agencies and emergency organisation, whose regular activities include the response to emergencies, crises and disasters. Such formal organisations have a dedicated role, assignment and responsibility in response efforts, as defined through disaster planning. These formal organisations in CDM often rely on the *Command and Control* (C2) paradigm as their *modus operandi* [DM03, adH04, WMH15]. C2 demands strong and central leadership based on a paramilitary chain of command, which, it is assumed, will be necessary to cope with a dysfunctional society in the aftermath of a disaster [adH04]. C2 aims to regain command over a chaotic situation and maintain control over disorganisation [Dyn94a]. The assumption that there is a need to apply such an approach in disaster situations is not without motivation: sociological disaster research, even at its early roots, postulated a 'cultural collapse' (cf. [Car32, Tur76]). The expectation is that the post-incident period is characterised by social chaos, which is a sharp break from the pre-incident normalcy; and that C2 organisations are required to return the broken down system to this normalcy [Dyn94a]. Take, for example, the following quote from an early publication by LaPiere:

> During a prolonged crisis, particularly a crisis of a large-scale and violent order, varied and changing types of panic behaviour will occur. [...] In a given panic situation, the people involved may dissipate their energies in fruitless individual ways; they may destroy one another; or each may destroy himself. [LaP38, p. 437].

Indubitably, given postulations of such behaviour, an approach that aims to gain control over an irrational adversary and establish command of a chaotic situation seems appropriate. Dynes thus also refers to the C2 paradigm as the 'military model' [Dyn94a, p. 142]. The civil protection systems that are now tasked with disaster response can themselves be traced back to military roots and wartime matters in many countries [Qua00]. The affinity of emergency organisations for employing the C2 approach may be due to these historic roots [DM03, p. 106]. Apart from historical factors, Dynes suggests that the popularity of C2 is due to its simple patterns rather than its utility [Dyn94a, p. 142]. Proponents of the C2 approach postulate that bureaucratic expertise, paramilitary leadership, centralisation and concentration of decision making, as well as hierarchical, top-down communications are necessary to cope with the chaotic crisis situation [DM03, p. 106]. Dombrowsky, on the other hand, argues that the emphasis on established rules and procedures is the attempt of military to make virtue out of human propensity to fall back on familiar processes under pressure [Dom13, p. 31]. Related to this penchant for familiar processes, Drabek found that contemporary research regards the C2 model as being too static outside of controlled environments [DM03, p. 107]. Unpredictable and complex crisis situations challenge patterns of C2 organisations and require flexibility in plans and procedures; as well as *ad hoc* adaptations to structure and culture [tRK93, UJF08].

Though it appears that this very complexity and unpredictability is what fosters heavy adherence to familiar procedures in the first place. Public expectation demands fast reaction, thus exerting pressure and leaving little time for consideration or reflection – moreover, a fast reaction along familiar procedures affords a feeling of security in both the acting party and the observer [Dom13].

The premises of C2 operations are apparently at odds with the empirical evidence for the response capabilities of civil society. The C2 approach expects that citizens will panic and exhibit antisocial behaviour, and that civil society will not be able to respond to crises adequately [DM03, adH04, WMH15]. Yet the essential role of civil society in crises and disasters has been reported many times over (see page 8f.). Consequentially, Drabek postulates that the C2 approach is following predominantly faulty assumptions [DM03, p. 106]. As a result of these assumptions, information being released to the public is often incomplete, to prevent an expected panic, while perimeter security is overly emphasised to contain chaos [PL03a, p. 341] and suppress convergence [CWB03]. Official, governmental information towards the public ('Information der Öffentlichkeit') is applied instrumentally, with an implied entitlement to compliance, in order to enforce planned behaviour on the side of citizens [Dom13, p. 44]. Both the incompleteness and instrumental character of information provided under the C2 model hamper informed decision making and decrease acceptance and trust.

Researchers, in opposition to C2, call for disaster planning that corresponds more to the natural response of citizens [adH04]. Emergent behaviour should be channelled through education and information [adH03]. The value of citizen response should be taken into account and made room for in crisis and disaster planning [HR04]. Dynes proposed an alternative to the C2 paradigm, which he calls *Problem Solving* [Dyn94a, p. 149]. In this approach, Dynes postulates that crisis and disaster response should follow these principles: (1) continuity, meaning not to assume a social collapse post-incident; (2) coordination as opposed to command and; (3) cooperation instead of control. According to this model, the primary focus of planning efforts should be on developing mechanisms for integrating convergent and emergent behaviours.

1.6 Formal and Informal Response

Thus, we can distinguish between two paradigms in response to crises and disasters: the emergent, *ad hoc* efforts of civil society that make up an *informal response system*; and the highly structured, planned operation of command and control organisations that constitutes the *formal response system*. As the primary subject matter of this work is the information exchange and cooperation between the formal and the informal response system, it is necessary to distinguish them in a decisive manner; such that the borders of these systems become clear.

In the middle of the 1970s, Dynes and Quarantelli [DQ76] defined a popular and often cited typology of organisational behaviour in crises. In this typology, they differentiate between organisation types along two axes: the regularity of tasks being performed

and the consistency of structures and norms within the organisation [DQ76, p. 18]. Cross-tabulating these two dimensions results in four types of organisations:

Type I: Established (regular tasks, old structure) Organisations that have predefined roles in CDM and perform these roles in a crises or disaster (thus performing regular tasks) without changing their organisational structure to do so. Emergency organisations are the prime example of this type of organisation.

Type II: Expanding (regular tasks, new structure) Organisations that have a predefined role in crises and disasters, but whose organisational structure exists only 'in theory' outside of crises or disasters; that is to say, their organisational structures are defined in disaster planning, but only come into reality after a disaster occurs. This is exemplified, e.g., by Red Cross volunteers (formal volunteers) who run a shelter after a hurricane (in their role of affiliated members of the Red Cross) [DQ76, p. 18].

Type III: Extending (non-regular tasks, old structure) Organisations that venture outside their typical field of work to support relief efforts, but do not adapt their structure to do so. An example for an extending organisation would be a Four Wheel Drive club that organises caravans, performs transportations or clears debris [WMH15, p. 363].

Type IV: Emergent (non-regular tasks, new structure) Organisations that form or adapt their structure to engage in tasks that they do not usually pursue or have not pursued before the crisis or disaster event. The phenomenon of emergence was discussed at length on page 11 and following.

I consider the border between the formal and informal system to run along the axis of regular versus non-regular tasks in this typology. An organisation is part of the formal response system if it has been included in institutionalised CDM procedures before the onset of the disaster. That means that established and expanding organisation make up the formal response system, while extending and emergent organisations constitute the informal response system. Effectively, this is a differentiation based on socialisation in the CDM domain: how much an organisation is structured according to the practices and norms of the field, and how much its individual members have internalised the nomenclature and rules (cf. [AT19]).

Due to their lack of socialisation in CDM, organisations of the informal response system cannot fulfil the expectations of professional responders. The formal systems assumes, by way of its response procedures, that responding organisations are known in advance and are well organised and trained [MJH07, p. 150]. This is not the case for informal volunteers, much less if they spontaneously contribute or self-organise. Thus, informal volunteers' lack of familiarity with formal processes can disrupt established procedures [TM17, SSS16]. A gap between the priorities of informal volunteers and the necessary organisational work further strains their relation with the formal response system [HL03, p. 183]. By these

stressors, in addition to the logistical challenges caused by informal convergence (see page 13f.), actors within the formal response system may perceive the involvement of informal volunteers as complication [SCTK14, SSS16]. When informal volunteers are involved, it becomes difficult for established organisations to form a perimeter or keep track of who is on site [BTTA07]. Informal volunteers often lack training or equipment and thus will inadvertently interfere with response efforts [WMH15, p. 363] or drain resources that were intended for victims [TM17, p. 451]. Preventing volunteers from causing harm (to themselves or others) can become a main priority for established organisations [BTTA07], as informal volunteers may put themselves at risk through their activity [WMH15, TM17].

Ultimately, how the formal response system should handle the involvement of informal volunteers and emergent groups remains an open issue [BTTA07]. However, Drabek found that many disaster sociologists have recognised emergence not as an aberration, but as an activity that fills a void [DM03, p. 107]. Unlike the C2 paradigm that dominates the formal response system, emergence minimises ritual behaviour – which bears the danger of becoming hollow enactment [Dom13] – and fosters flexibility, innovation and learning [DM03, p. 107]. Dynes, even after going into detail about the problematic aspects of informal response, concludes that emergence is the primary basis for solving emergency needs in the first place [Dyn94b, p. 17]. Because of this, multiple publications in recent literature speak of a paradox when it comes to the involvement of the informal response system (e.g., [HSS$^+$17, BTTA07, Dyn94b]). The potential of informal volunteers, as utility and resource, is acknowledged; yet the problematic aspects of their involvement, their disruptive influence and liability, are equally referred to. Volunteers are both necessary for relief efforts, and at the same time not wanted by crisis managers ('involvement/exclusion paradox') [HSS$^+$17]. Dynes considers the tension between formal and informal response systems a paradox that is an inherent part of disaster management: it complicates relief efforts, making them inefficient, while being the reason that an effective emergency response is possible at all [Dyn94b, p. 17].

The relation between the formal and informal response system constitutes not only a paradox, but a conundrum: if emergence and convergence exhibit detrimental side effects, but are essential for effective relief as much as they are an inevitable part of crises and disaster situations, then what should be the course of action? The consensus, among those researchers that do not advocate suppression of emergence, appears to be that channelling the efforts of the informal response system is a recommendable approach. Whittaker *et al.* argue that emergency organisations need to value the contribution of citizens; include emergence in their planning; and manage it, to reduce the liability posed by untrained and uncoordinated volunteers on site [WMH15, p. 364]. Quarantelli postulated that, since the emergence of informal efforts is an inherent part of crisis response that cannot be suppressed, it should rather be included and anticipated in planning efforts [Qua94]. These measures should not only be seen as the prevention of liability and disruption. Rather, they may also enable crisis managers to draw on the knowledge, skills and resources of citizens [WMH15, p. 364]. The Problem Solving paradigm that Dynes postulated plays into this idea by emphasising coordination and

cooperation over command and control [Dyn94a, p. 149]. Twigg and Mosel urge that disaster managers will have to adapt and improvise in crisis situations and that dealing with emergent groups is one aspect of such improvisation – not only in the sense of acknowledging that informal response will inevitably take place, but that this response should further be integrated into response efforts [TM17, p. 453].

However, the integration of informal volunteers or emergent groups is challenging for established organisations. The intermittent nature of reflexive, informal volunteerism requires structural adaptations in the formal response system [HL03, p. 183]. The uncertain availability of informal volunteers and their unfamiliarity with reporting, communication procedures, and the chain of command in the formal response system is problematic [SSS16, p. 60]. Coordination and communication with the many different informal volunteers puts a strain on the limited resources of established organisations [TM17, p. 451]. It is difficult to verify the capabilities or trustworthiness of informal volunteers [TM17]. Thus, established organisations may rather turn them away [BTTA07] or run the risk of becoming liable by integrating volunteers without background checks [SCTK14]. Organisations may actively resist the participation of volunteers if they feel that their autonomy is threatened [Dyn94b, p. 13]. Whittaker *et al.* caution that integration into the formal response system may in itself be the wrong approach to accommodating informal response, as it removes the very advantages of the emergent approach (innovation, adaptability, and responsiveness) [WMH15, p. 366]. They consider measures like volunteer registers and training programmes likely to be ineffective in handling highly informal and emergent phenomena.

1.7 Information and Communication Technology in Crises and Disasters

> [M]ost human problems of disaster originate in the lack of co-ordination among the great mass of people, small groups, and official disaster agencies, each of which is viewing and attempting to meet the needs of the disaster in terms of its own perspective and capabilities. [FW57, p. 50]

The 'lack of co-ordination' that Fritz and Williams allude to is caused by information scarcity and lack of clear responsibility as well as unfamiliarity with the situation [DM03, p. 99]. It may stem from disjunct information [Tur76] or lack of appropriate information [FPF16], leading to difficulties in individual decision making [DM03, FPF16]. It is the function of communication to provide such information as allows successful crisis management [Wil57, FPF16]. *Information and Communication Technology* (ICT) supports this function [CSJD01]. It is therefore a foregone conclusion to investigate the application of computational systems in CDM.

The origins of ICT in CDM can be traced back as far as the 1970s. In a historical perspective on information systems in CDM, Turoff describes the development and use

of an early knowledge management and collaboration system [Tur02]. It should allow groups of experts to contribute to planning and response processes remotely and support the group communication process. He recalls that the system was not specific to any incident or type of crisis, but could be tailored to the needs of specific events by a human operator that defined corresponding structures. Turoff faults that the sophistication and adaptability of this system has not been achieved with any of 'the available communication support modes today' [Tur02, p. 32]; he calls for a group communication system that is both adaptive yet structured, to accommodate coordination involving a large body of persons, such as is needed in crisis response.

Recently, the rising ubiquitousness and rapid development of ICT affords new forms of communication in CDM [PL07, CM09]. Emergency organisations and researchers are developing new ways to communicate with responders on site [BW14] and coordinate between emergency organisations via ICT [EHB13, LPSW13, MM13]. Social media and collaborative online tools have afforded emergence on a new scale [TM17, p. 453]. Members of civil society have started to use ICT to organise grassroots efforts towards disaster response. They utilise online services to organise volunteer efforts both on and off site [PVLH09, RM11, Riz14, SP11]. ICT has enabled the rise of 'digital volunteers', who utilise online social media to consolidate and evaluate online data to synthesise usable information [SP13]. Thus, the advent of *new media technologies* – online social networks, social media and collaborative geographical tools being foremost among them – has had a noticeable impact on the CDM landscape [RK18].

Intersubjective Sense-Making

In the context of information systems, *sense-making* refers to how individuals collect and frame data to create a better understanding of events – to overcome a cognitive gap where they have incomplete information [SBME18, p. 5]. Based on Suthers [Sut06], Stieglitz *et al.* understand *intersubjective* sense-making as taking place when 'multiple participants contribute to a composition of inter-related interpretations', through which they achieve a joint composition of interpretations [SBME18, p. 6]. Based on pre-existing tendencies of information seeking (p. 12), communities now adapt new technological possibilities as basis for collective response. This has lead to the emergence of new, ICT-supported information seeking practices [SPS08, p. 135]. Stieglitz *et al.* note that new technological platforms have facilitated intersubjective sense-making in a way that was 'unimaginable' before [SBME18, p. 6]; the Internet has changed the speed with which information can converge [HPS+08]. The use of online social media in particular has been the focus of academic interest since the mid-2000s. Palen *et al.* describe the use of ICT during and after a shooting incident on the Virginia Tech campus; they find that online activity to gather, generate and share information has led to accurate, peer-produced information as the result of collective intelligence [PVLH09]. In their research regarding the same event, Vieweg *et al.* have collected and analysed online interactions from various sources and come to the conclusion that their data 'provide evidence of an emerging phenomenon of highly distributed, decentralized problem-solving' without the need for

outside policing and control; an 'instance of the kind of on-line collective action of which we will see increasingly more' [VPL+08]. Fischer-Preßler, Schwemmer and Fischbach, similarly, found that online communication supported typical sense-making reactions in the immediate wake of the 2016 terror attacks on a Berlin Christmas market [FPSF19]. ICT facilitated the search for sense and meaning, pro-social behaviour and the need to find and share information – the latter category making up 50% of content. By supporting such intersubjective sense-making and collective intelligence, ICT facilitates a more accurate and detailed understanding of the situation – one that can provide more relevant information for information seekers than broadcast media can [SPS08, p. 134]. This means that civil society is no longer dependent on information provided by official channels, but can synthesise information from data shared through a common infrastructure.

Digital Volunteers and Orchestration

Citizens use social media not only for intersubjective sense-making, but to organise as informal volunteers and orchestrate efforts in the informal response system. *Digital volunteers* are informal volunteers that have emerged as a result of the increasing use of online tools for information exchange during crises and disasters. Digital volunteers work remotely to aggregate data, synthesise information or coordinate efforts. In pursuit of this activity, digital volunteers may form emergent groups online to conduct specialised activities [HT15]. Such digital emergent groups can now be considered a feature of crisis and disaster response, with some of them establishing a continued online presence after the precipitating event [CMP+14]. Emergent digital groups appropriate existing ICT infrastructure – such as social media – and incorporate it [Sta12, VYK15, WK15]; thereby shaping their organisational structure according to the tools [SP13]. Two prominent examples of such groups are 'Humanity Road' and the 'Standby Task Force'. The Standby Task Force was formed out of spontaneous crisis mapping[5] and translation activity after the Haiti earthquake of 2010 [Liu14, p. 399f.][WMH15, p. 364]. Liu describes the Standby Task Force as a 'loose, informal network of volunteers distributed worldwide' with established social relationships and ongoing conversations between volunteers [Liu14, p. 400]. Similar to the Standby Task Force, Humanity Road formed in 2010 around a core group of digital volunteers that were active during the Haiti earthquake [SP13]. Humanity Road organises and operates through digital tools and works to collect information by monitoring and filtering social media; verifying and integrating it into reports; and disseminate it to the affected public [Sta12]. Humanity Road and the Standby Task Force have cooperated to analyse social media data and create maps of relevant information in the aftermath of multiple disasters [Sta12, Liu14].

New media technologies enable not only the emergence of digital volunteers, but also the coordination of informal volunteers who operate in the physical space around the affected area. I will refer to them as *digitally enabled volunteers*; in contrast to the digital

[5] An activity whereby important resources and occurrences are (collaboratively) marked on a dynamic map to provide a better, common understanding of the current situation [Mei12].

volunteers, who's activity is exclusively conducted in the virtual space. Kaufhold and Reuter found that the infrastructure of social media was used to coordinate between affected persons and informal volunteers during the German floods in 2013 [KR14]. Locally and thematically oriented Facebook groups were used for this purpose, according to norms and conventions communicated within the group. Lockwood, Weaver and Munshi describe how youth volunteers self-organised into informal groups to help with cleaning up the 2011 oil spill in New Zealand [LWMS16]. New media technologies were used as a tool for outreach and awareness as well as coordination of on-site activity, e.g., collecting and delivering food donations for helpers. The creation of a virtual space, in addition to the physical, provided informal volunteers with a point of congregation and communication. Lockwood *et al.* emphasise the importance of this space being facilitated by volunteers themselves; and not by officials [LWMS16, p. 37]. Kornberger *et al.* found that, during the European migration crisis (2015 – ongoing), a large, emergent group of informal volunteers excelled at using new media technologies to connect distributed users and their resources [KLMH18]. Through the use of ICT, the emergent group gained and orchestrated about 300.000 supporters, whereby social media was important in recruitment as well as organising resources. While many emergent groups of digitally enabled volunteers appear proficient in the utilisation of new ICT and adeptly use it to their advantage, the technology appears to not be as integral to their work as to that of digital volunteer groups. Liao, Bellotti and Youngblood found that, during the orchestration of on-site work, ICT was often a 'haphazard exigency' to 'satisfy many idiosyncratic and possibly temporary needs' [LBY16].

It is worth noting that, when talking about the online activity of digital and digitally enabled volunteers, appropriation and incorporation of new media technologies does not refer to one single tool. Rather, these volunteers utilise a wide range of different online tools. Some tools are used for social connectivity and coordination within the group, while others are used operationally to get work done [VYK15]. The accumulation of these solutions forms a digital ecosystem that supports the work of digital and digitally enabled volunteers – a 'heterogeneous patchwork of people and platforms' [DS17, p. 1280].

Response Organisations and New Media Technologies

ICT in the context of crises and disasters is not without drawbacks and caveats for established organisations. Based on a literature review, Fischer, Posegga and Fischbach list multiple technological challenges to the adoption of new ICT [FPF16, p. 5]. Firstly, telecommunications infrastructure can fail, leaving responders and citizens without the communication capabilities that they may have come to rely upon [Jen12]. Secondly, acceptance of new technological solutions may be low among professional responders, who prefer to stick to tested and proven solutions. Thirdly, if organisations accept new ICT solutions, there is often a lack of interoperability with the solutions of other organisations. Lastly, the increasing use of social media and the volume of data it creates poses a problem for responders.

Especially adaptation to the use of new media technologies appears challenging for

established organisations. However, such adaptiation could benefit the overall response to crises and disasters. Social media can provide functions of both warning and informing [FPF16] and new media technologies have the potential to improve coordination with volunteers [HT15]. Established organisations attempt to accommodate or incorporate new media technologies [PL07, HS16] and at times overrule established procedures for this purpose [HSPA14]. However, they are facing multiple obstacles [RK18, p. 393]:

1. The large amount of resources required to process data on social media.
2. The varying quality and unknown validity of information obtained from that data.
3. The lack of procedures and clearances for the use of social media.

Information overload, as a characteristic of informational convergence (p. 13f.), has always been a challenge for emergency organisations (cf. [FM57, p. 15]). However, the volume of citizen-generated data that flows through social media channels exacerbates this issue. Hiltz and Plotnick surmise that so much information is now broadcast during emergencies 'that it is infeasible for humans to effectively find it, much less organize, make sense of, and act on it' [HP13, p. 324]. In a literature review, Simon, Goldberg and Adini find that it is extremely challenging for crisis managers to analyse social media data without suffering from cognitive overload, thus making it difficult to understand and act upon information [SGA15, p. 616]. Schmidt *et al.* observed that, even in an exercise environment, a web monitoring team deployed by an emergency response organisation, 'struggled to keep up with the information overload' and that messages that were 'received in the morning were only answered later that afternoon' [SWFB18, p. 5]. In addition to the sheer volume of information being put on social media, the varying quality and relevance of this information also poses a challenge [FPF16, SGA15]. Social media have high potential to generate and disseminate rumours, as a result of community intelligence [OAR13], which can interfere with decision making [FPF16]. Incorrect rumours are corrected, but the correcting information does not always match the propagation of misinformation, and often exhibits a delay [SMO$^+$14, p. 661]. Consequentially, established emergency organisations perceive information obtained from social media as untrustworthy [TBJY11]. Verifying information requires a lot of resources [FPF16, SGA15], which are already stretched thin in a crisis or disaster situation. Apart from processing the data on social media, emergency organisations are also expected to switch to an interactive, two-ways communication model via new ICT [PL07, HS16]; whereas they are currently using them primarily as broadcast media. Engaging with citizens and informal volunteers in such a manner means that established organisations open themselves to public accountability about how they respond to requests on social media (cf. [HSPA14]) – which means that they subsequently have to address the expectation that they *will* respond on social media. Established organisations need to verified information that they pass on during interaction with citizens. Verification incurs a delay, whereas updates are expect and requested almost in real-time [SGA15, p. 615]. Interacting with the public through social media would require the definition of corresponding norms and procedures within

established organisations, owing to their bureaucratic nature. However, such rules remain the exception [SAP14].

All of the above points pose deterrents to the adoption of new media technologies and the corresponding changes to procedures and norms. Nevertheless, multiple contemporary publications have argued that established organisations' adaptation to new media technologies is a necessity. In their literature review, Fischer *et al.* note that information exchange between organisations and the public through social media is increasingly being emphasised [FPF16, p. 10]. Alexander concludes that, despite difficulties in adaptation and the downsides it brings, 'incorporation of social media into pre-existing emergency management systems is inevitable, owing to the sheer weight of public usage of such facilities' [Ale14, p. 730]. Stieglitz *et al.* note that emergency organisations and responders could positively influence sense-making on social media [SBME18, p. 13]. Bunker *et al.* find that the information that is gathered and shared by 'impassive bystanders' in the vicinity of the affected area, a form of convergence behaviour enabled through social media, may prove an important resource [BMS17]. Thus, established organisations could benefit from the information they gain through new media technologies and at the same time positively influence the decision-making of citizens.

Several approaches to handling new media technologies have been proposed. Hiltz and Plotnick see the way forward in computational methods that support humans in understanding and using the vast amounts of information online [HP13]. Reuter *et al.* propose a form of computational support that attempts to channel information from social media by providing cross-platform dissemination capabilites and consolidating information from multiple sources [RLKP15]. Hughes and Shah present a solution that enables inter-organisational reporting, documentation and sharing of online social media; thereby supporting information officers' needs to show the value of social media information within their organisation [HS16, p. 400].

Hughes and Tapia argue that socio-technical changes are required to accommodate the new communication pathways between emergent groups and established organisations [HT15]. Interfacing should not be the sole responsibility of established organisations. Informal volunteers need to demonstrate the accuracy and reliability of their data; form stable structures, out of which leaders and liasions must appointed; and they need to be accountable for their involvement [HT15, p. 699]. Established organisations, on the other hand, need to make clear what services and data are useful; they need to expose their decision-making processes and make their own data open and shareable, which may require legal and administrative changes [HT15, p. 699]. One approach that may be the first step towards such socio-technical changes is to use mediating agents for the information exchange between the formal and informal response system. In the context of social media, the concept of a Virtual Operations Support Team (VOST) has been proposed for this purpose. A VOST is a group of trusted persons[6] who are mobilised to extend the communication capacities of established organisations and monitor activity on new media [SHP+12].

[6] that is, not necessarily professionals or even formal volunteers.

Concluding Remarks

Judging from the corpus of literature recounted in this section, CDM appears to be in a phase of technological adaptation. Established organisations begin to realise the necessity to integrate social media for information exchange with actors outside the formal response system. This endeavour is hampered by their structural and operational inability to meet the expectations that citizens and informal volunteers have, with regards to interactions on social media. Emergent groups and informal volunteers, meanwhile, have already appropriated social media to organise and coordinate, as these new tools much better fit their organisational structure.

CHAPTER 2

Research and Thesis

I have argued (p. 1) that, as far as CSCW is concerned, crises and disasters are constituted by the articulation work between actors. Investigating the involvement of civil society in crises and disasters from this perspective, the purpose of my research is thus: to identify possible applications of computational support for articulation work between formal and informal response systems, under consideration of the socio-technical factors that cause tension between them, to improve coordination such that the efficiency of response may be increased.

As this is a cumulative thesis, the following chapter will heavily summarise and condense my research. I will omit details for the benefit of creating a narrative that spans my publications. To draw on the full details of methodology and results, I encourage the reader to peruse my papers in the order in which they are given in Figure 2.2 (p. 32). All papers can be found, in full, in the appendix of this work (p. 77ff.).

2.1 Statement of Problem

There is a gap between the formal and informal response system, which, according to the exposition given in Chapter 1, presents itself as follows. The gap is caused originally by the organisational paradigms of the two systems. The informal response system is characterised by high flexibility and adaptability, a problem-centred approach and emergent structures. The formal response system consists of bureaucratical procedures, of hierarchical structures and of formalised roles. Such divergent norms hinder communication and make it difficult to establish a common perspective. The lack of socialisation in CDM, usually exhibited by informal volunteers, means that they are unfamiliar with the vocabulary and communication conventions of the formal response system. *Vice versa*, the static nature and process-oriented operation of command and control (C2) organisations can become frustrating for informal response; which acts problem-oriented to address immediate needs. Thus, any one of these two systems will have difficulties to

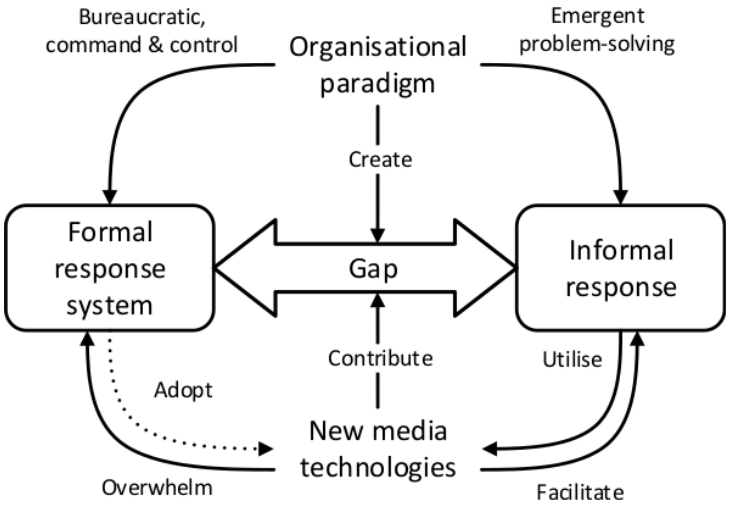

Figure 2.1: Conceptualisation of the gap between formal and informal response [AT19].

fulfil the expectations of the other in coordination. The gap of organisational paradigms is exacerbated by the introduction of new ICT. New media technologies provide an almost unilateral advantage to the informal response system. Emergent efforts of civil society are, by nature of their organisational structure, better able to utilise social media, online social networks and collaborative online tools *ad hoc* to solve specific problems. Their self-organisation and intersubjective sense-making is at the same time enabled and shaped by the infrastructure that new media technologies provide. The C2 paradigm that is prevalent in the formal response system, on the other hand, does not easily afford rapid adaptation to new technology, thus leaving established organisations out of the digital ecosystem that informal volunteers and emergent groups use.

In résumé, the gap between formal and informal response is organisational at its root; but increased by technological developments that accommodate the need of one side more than that of the other (Figure 2.1). To facilitate coordination between formal and informal response, with the ultimate goal of increasing the effectiveness of overall response, this gap needs to be addressed. The circumstance that it has both an inherent organisational component and a technological aspect makes the gap a rather complex socio-technical problem. The assumption that ICT contributes to it also leaves me, as a student of informatics, in a precarious situation. If this postulation holds true, the idea of facilitating coordination through *more* ICT must be looked at critically; lest I risk the rightful accusation of neglecting reflection on my research. With this in mind, I abstract and reprise the problem statement such:

> *There exists a socio-technical gap between the formal and informal response system in crisis and disaster situations. This gap is formed by differences in organisational culture and adoption of new communications technology. This gap impedes coordination and thus decreases the efficiency of overall response.*

> *The problem lies in determining the nature of the gap and identifying viable applications of information and communication technology, such that actors are supported in overcoming it.*

Irrespective of its up-front positioning in this document, much of this problem statement was unknown to me at the start of my doctoral research. I arrived at this problem statement through work on my early papers, which in itself required a substantial amount of insight. Later publications, then, deal with addressing this problem statement.

2.2 Motivation and Origin

My doctoral research originally started with the digitalisation of volunteer management; that is, management of formal volunteers in what I have referred to as the 'traditional' sense (p. 9). In 2007, the Austrian Red Cross, jointly with a nationwide radio station, founded a volunteer platform called 'Team Österreich' (TÖ). Team Österreich aims to 'accept civil society's willingness to help and organises it in a professional and useful manner'[1]. The concept of TÖ had already been conceived in 2002, as an approach to coping with informal convergence [Mal13]. The platform works with pre-registered volunteers, whereby citizens can sign up to become TÖ members and are subsequently called upon as volunteers if the need arises. That means TÖ is an expanding organisation according to the typology of Dynes and Quarantelli (see p. 16). The volunteers of TÖ are not formally members of the Red Cross, but they receive insurance and are integrated into the organisational structure. At the time when I began my doctoral research, the workflows of TÖ were based upon mobilisation of volunteers via text messages, personal pre-deployment meetings, work under guidance of a formal Red Cross member and a concluding de-briefing. An in-depth description of the workflow of TÖ can be found in my first and second publication [ACT15, AGT15]. TÖ, as a media and public value campaign, was discussed by Malli [Mal13]. TÖ deployed successfully in this manner on multiple occasions. In the wake of the floods of 2013, about 3.250 of 50.000 registered members were mobilised during clean-up and recovery[2].

2013 also saw the beginning of 'Resilience Enhancement by Advanced Communication for Team Austria' (RE-ACTA), a national research project aimed at transferring the established and proven TÖ workflow to new media technologies. I was involved in RE-ACTA to support the design process and carry out evaluation of this digitalisation. Evaluation of a prototype implementation revealed the benefits of digitalising volunteer management: rapid assignment of appropriate tasks to qualified volunteers with the result of highly relevant information from the field. Yet results of RE-ACTA also indicated that further consideration was required, for highly emergent phenomena among volunteers.

In the autumn of 2015, after RE-ACTA had concluded, the migration crisis in Europe came to its erstwhile climax. Lack of reaction from the public administration, which

[1] `https://www.roteskreuz.at/site/team-oesterreich/`, visited 2019/07/27.
[2] `https://oe3.orf.at/teamoesterreich/stories/2591639/`, visited 2019/07/27.

was at once overwhelmed by the number of displaced persons and hesitant out of political considerations, left a void that was quickly filled by emergent volunteerism [KLMH18, Sim17, MS18]. Alongside humanitarian and emergency organisations, civil society stepped in to provide reception, provisioning of necessities, and accommodation. Recent memory does not offer a second instance of comparably extensive emergent efforts of civil society in Austria, as were observable during the autumn and winter of 2015. Without the heavy involvement of informal volunteers and emergent groups, Austria would have faced a humanitarian disaster while the state was unable to cope [Sim17, MS18]. It became apparent to me that the workflows that I had helped digitalise in RE-ACTA were not a good fit to address this form of emergence. Consequentially, I started a second research effort, the national project 'New media technologies in crisis and disaster management for enhancing the resilience of communities' (MEDIATOR); to investigate the interactions and cooperation that had taken place between the formal and informal response systems in 2015. The aim was to determine potentially viable applications of ICT that could improve the cooperation between emergent groups and established organisations. The research of MEDIATOR culminated in a conceptualisation of socio-technical factors that affect the tension between formal and informal response; as well as design implications for ICT systems derived from this conceptualisation.

2.3 Methodology in Summary

As is indicated by the previous section, my PhD studies span two research projects. Each project was conducted according to a coherent, but self-contained methodology. As a consequence, there is no unified methodology over the entire course of my doctoral research. Methodology in RE-ACTA was characterised by an analysis of existing processes and practices by means of focus groups; followed by an iterative evaluation of a digitalisation concept; and culminating in a field test, with observation and subsequent group discussions [AGT15, AGTP16, AT17]. The methodological approach to MEDIATOR was less oriented towards evaluation of a computational system than that of RE-ACTA. Rather, the project was concerned with conceptualising the socio-technical factors that influence coordination between established organisations and civil society; and with designing ICT that is viable in the complex environment created by these socio-technical factors. MEDIATOR was exploratory, in that the socio-technical aspects of interactions between established organisations and civil society were unknown at the outset. The data for MEDIATOR was gathered through group discussions with established organisations and interviews with emergent groups as well as mediating agencies [AT19, AGT19]. I applied inductive thematic analysis [BC06] to this data over four phases, performing multiple iterations of increasing abstraction. (cf. [AT19]).

An inductive approach to thematic analysis presumes lack of existing categories and assumptions. However, I cannot be completely free of preconceptions. I have noted three assumptions in my methodological diary that were present when I started coding and may have influenced the analysis outcome. These assumptions are (1) that there was some form of disconnect between emergent groups and formal organisations; (2) that one

or both parties did not want to cooperate for reasons unknown; and (3) that there was a need to coordinate from both sides, but this was hindered for some reason.

The socio-technical dynamics that were ultimately derived from my thematic analysis describe the interaction between established organisations and emergent groups as well as highly spontaneous volunteers. The socio-technical dynamics make up a network of interlinked behaviours, under the influence of technology, that either inhibit or facilitate coordination. This network of dynamics revealed specific aspects that may be addressed through selective application of ICT. I framed such application of ICT in the form of design implications. Technological feasibility of the design implications is partially shown by means of a prototype that implements a sub-set of the stipulated functionality. Viability and usability will be evaluated by means of interviews and field testing, but this in-depth evaluation is outside the scope of my thesis.

Beyond applied methodology, MEDIATOR differed from RE-ACTA in that it shifted perspective away from the formal response system. Narratives of the formal response system often overshadow those of communities, creating a blind spot for the social context that leads to emergence [Tie07, p. 515]. The information system developed in RE-ACTA was based on existing procedures and newly identified requirements of the formal response system. In MEDIATOR, both the formal and informal response system were consulted, in an attempt to derive a comprehensive understanding of the problems in coordination. Linked to this is a difference in the direction of reasoning that led to the respective projects' conclusion. The investigations of RE-ACTA were akin to *deduction*; in that they started from existing, successful procedures for management of pre-registered volunteers, and then added the premise that digitalisation benefits the management of pre-registered volunteers; inferring that a transfer of the existing procedures to an information system would result in increased resilience to disasters. These assumptions were then tested empirically through observation. On the other hand, the way that hypotheses were derived in MEDIATOR is more akin to *abduction*. The socio-technical dynamics I have formulated are an explanation that I hold as likely, of the emergent phenomena observed during the migration crisis, based on the analysis of first-hand reports, without existing categories or theories to match data against, and made in such a way that allows falsification.

2.4 Research Progress and Outcomes

The history of research results and publications that I co-authored is shown in Figure 2.2 (p. 32). Publications at the central pathway of this visualisation directly furthered my understanding of the role that ICT has (or could have) in the involvement of civil society. Thus, each progressed my thesis.

The starting point for this progress was my research on the management of pre-registered volunteers. My first publication, *Moving Towards Crowd Tasking for Disaster Mitigation* [AGT15], investigated potential digitalisation of highly structured participation by volunteers ('crowdtasking') as part of project RE-ACTA. As such, it was oriented

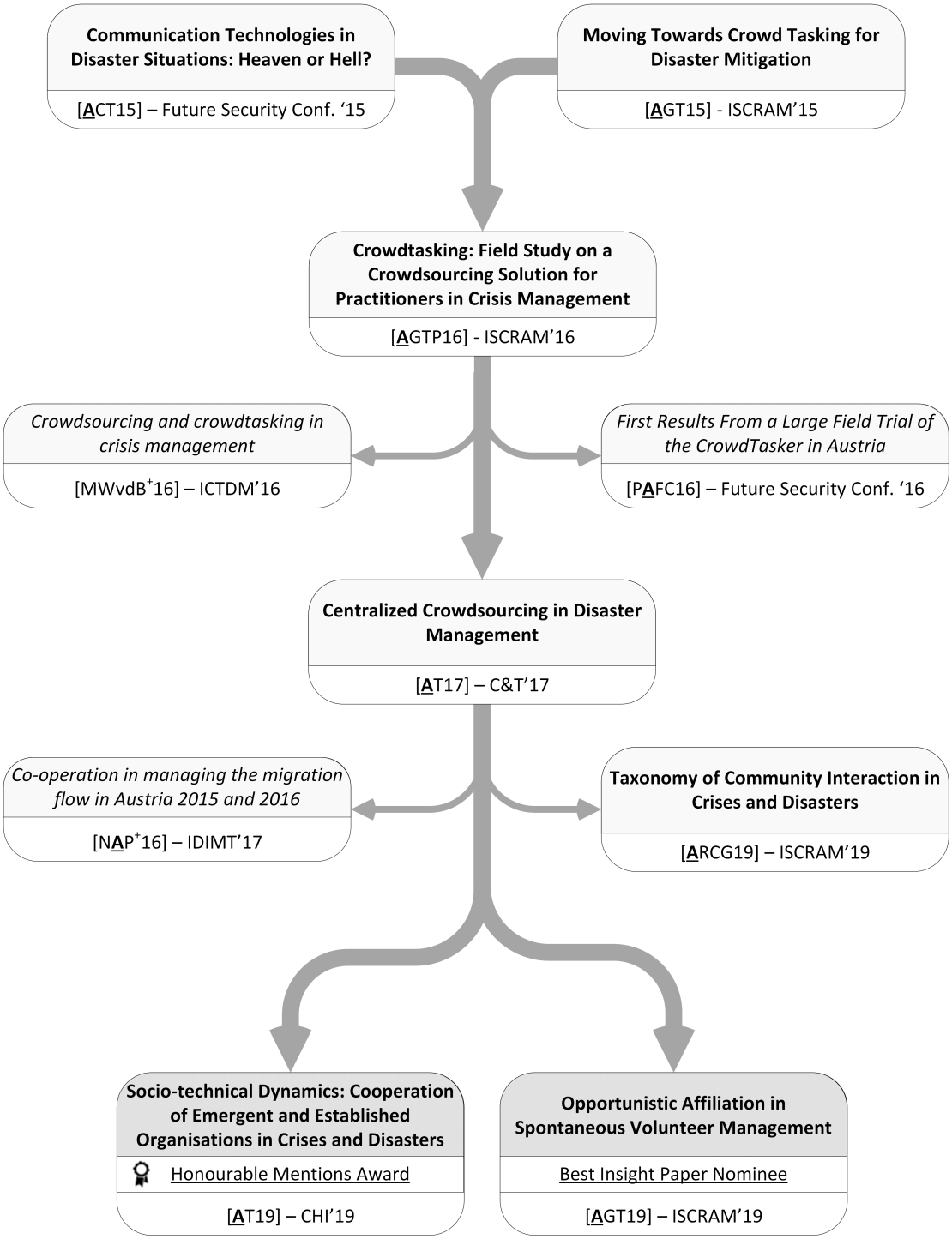

Figure 2.2: Pathway of research results towards the formulation of this thesis. The corresponding papers are appended to this document (p. 77ff.).

towards affiliated forms of participation and characterised by influences of the formal response system. This approach was first contextualised by my second publication. In *Communication Technologies in Disaster Situations: Heaven or Hell?* [ACT15], I discussed potential downsides of applying ICT in the context of CDM.

The influence of this second publication afforded me a more critical view in my third paper, which I presume would not have been possible otherwise. Hence, *Crowdtasking: Field Study on a Crowdsourcing Solution for Practitioners in Crisis Management* [AGTP16] is visualised as a join of my first two publications in Figure 2.2. This paper provides a more balanced reflection and evaluation of crowdtasking. I highlight that the crowdtasking approach is well suited for a specific type of volunteer, i.e., an individual, pre-registered volunteer that has already signed up with a formal organisation. Yet I also discuss suspicions of shortcomings, where more spontaneous and self-determined forms of participation are concerned. Subsequently, the crowdtasking concept was further tested and evaluated. From these evaluations resulted two publications: *Crowdsourcing and crowdtasking in crisis management* [MWvdB+16] and *First Results From a Large Field Trial of the CrowdTasker in Austria* [PAFC16]. These publications corroborated previous results and did not substantially advance my understanding of the interaction between volunteers and formal organisations. Thus, I consider them supplementary. Hence, they are depicted as branching off the main strand of my research.

My research was again substantially advanced by the publication *Centralized Crowdsourcing in Disaster Management* [AT17]. In this paper, I tried to conceptualise the issues I had encountered with crowdtasking, pertaining to highly emergent volunteers. Highly emergent volunteers had become a noticeable phenomenon in Europe at this point, owing to the response of civil society to the ongoing migration crisis. I discussed the relation of C2 to emergent efforts, and offered a different approach to supporting their coordination through ICT. This new approach would treat emergent groups and structures as permanent, equal entities in an information space that is shared with established organisations. As such, this paper is the first significant departure from an orientation towards the requirements of established organisations. From this conceptualisation again came two supplementary publications, branching off the primary path of research. Despite not furthering my research on emergent groups, I consider *Taxonomy of Community Interaction in Crises and Disasters* [ARCG19] to have had a meaningful research impact. This publication provides a tentative categorisation of actors and interactions that occur between established organisations and the public. Much of this work is also reflected in Chapter 1. The second supplementary publication of this research phase, *Co-operation in managing the migration flow in Austria 2015 and 2016* [NAP+17], contained preliminary results of interviews and group discussions with emergent groups and established organisations in the context of the migration crisis.

The last substantial progression of my thesis happened in the form of an in-depth analysis of qualitative data gathered during the migration crisis. This resulted in two models of socio-technical dynamics, which exist between established organisations and emergent volunteers. One model, described in *Opportunistic Affiliation in Spontaneous Volun-*

teer Management [AGT19], concerns the relation between established organisations and individual, spontaneous volunteers. The second model, described in *Socio-technical Dynamics: Cooperation of Emergent and Established Organisations in Crises and Disasters* [AT19], on the other hand, pertains to the relation between established organisations and emergent groups.

The description of socio-technical dynamics, and the design implications they entail, provide a conclusion to my problem statement, of trying to identify the nature of the gap between formal and informal response systems, and finding viable applications of information and communication technology to reduce the gap between them. For this reason, I consider these two papers on socio-technical dynamics [AT19, AGT19] to be the culmination of my doctoral studies.

Project RE-ACTA: Evaluating Centralised Crowdsourcing

The first stage of my research was characterised by the research question that stood at the core of project RE-ACTA: what contributions can new media technology and handheld devices make to support the management of pre-registered volunteers, to reduce barriers to entry, and provide relevant and adequate information?

In 2015, the first publication of my PhD studies described a concept that answers this research question. Methodologically, this concept was derived from TÖ operating procedures, in an iterative and user-oriented process. First, group discussions and interviews with representatives of formal organisations, as well as volunteers, were conducted to elicit a formal conceptualisation of TÖ workflows. Based on this conceptualisation, a digitalised design was defined in the form of a process model. Because this process modell was quite extensive and not fit for user involvement, I 'instantiated' it with real world examples in multiple realistic scenarios. Through this, I created a narrative of use cases, which I could then evaluate with representatives of the Austrian Red Cross. This not only provided a way to keep users engaged during a rather theoretical discussion of a novel concept. It also offered a way for both parties, end users and researchers, to improve their common understanding of the context.

The core of the resulting digitalisation concept was a three-stage process [AGT15]:

1. Preparation and mobilisation: volunteers sign up through a website or mobile phone application and provide information about their skills and place of residence. To further participate, volunteers have to install an application (app) on their smartphone. The app is intended to push situational information and context-aware tasks to the volunteers. This information is created and distributed via a specialised web interface, operated by a trained professional. This professional sets up a pool of volunteers by defining one or more criteria, such as a person's current location or skills. Persons fulfilling the criteria will receive a notification asking for their participation, which they may accept, decline or simply ignore. Should they accept, they will become eligible for the next stage.

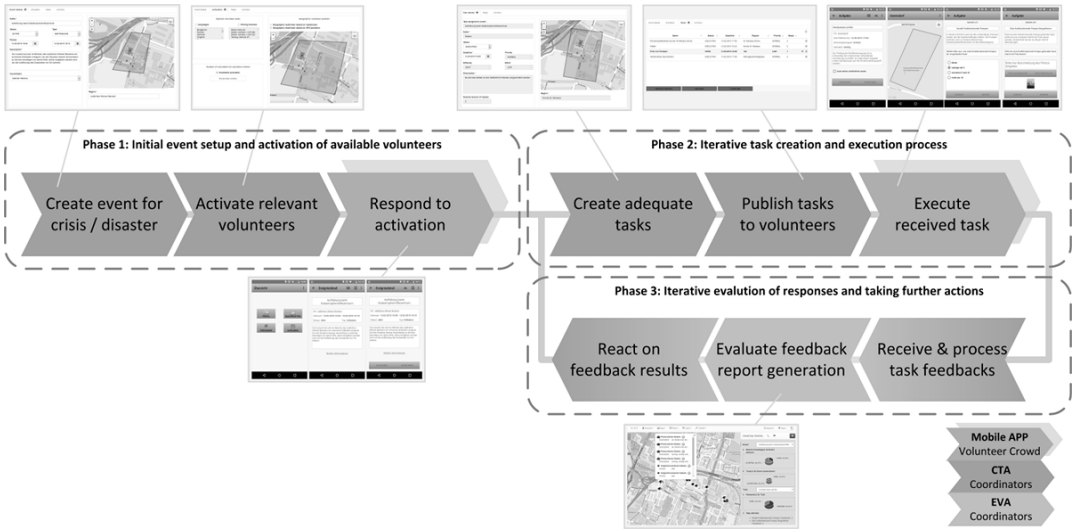

Figure 2.3: Workflow of the RE-ACTA prototype system [FNRC15].

2. Task distribution and execution: the professional operator creates tasks for persons that have agreed to participate in the previous phase. Tasks may consist of one or more steps, each having a well-defined result. Possible result types for a step are: an image, a video, an audio recording, pre-defined text values (single or multiple choice), or free text. Once all steps of a task have been defined, the operator may publish the task, which is then pushed to the mobile app of volunteers in the field. Volunteers may opt to accept or decline tasks as they deem appropriate.

3. Analysis of results: volunteers who accept tasks and complete task steps generate data on the mobile app. Once each step of the task is completed, this data is sent back to the professional operator. The data is displayed on an interactive map, where the operator may easily access individual responses or perform limited data aggregation for situational awareness. The cycle of defining, completing, and processing tasks, as well as the evaluation of their results, then continues until the crisis is declared resolved.

My paper discusses how this confluence of digital crowdtasking [NNJ+13, SHP15] and the proven TÖ practices promises a lower entry barrier to volunteering and a more rapid, direct assignment of tasks. However, these digitalised workflows are also less rich in personal contact and by design do not allow spontaneous contribution or any other form of emergence. A second publication in 2015 discussed the problematic aspects of such digitalisation. Choice of technology, language and user interface design may exclude vulnerable target groups from participating, resulting in segregation through digitalisation [ACT15].

Based on the progress of project RE-ACTA thus far, I formulated a hypothesis regarding digital crowdtasking. I hypothesised that (1) digital crowdtasking does indeed lower

the barriers to entry and enables rapid participation of volunteers that have little to no former training and that (2) the digital crowdtasking workflow I had described could improve the operational picture of formal organisations by providing timely and relevant data from the field. These hypotheses were empirically tested in a realistic field scenario. I evaluated a fully functional prototype implementation, a system named 'CrowdTasker'[3]. Figure 2.3 shows the workflow of CrowdTasker as it was implemented for the evaluation. Evaluation of CrowdTasker took place during a field exercise, in cooperation with the Austrian Red Cross. Observation, interviews and group discussions showed that CrowdTasker worked well for rapid assignment of relevant tasks to pre-registered volunteers; as well as using their feedback to supplement the operational picture at the Red Cross headquarters. Acceptance of this approach was high among crisis managers and formal volunteers [AGTP16]. Neither of my hypotheses could be refuted through empirical testing. Volunteers were able to provide relevant and usable data from the field through the mobile app with minimal introduction. Operators in the headquarters were able to use this data to assess the situation and improve their operational picture.

However, I found that younger participants in particular showed initiative to send reports that had not been asked for, and asked to organise among themselves to perform tasks. As far as processes in CrowdTasker were concerned, neither initiation of communication with the command center nor lateral communication between volunteers were supported. This caused frustration among some volunteers. Later in 2016, I contributed to two more publications [MWvdB+16, PAFC16] that each investigated CrowdTasker in different field tests. Observation of these tests corroborated my conclusions about CrowdTasker: the system works well for the intended use case, i.e., digital management of pre-registered volunteers. In summary, my publications on crowdtasking contributed to the corpus of CDM literature by offering the conceptualisation and evaluation of a digitalised workflow for coordinating pre-registered volunteers that is expected to lower barriers to entry and facilitate more spontaneous contribution than traditional volunteering options.

Project MEDIATOR: Emergent Groups and Spontaneous Volunteers

Starting September 2015, the preliminary climax of the migration crisis substantiated my suspicions about crowdtasking and pre-registration: though digitalisation according to the crowdtasking principle lowers the barriers to entry and enables more spontaneous sign-up and participation, highly emergent efforts of civil society are not easily addressed in this way. Not only did emergent efforts manifest with astounding magnitude, but they apparently operated independently from the formal response system – rendering the core idea of CrowdTasker ineffective as means of coordination with the informal response system.

Due to the way that requirements had been defined in RE-ACTA, the digitalisation that

[3] `https://cdm-demo.ait.ac.at/portal/projects/crowdtasker/`, visited 28/07/2019.

it provided transferred the principles of the C2 paradigm[4] to an information system. RE-ACTA and CrowdTasker aimed at *integration* of citizens into the formal response system – which Whittaker *et al.* would postulate, in the same year, to be ineffective in the face of highly emergent phenomena [WMH15, p. 366]. The massive emergence of self-organised groups in late 2015 supported their assumption. That is not to say that either TÖ or CrowdTasker are without merit – the membership numbers of TÖ[5] alone disprove that. Rather, the emergence of self-organised volunteer groups in 2015 showed that not all kinds of informal participation were covered by pre-registration offers; low barriers to entry and spontaneous sign-up options notwithstanding. Consequentially, I argued that the C2-oriented approach of CrowdTasker should be complemented by inclusion of emergent efforts in a shared information space [AT17]. This postulation was the substantial foundation for project MEDIATOR. From the beginning, project MEDIATOR was intended to investigate those highly self-determined forms of volunteering that had not been covered in RE-ACTA. The following research questions guided my work in MEDIATOR:

RQ1 What are the current challenges regarding the interaction and collaboration between emergent, self-organised groups using new media technologies and formal organisations for crisis and disaster relief? [AT19]

RQ2 What reasonable contributions can ICT make to mitigate challenges determined in `RQ1`? [AT19]

RQ3 How was the spontaneous volunteer effort during the recent migration crisis perceived by representatives of the formal response system? [AGT19]

RQ4 What organisational structures, measures, or tools were in place to integrate spontaneous volunteers into formal relief efforts? [AGT19]

RQ5 What were the obstacles encountered in the integration of spontaneous volunteers into formal relief efforts, if any? [AGT19]

Methodologically, I used qualitative research to answer these research questions. Unlike in RE-ACTA, requirements for technological support were gathered from both informal volunteers and formal organisations. I held two guided group discussions with a total of six representatives of formal organisations that had provided humanitarian aid during the migration crisis. All participants had been active in tactical or operational roles. In the group discussions, I explored the formal organisations' perception of, and experience with, spontaneous and self-organised participation, and self-determined activity of citizens. I also conducted interviews with nine members of seven different emergent groups. All

[4] Centralisation, concentration of decision making, and hierarchical, top-down communications [DM03, p. 106].

[5] Approximately 50.000 according to the co-founding national radio service Ö3; `https://oe3.orf.at/teamoesterreich/stories/teamoesterreich/`, visited 29/07/2019.

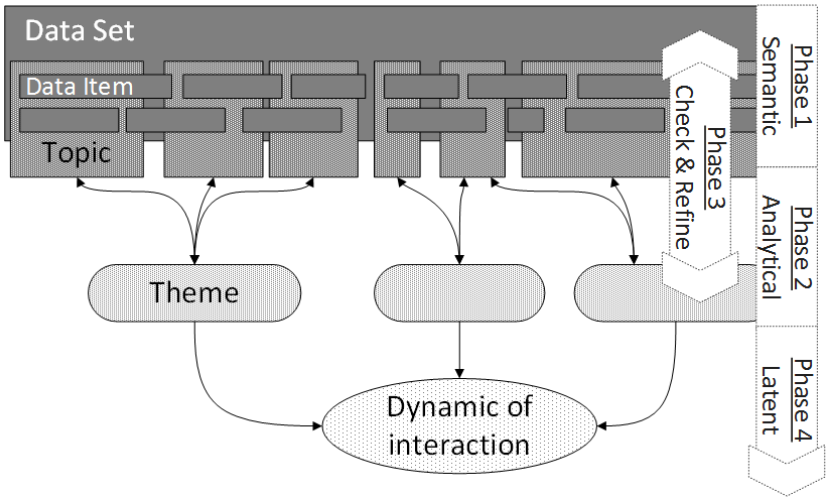

Figure 2.4: Thematic analysis to derive socio-technical dynamics of interaction [AT19].

groups had formed in response to the influx of migrants in Austria in 2015. All but two participants had been present since the formation of their respective groups. I used these interviews to explore the formation of groups, their internal organisation, cooperation with other organisations, and usage of ICT. Further, I conducted two complementary interviews with representatives of state-funded intermediating agencies, which worked to connect volunteers with formal organisations. I interviewed them regarding how their work had changed during the migration crisis and which issues in collaboration they had experienced between formal and informal efforts.

Audio recordings of all interviews and group discussions were taken with the permission of participants, resulting in roughly 14 hours of data. All recordings were transcribed to build a data set for analysis. I used thematic analysis [BC06] to construct themes with firm grounding in this data set. The analysis was inductive in nature, as there were no existing categories to fit the data into. Themes were built 'bottom up' over the course of multiple phases, which were increasingly abstracted from the original data set. Figure 2.4 illustrates these phases and the artefacts they created.

During the first phase of analysis, I coded the entire data set. I conducted this coding according to the research questions outlined above; meaning that data was considered relevant if it appeared to relate to at least one research question. Through this process, I created *data items*. Multiple data items (preferably from different participants) that addressed a common issue were grouped by establishing a new *topic*. Topics were purely semantic artefacts. In the second phase, I constructed *themes* from topics that showed inter-connectedness. As such, this was the first step not based purely on semantics, but instead on the meaning of collated topics. This phase resulted in *candidate themes* that showed a fair level of abstraction from data items. Candidate themes also provided a new lens from which to view data items. They were useful in revealing the relevance

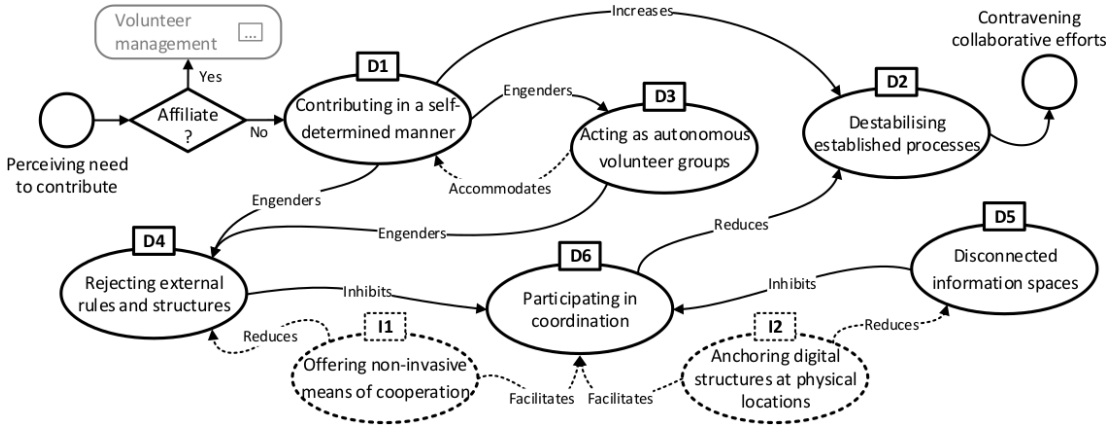

Figure 2.5: Socio-technical dynamics in the interaction between emergent groups and established organisations [AT19].

of data items, or connections between data items, that I had missed in the first phase. Thus, in the third phase, I checked and refined existing themes by looking at the data set through this new analytical lens. This step also saw some adaptation to the thematic landscape I had built so far, as themes started to show variances within them. Once I could no longer find variances within themes or inter-connectedness between them, I felt comfortable to consider the remaining themes as final. These final themes answered, in particular, research questions `RQ1`, `RQ3` and `RQ4`. However, I felt that these final themes did not entirely capture the implications present in the data set. Thus, I established a new perspective, based on the final themes, that aimed to establish how actors' actions impact each other. In doing so, I created *socio-technical dynamics of interaction*. It is noteworthy that these dynamics are not another level of abstraction. They represent a shift of the analytic lens to pursue those research questions that depended on an understanding of how behaviours and technologies influence other actors (i.e., `RQ2` and `RQ5`).

The iterative thematic analysis of the MEDIATOR, down to patterns at the latent level, revealed two sets of socio-technical dynamics that influence cooperation between established organisations and emergent efforts. One set concerns the interaction between established organisations and emergent groups [AT19] and answers research questions `RQ1`, `RQ2` and `RQ3`. The other concerns factors in the integration of highly spontaneous individual volunteers [AGT19] and addresses `RQ3`, `RQ4` and `RQ5`. Both will be discussed below.

Socio-Technical Dynamics: Technologically Intermediated Coordination

The first set of dynamics is shown in Figure 2.5. It assumes that an emergent group has formed in response to a perceived need. The members of this groups are supposed

to be either unwilling or unable to affiliate with an existing, established organisation for their contribution. The postulated dynamics then describe socio-technical factors in the emergent group's interaction with the formal response system. In line with related literature (cf. p. 13), I found that uncoordinated action of emergent groups can destabilise relief activities of the formal response system; by causing inefficiency (in the form of unnecessary convergence) and eroding formal procedures. Destabilisation of the formal system can also happen through the use of personal relations for information exchange, which leads to the injection of unverifiable word-of-mouth information into the formal response system. Noteworthy in this first set of dynamics is that there is no general aversion to coordination from either the formal or informal response system. Participants that were members of emergent groups mostly considered coordination with the formal response system to be desirable; at the least, they were aiming to avoid conflict. Members of established emergency and humanitarian organisations considered involvement of emergent efforts a necessity, but had some reservations regarding the reliability of their potential cooperation partners. The general willingness to coordinate efforts was undermined by two socio-technical dynamics in particular. First, there was a disconnect in the information spaces of the involved parties, including between emergent groups themselves. The online social networks and messaging services that found widespread use among emergent groups do not currently support an explicit link between the group's online activity and the location concerned by this activity[6]. Combined with the lack of a central point for information exchange, this disconnect means that finding and contacting emergent groups in a specific area becomes a non-trivial task. Second, emergent groups' tendency to reject external rules and maintain their autonomy contradicts the traditional approach of integrating volunteers into the organisational structures of established organisations; be these structures digital or otherwise. This dynamic mostly invalidates an integrative approach to handling informal volunteers, as far as emergent groups are concerned: requiring groups of informal volunteers to register on a volunteer platform, such as Team Österreich or CrowdTasker, conflicts with their tendency for autonomy.

I postulate that it is possible to design an information system in such a way that it specifically addresses these two inhibiting dynamics. First, an information system can be designed for *non-invasive means of cooperation*, i.e., so that the representation of a group on social media becomes an artefactual part of a shared information space. This is achieved by introducing a technological mediator between the appropriated infrastructure of the emergent group and the information systems of established organisations. I surmise that this approach shifts the intent of the resulting information system: from an *integration* of volunteers to a *participation* of emergent groups, allowing them to keep their integrity and identity (cf. [AT19, p. 8]). Further, I suppose that we may create a shared information space between emergent groups and established organisations that is *tethered to a physical location*, implicitly linking groups to activity at a geographic site.

[6]Implicit links may be achieved through naming conventions; however, no inter-group naming conventions for digital coordination of on-site activities emerged in 2015.

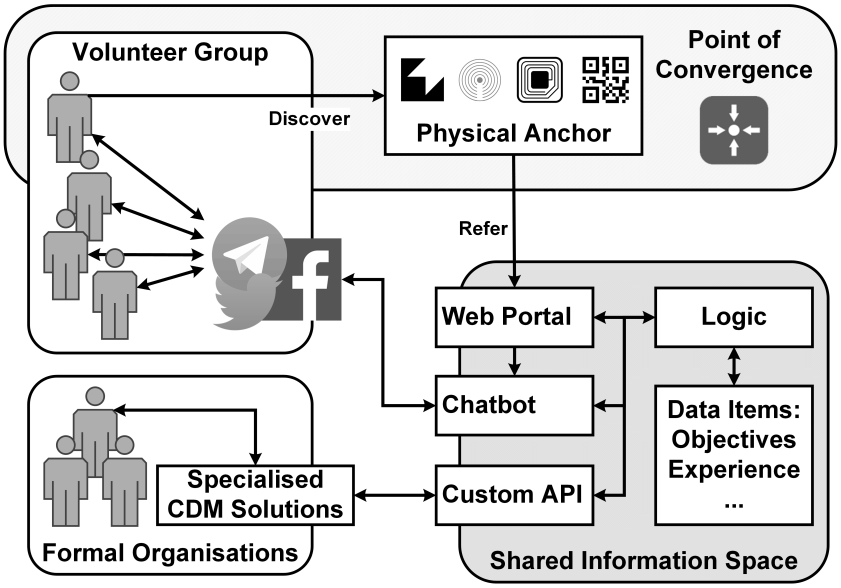

Figure 2.6: High-level technological architecture for a shared information space according to the proposed socio-technical dynamics [AT19].

The shared information space thus created uses perceived needs of participants as coordinative protocol to facilitate articulation work. I argue against using one such shared information space globally. Instead, I suggest instantiating smaller information spaces that are 'localised' by implicitly anchoring them to physical locations. This may be achieved through, e.g., clearly visible signs at central locations or situated displays (cf. [LKR+16]). This could at once reduce data volume on the information space and link active groups to a geographical site, increasing the relevance and accuracy of information [dAHBZ15, SPS08]. I refer to this form of participation by emergent groups as *technologically intermediated coordination*. It is my hypothesis that the shared information space that is created by technologically intermediated coordination supports both, the intersubjective sense-making of volunteers, and the articulation work between formal and informal response.

Regarding the research questions of MEDIATOR (p. 36), my first publication on socio-technical dynamics [AT19] answered RQ1 and RQ2, as well as RQ3 to a lesser extent. The paper explicitly conceptualises the gap between emergent efforts and established organisations, thus addressing RQ1. In the present work, this gap has already been discussed in Section 2.1. The paper also partially addresses RQ3, in that it postulates that emergent groups were not generally perceived negatively and that there was no aversion to coordination.

Pertaining to RQ2, the reasonable contributions that ICT can make are laid out with the concept of technologically intermediated coordination. For an implementation of technologically intermediated coordination, I suggest a shared information space that is

analogous to a message board or notice board. It would have a relatively open and flexible data structure, where participants may create new posts (or 'messages', or 'notices') that are available to all participants. Posts consist of nothing more than a statement which describes an urgent topic or perceived need. There is no restriction on the manner of content that can be shared. A post may be, e.g., an offer of support, a request for goods, or general information regarding the situation. Any participant in the shared information space may comment on a post. These comments, also, are visible to all participants of the shared information space. This in itself is not a particularly novel or noteworthy concept, as it has already been used extensively, e.g., in online message boards. However, the implications of non-invasive means of cooperation, paired with a physical tether, as postulated in technologically intermediated coordination, would make such a shared information space well suited for coordination of, and with, emergent groups. A high level representation of this technological concept is shown in Figure 2.6. First, physical anchoring may be achieved through, e.g., Bluetooth beacons; or simply by deploying a large sign that spells out a Uniform Resource Identifier (URI). Such a situated anchor affords us to notify digitally enabled volunteers in the vicinity about the information space's web portal, where they may receive further guidance. Thus, users that participate in the shared information space also implicitly state interest in the location, making it easier to follow local emergence. Second, the increasing pervasion of 'bots' in online social media and messaging services affords us the implementation of non-invasive means of participation. I hypothesise that bots will allow for a technological mediator that integrates emergent groups' digital representation as artefact in the shared information space. Simple workflow-based bots can be added to groups on social media. Through these bots, a group may create posts and comments in the shared information space. Vice versa, they may receive updates from the shared information space directly in their group's established communication infrastructure. In this way, they do not have to forgo their own organisational structures (on social media) for the sake of participating in the shared information space.

Socio-Technical Dynamics: Opportunistic Affiliation

Figure 2.7 shows the second set of socio-technical dynamics that I have postulated [AGT19]. It concerns the interaction between established organisations and highly spontaneous, individual, informal volunteers. Like in the first set, participants of group discussions and interviews confirmed such informal contributions as a potential stressor of the formal response system that can decrease the efficiency of relief efforts. The assumption behind the second set of dynamics is that an informal volunteer acts reflexive and self-determined, but exhibits some readiness to integrate into existing organisational structures (albeit temporarily and *ad hoc*). This is the primary differentiating factor between the two sets of socio-technical dynamics. The second set concerns the *integration* of, rather than cooperation with, spontaneous informal volunteers.

I found that established organisations struggle to support spontaneous, short-term oriented volunteer behaviour through their existing structures. The volume of participation

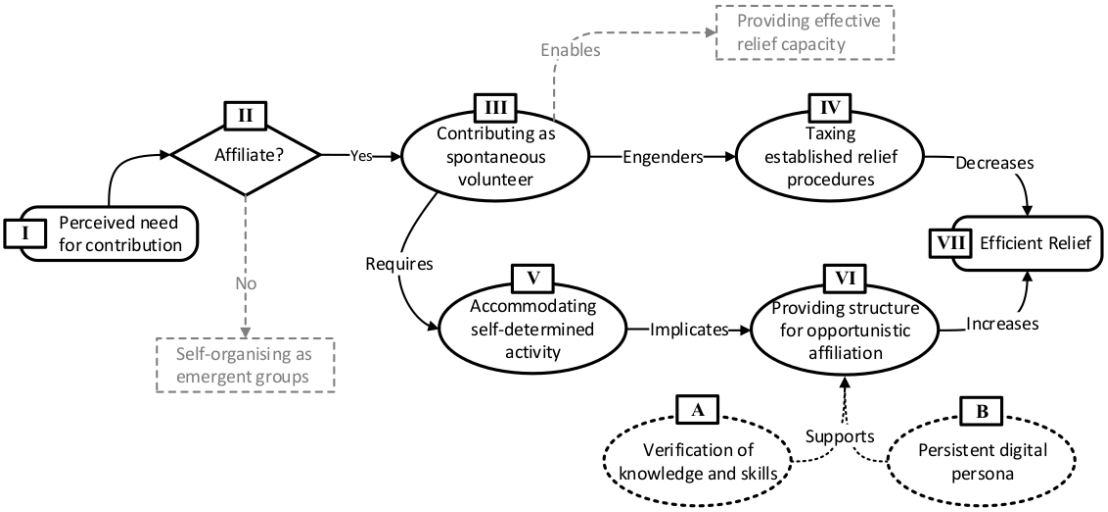

Figure 2.7: Socio-technical dynamics of established organisations interacting with highly spontaneous ('opportunistic') volunteers [AGT19].

can overwhelm their surge capacity of commanding personnel. Furthermore, *ad hoc* registration of volunteers on site is paper-based and prone to data loss and lacking in interoperability with other organisations. Nevertheless, established organisations try to accommodate self-determined and highly spontaneous activity, e.g., by streamlining their registration procedures. The consequential continuation of supporting progressively more spontaneous and short-term informal volunteerism leads to what I have dubbed *opportunistic affiliation* [AGT19, p. 6f.]. In opportunistic affiliation, established organisations provide participation structures that are flexible enough to allow *ad hoc* contributions, but still support the volunteer; by offering meaningful ways to contribute as well as caring for the volunteer's health and well-being. Opportunistic volunteering considers the volunteer as a continuing entity that is separate from organisational structures. Currently, this is often not the case. Volunteers have to undergo a registration process each time they contribute with a new organisation; thus effectively becoming a 'new' volunteer. The postulation that a volunteer should be regarded as continuous entity, even outside of the organisational silo they originally registered with, contradicts some of the traditional understandings of volunteering. In the historical understanding of volunteering, a volunteer strongly identifies with *one* organisation over a long period of time. For opportunistic affiliation, established organisations need to complement this understanding by the acceptance of episodic, short term participation that occurs on the spur of the moment and can shift between organisations. Furthermore, the traditional, static C2 organisation does not provide the necessary surge capacity in their command structures to integrate large volumes of opportunistic volunteering. I suggest that pre-registered, trusted volunteers (such as experienced Team Österreich members) can be trained in advance, to be deployed as expanding command structure that can cope with a spontaneous influx of opportunistic volunteers.

I have formulated two design implications that derive from the conceptualisation of opportunistic affiliation (cf. [AGT19]). First, highly spontaneous participation requires support for verification of volunteers' skills and prior experience. Especially if there is a high volume of personal convergence, representatives of the formal response system do not have the resources to vet newcomers. I propose a distributed, permissioned ledger that is shared by emergency organisations of the formal response system. Transactions in this ledger would happen between participating established organisations of the formal response system and highly spontaneous volunteers. Transactions comprise of date and manner of participation. Linked to a personal identifier that the volunteer carries with him or her, organisations of the formal response system would be able to immediately verify capabilities of a person, even if they were active within the structures of another organisation. Such an information system requires the creation of a persistent, digital persona for each volunteer – the second design implication of my paper. This persona needs to be created during the first affiliation of a volunteer with an established organisation. This, in turn, requires the selective digitalisation of the reception procedure for helpers on site. A digital persona for volunteers may be realised as the sum of their participation, as it is stored in the distributed ledger system proposed above; or it can be implemented as a local storage on the volunteer's smart device, digitally signed by a representative of the formal response system. The confluence of a digitalised reception and a persistent volunteer persona also, ultimately, allows for an efficient check-in / check-out of informal helpers, so that established organisations can be aware of the presence of persons on site.

With regards to RQ3, I found that the stance of formal organisations towards individual spontaneous efforts was generally positive. They attempted to accommodate and integrate individual spontaneous volunteers, rather than attempt to suppress their activity. Regarding RQ4, I found that established organisations already started to establish rapid registration processes with low barriers to entry. The overhead of sign-up procedures and the timeframe between registration and volunteer activity were reduced; by providing reception (sign-up) on site and facilitating quick contribution. Lastly, concerning RQ5, the challenges stem predominantly from the unpredictable influx of volunteers. These challenges are in part organisational, and in part technological. There is a lack of scalability in command structures and a need to adopt appropriate leadership styles. Further, paper-based registration does not scale well over time or with an increasing amount of arriving volunteers. The implications that this has for technological support have been outlined in this section already: there is a need to support highly spontaneous participation through a shared ledger of verified volunteer activity; as well as the prerequisite that there exists a persistent, digital persona for volunteers that is independent of any one established organisation's information system.

Taxonomy of Actors and Their Interactions

With the insights of both RE-ACTA and MEDIATOR, I felt confident enough to synthesise a taxonomy of ICT-related interactions that take place between the formal response system

and civil society [ARCG19]. This taxonomy encompasses the contribution and volunteer management functions of RE-ACTA; the functions of coordination, personalisation and support that were revealed in MEDIATOR; and was complemented by functions of information dissemination from other research projects at AIT, courtesy of my co-authors. No less important, the taxonomy also provides a fine-grained classification of individual as well as composite actors, both from the formal and informal response system. I expect this taxonomy to only partially cover the actors of the formal and informal response system, owing to its rather one-dimensional nature of classification. Future iterations will be needed to differentiate actors better, in a multi-dimensional space, thus also multiplying the interactions that can happen between them.

2.5 Consolidating a Thesis

Superficially, on a temporal level, my research builds a narrative of insight about the multiple forms of informal volunteering and influences of new media technologies, which need to be considered when designing ICT for CDM. To understand the research of RE-ACTA in conjunction with the phenomena observed during the migration crisis was the premise to realising the necessity for investigating emergent groups. Insights about emergent groups, in contrast to the perspectives that shaped CrowdTasker, were in turn necessary to find distinguishing properties for classification and taxonomy. Each publication expanded my understanding of civil society and technology in crises and disasters over time. However, more importantly, my publications also form a cohesive thesis on a latent, theoretical level. In Section 1.4 (p. 9), I discussed how literature purports a shift in volunteering: how transitory, detached, and self-centred involvement is increasingly noticeable. The acceptance of informal volunteers means a departure from the concept of formal, long-term volunteerism that assumes a strong identification and long-lasting membership [HL03]. My publications echo this transition. Suppose a continuous spectrum of volunteer participation, where on one end is situated the traditional, formal, affiliated volunteer, and on the other end are placed volunteers whose manner of participation is so reflexive, self-centred and detached from the formal response system that they do not want to be associated with it. The spectrum that stretches between these extremes is a gamut of participation manners, where helpers are situated according to their disposition towards integration into the formal response system. My publications, then, move along this spectrum (Figure 2.8). The first block of my publications, about crowdtasking as centralised form of crowdsourcing, is concerned with pre-registered volunteers. The nature of their participation is similar to formal volunteers, in that they identify with their volunteer platform and are affiliated with it for some time, but their participation is too episodic for the formal volunteer model. The second block, socio-technical dynamics of opportunistic affiliation, treats the issue of volunteers whose form of participation is too transitory and detached from organisations to be addressed through pre-registration, but nevertheless allows for temporary integration into the formal response system, with a high degree of freedom being afforded. The third block, socio-technical dynamics of technologically intermediated coordination, dwells on a

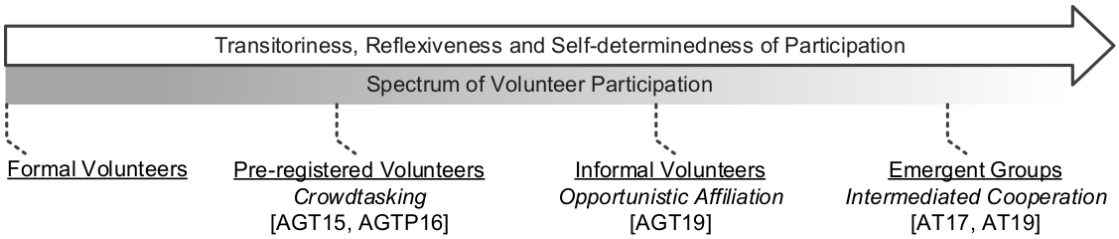

Figure 2.8: Situation of my research along a spectrum of volunteering.

far point of the supposed volunteering spectrum. It is concerned with informal volunteers who form self-organised groups that are independent of the formal response system and cannot be integrated into it.

This, ultimately, is my thesis: that the ICT concepts discussed in my publications address progressively more reflexive and self-determined manners of informal participation. A range of such informal participation is likely to be present at the same event. They cannot be covered sufficiently by focusing on any single notion of volunteering when designing ICT support. My individual publications show that each form of participation has diverging requirements with regards to ICT. I have described potential applications of ICT to facilitate coordination according to the requirements of each manner of participation. I have put these research outcomes in relation to each other and located them in the larger frame of interactions between the formal response system and the public through a taxonomy. To my knowledge, there exists no published literature that conceptualises socio-technical tensions between established organisations and emergent efforts in a manner as detailed as I have provided; nor are there any attempts at a comprehensive taxonomy of interactions between the formal response system and the public. Putting forth research that addresses these shortcomings, in a form that is transparent and comprehensible to the point of allowing falsification, is my contribution to the scientific corpus on computer supported cooperative work in the context of crises and disasters.

CHAPTER 3

Perspectives and Discussion

I will give, to the best of my abilities, a critical examination of my own hypothesis to facilitate reflection. Some of the points below have already been briefly addressed in my publications, while others are unpublished. In either case, the present work affords me to discuss my notions in more detail than was possible in the context of the respective original publications.

3.1 The Role of Formal Response vis-à-vis Emergence

In the previous sections, especially in Chapter 1, I have focused rather heavily on the informal response system, but offer primarily criticism of the formal system. This might evoke a skewered perspective; both about these actors' situation in the larger picture of relief efforts, and my judgement thereof. Formal organisations, despite all the criticism levelled at their bureaucratic approach, are still the essential actors of CDM. In the words of Dynes:

> The previous discussion of volunteers does not mean to imply that emergency relevant organisations do not constitute the core element of the emergency response. Obviously, they do. [Dyn94a, p. 155]

Being the 'core element' in this case does not necessarily mean being the seat of centralised command[1]. I would argue for using the term *stem*, in the sense of a botanical trunk, rather than core, to describe the role of the formal system in crises and disasters. With their training, knowledge and practical experience, actors of the formal response system are the best equipped personnel in a crisis and disaster environment. This enables them to

[1] Given Dynes' stance on the C2 pattern (see also, e.g., [Dyn06]), I presume he did not mean to evoke such interpretation, either.

function as the foundation of relief from which emergent efforts can grow. The role of the stem, then, would be to give guidance and support to the sprouting efforts of civil society. Simsa *et al.* refer to this notion as *structured self-organisation* [SRAT19]. They postulate that finding the right balance, between self-organisation of informal volunteers, and coordination with the formal response system, is the crucial challenge. To that end, they propose that space be given to self-organisation processes, while supporting them through structures of established organisations. I concur with this assessment, and my analysis results reflect this as much as the design implications I propose. Both of my publications on socio-technical dynamics ([AT19, AGT19]) allow to re-interpret the role of established organisations. In this re-interpretation, their role shifts from being a utility in establishing order and exerting control, to offering support for self-organised efforts of civil society [2]. Accommodating opportunistic affiliation implicitly requires established organisations to provide the support structures for self-determined contributions of individuals (albeit not for the sake of self-organisation). Technologically intermediated coordination with emergent groups corresponds more directly to the structured self-organisation proposed by Simsa *et al.*, in that it aims to facilitate articulation work while allowing emergent groups to retain their structural integrity; i.e., it leaves them the (digital) space they require.

The concept of structured self-organisation seems to have emerged at the same time as I have formulated my own analysis and designs, judging from the date of the corresponding publication [SRAT19]. This is not surprising, considering that both research outcomes are based on data from the same event and timespan. Because I presume that they evolved independently, I regard the work of Simsa *et al.* as a corroboration of my own conclusions regarding the role of established organisations opposite emergent efforts and self-organisation.

Whittaker *et al.* postulated that efforts of pre-registration and volunteer platforms are ineffective in the face of highly emergent efforts [WMH15]. I concur with this statement, insofar as these measures are seen as ways to *integrate* highly spontaneous, informal volunteers or emergent groups. However, I postulate that pre-registration and volunteer platforms can very well help the interaction with highly emergent phenomena; in that they can expand the capacity of established organisations not only operationally – but also in the coordination with highly emergent efforts. I suggest that it should be possible to use pre-structured, pre-registered volunteers that are trained and trusted, such as those of Team Österreich, to expand command structures for managing a high volume influx of informal volunteers.

Alternatively, instead of expanding its own command structures, an established organisation may also cede management of spontaneous, informal volunteers to external groups.

[2] It should be noted that this notion was instigated by the study participants themselves, who work in the formal response system. This means that there exists an awareness for the possibility, or even necessity, of re-interpreting their role; and that the participants that represented established organisations did not see their roles in what literature purports as the traditional C2 perspective (cf. [Dyn94a, DM03, adH04, WMH15]).

The concept of mediators, as means to support the interaction between established organisations and volunteers, is common in CDM (cf. [HT15, p. 691f.]). Trusted groups of digital volunteers have been reported to take over resource intensive tasks, such as monitoring and collating data from social media, to relieve the formal response system; thus acting as intermediaries between citizens on social media and established organisations (cf. 'Virtual Operations Support Team' [SHP+12]). Skar, Sydnes and Sydnes have found that professional responders use formal (affiliated) volunteers as link with informal volunteers; to manage and include them in the response efforts [SSS16, p. 60]. Zettl *et al.* have proposed intermediary organisations as third parties to which established organisations can 'outsource' the management of individual, informal volunteers [ZLKS17, p. 426]. This is sensible insofar as emergent groups can accommodate the different manners of informal participation more flexible than the formal response system is currently able to. Kornberger *et al.* have noted how an emergent group was able to offer very attractive manners of participation to informal volunteers during the migration crisis; by being the confluence of a digitally enabled platform and a social movement [KLMH18].

Thus, we can contrast two approaches to handling spontaneous informal volunteers. Established organisations can either try to accommodate spontaneous contribution by expanding their own structures, as is the premise of my conceptualisation of opportunistic volunteering. Or they can 'outsource' management of spontaneous volunteers to a third party. The contrast of these two approaches invariably invites the question: who shall be responsible for integrating individual, informal volunteers into relief efforts? The established and expanding organisations of the formal response system; or the emergent and extending organisations of the informal response system? The border between the formal and informal response system blurs around this question – and with it the articulation work that is the subject matter of my thesis.

Opportunistic affiliation, as I have introduced it, implicitly makes the accommodation and support of highly spontaneous, informal volunteers a matter of the formal response system. It corresponds to Hustinx's interpretation of present-day volunteers and their complex and contingent interdependencies with organisational and institutional environments [Hus10]. Both the concept of opportunistic affiliation, and the technological support I have proposed for it, support what Hustinx has termed *institutionally individualised volunteering*. Through institutionally individualised volunteering, Hustinx seeks to conceptualise how volunteers become re-embedded in the late modern context; where organisations change their management approaches to be centred on the individual, but at the same time become more rational in their processes. Institutionally individualised volunteering is a double-edged sword in this way, but nevertheless is geared towards embedding volunteers in the formal response system by accommodating them. The concept of intermediary organisations, as introduced by Zettl *et al.*, on the other hand, places the inclusion of spontaneous informal volunteers within the scope of responsibilities of the informal response system. While such intermediary organisations have to be 'deputised' by an established organisation [ZLKS17, p. 427], they are insinuated to emerge from civil society in response to perceived needs, and thus are part of the informal

response system first and foremost. The function of intermediary organisations appears to be the abstraction of interaction between the formal and informal response; they abstract the management of individual volunteers and instead offer pre-structured groups as more easily accessible interface towards established organisations.

To summarise, there appear to be two approaches to handling highly spontaneous, individual volunteers: (1) directly accommodating them within the formal response system, necessitating structural adaptations in command structures and operating procedures, versus (2) relegating their management to the informal response system, using intermediary organisations as buffers, who offer attractive ways of participation to informal volunteers through the very nature of their organisation.

I would be presumptuous in claiming an answer to the question of which approach should be pursued. I consider it a question for professionals and practitioners of CDM. Time will tell which, if any, of the two concepts proves itself in the field, and becomes the popular approach. However, any eventual outcome has implications for whether my present work will remain appropriate, or whether it will need to be adapted at a later point. Let us assume that, in time, the approach of using intermediary organisations turns out to be the one best suited for interaction between established organisations and informal volunteers. This, then, would invalidate my assumption that crowdtasking and technologically intermediated cooperation are complementary to opportunistic affiliation, as means of coordination between the formal and informal response system. Because then, opportunistic affiliation would no longer be an interaction between the formal and informal response system; but an interaction within the informal response system itself. Predominance of the intermediary organisations approach would also require a new form of articulation work that is not covered in this thesis; since I expect that coordination between established organisations and trusted intermediary organisations would differ from coordination with highly emergent groups, as it was discussed in this work. This being said, my conceptualisations of computational support are not a statement in favour of either approach. I derived opportunistic affiliation as a concept by extrapolating from the tendencies observed in the formal response system during the migration crisis. As such, the concept is an outcome of trying to support the cooperative work of established organisations and spontaneous informal volunteers – not an attempt to shape it. What remains is to observe if this conceptualisation retains applicability.

3.2 Problematic Aspects of the Proposed Digitalisation

The technological support that I have conceptualised in my work has problematic implications. Firstly, there are *social and societal implications*. ICT in the context of CDM has the potential to increase social segregation [ACT15]. While it is true that society as a whole is equally at risk of being affected by a disaster, not all demographics are affected equally [LV13, p. 79]. Some groups are made especially vulnerable to changes in their environment by a disadvantaging distribution of one or more forms of capital (cultural, social, or economical [Bou83]). The distress that such vulnerable demographics

face in crises and disasters is not caused by impairment of technological infrastructure, and reducing our conceptualisation of disasters to physical infrastructure damage creates a blind spot for social vulnerabilities [LV13]. Considering this, it appears important not to reduce the intent of cooperative systems in CDM to managing the physical damage of infrastructure. I have tried to pay tribute to this notion in the design of technologically intermediated coordination, which uses perceived needs as coordinative protocol. I consider perceived needs to be the most general way to capture a common cause and make it visible. Actors can contribute what *they* perceive to be an unfulfilled need. This may go beyond what the formal response system perceives, and can considerably widen the horizon of issues that are recognised in the event of a disaster – with all the challenges this brings with regards to data processing. In this way, I tried to conceptualise technologically mediated participation in such a way that it is inclusive of multiple perspectives.

Apart from the content that is communicated through ICT, the danger of fostering segregation is also present in the choice of technology being used. This thesis focuses a lot on new media technologies and how to incorporate them in CDM procedures. This in itself is a form of exclusion, as it leaves out those actors that are unable or unwilling to use social media, messenger services or collaborative online platforms. However, I would argue that focusing on technological infrastructure that many already incorporate in their daily routines is also a form of inclusiveness. In future technological implementations, it will be important to also supply information from an eventual shared information space through other channels; channels that are easily accessible and do not rely on the use of either proprietary, professional software, or new media technologies. Examples for such include easily accessible public websites, that focus on simple design and compatibility with a large range of devices, as well as situated solutions such as, e.g., public displays.

In the previous chapter, I postulated that computational support for opportunistic affiliation requires the creation of a persistent digital persona per individual volunteer. This creates transparency that, on one hand, may foster trust and help include individual volunteers better. On the other hand, such transparency has severe *privacy implications* [AGT19]. Should this persistent volunteer profile ever become public, either through a security breach or change of policy, it may lead to reciprocation or discriminative treatment. Consider, for instance, the situation of the migration crisis in late 2015. The atmosphere surrounding emergent efforts of civil society was initially positive. However, the potential humanitarian crisis increasingly became a political issue. During the Viennese elections, the populist right-wing party fostered resentment against refugee seekers and nurtured insecurity among the public [Sim17]. As the migration crisis continued, public opinion of relief efforts became more negative, even outright hostile. In such a politically tense environment, it is not hard to imagine that public records of participation could lead to negative repercussions against volunteers. Considering this, I favour a decentralised approach to storing the permanent volunteer persona. The personal data of the volunteer can be stored locally on his/her device [AGT19, p. 9], as a form of *self-sovereign identity management* [EMB+18]. In this case, a public permissioned blockchain or trusted third party service can be used to collaboratively maintain a shared

record of volunteer activity among emergency organisations without storing the user's personal information. Wüst and Gervais argue that a blockchain implementation should not be used if an always online, trusted third party service suffices [WG18] – which it does in this use case. However, making do without such an always online services may be beneficial in the crises and disaster context. Dependency on a centralised, off-site service can be detrimental in the face of infrastructure failures and presents a single point of failure. Irrespective of whether or not volunteer activity is stored by a central service or in a permissioned blockchain, only an anonymous identifier would connect personally identifiable data with that person's record of volunteer activity. Effectively, this gives the volunteer increased control over their personal data.

The open and flexible nature of the shared information space created by technologically intermediated coordination hopefully fosters inclusion, as discussed above. However, it also opens the system up to actors with *malicious intent*. In my design, I have not included any mechanisms that could prevent an actor from deliberately spreading false information[3] or wilfully taking other action that disrupts articulation and coordination of actors. I see two ways to address this issue: (1) install a central authority that monitors and moderates content on the shared information space; or (2) use collective moderation to filter harmful information. The first approach does not match the philosophy after which technologically intermediated coordination is conceptualised – centralisation of moderation power would at once implicitly declare an owner of the information space and at the same time is likely to colour articulation work after the notion of said owner. The shared information space would lose the intermediary aspect and become a feature of either the formal or informal response system, depending on the background of the person being installed as moderator. Additionally, this approach potentially imposes extensive resource requirements on the moderating party, depending on the volume of data that is to be moderated. I would favour to investigate collective approaches for curation and filtering. Previous publications have discussed *distributed moderation* for this purpose. In distributed moderation, content is filtered through collective ratings by all or selected users of the community. This is a feasible approach to foster 'reasonable, civil discussion' as well as to build consensus and norms among users regarding what constitutes appropriate moderation [LZL+14, p. 323]. Distributed moderation is a way to cope with information overload by increasing the visibility of relevant information. This includes filtering out disruptive contributions [LZL+14]. Sites operating under distributed moderation can thus become curated news sources [Ova15]. Various models exist for distributed moderation. Moderation can happen through, e.g., collective voting, where all members rate contributions to increase the visibility of what they consider relevant. Alternatively, moderation can be handled by dedicated moderators, who are either granted such status by the rating of their content or are hand-picked from the community[4]. Distributed moderation, too, has drawbacks. First of all, when ranking of

[3] Intentionally spreading false information is not to be confused with rumouring as means of intersubjective sense-making (cf. p.12f.).

[4] Again, this would mean a centralisation of power, in the position of the 'picker' of moderators. However, picking moderators from within the volunteer community appears a reasonable compromise –

content or appointment of moderators is achieved through voting, the system relies on the assumption that there are more volunteers with benevolent intent than malicious users. Second, collective moderation, as a ranking system, may lead to a lack of diversity of opinions. Users tend to interact with other users of similar perspective [BMA15], potentially fostering ideological segregation by forming 'filter bubbles' [PZC14] that skewer the perspective in the respective social network[5]. Third, lack of information diversity can create an 'echo chamber' [PZC14]; where information from within one group creates a positive feedback loop, when it is picked up and re-posted by another group, ultimately flowing back to the original source as news. This then reaffirms the original perception, if there is no central moderation that is aware of such a dynamic and limits re-posting of information. Thus, communities can become self-referential, rather than including information from outside the system boundaries [SFM+14]. However, the effect of such technologically fostered filter bubbles and echo chambers has been disputed [FGR16, BMA15, BTM+16]. Ultimately, a conclusive judgement on whether or not these phenomena occur, as negative side effects of distributed moderation in a temporary, shared information space, will require empirical data.

Another, less malicious form of manipulation may occur in opportunistic affiliation. Acknowledging volunteers for their activity is a reasonable factor in motivation to participate [LBY16]. This may happen through a show of appreciation [KBM08], potentially resulting in social benefits, or even through rewards that hold economical worth (e.g., vouchers or perks). In these cases, actors may try to game the system for such rewards, thus inducing instability through unexpected behaviour. That being said, motivation itself is not part of the system design I have proposed. Thus, I will consider both, volunteer incentives, as well as potential approaches to the prevention of misuse, for future work.

Lastly, the design implications I have discussed also have problematic *legal aspects* to them. The General Data Protection Regulation[6] (GDPR) of the European Union theoretically grants extensive rights of privacy and data protection to citizens of the EU. I expect the GDPR to apply to both the shared information space and computational support for opportunistic affiliation, as I have described them ([AT19, AGT19]). Assuming self-sovereign identity management for opportunistic affiliation, personal data would be stored on the user's own device; as far as this information is concerned, GDPR does not come into effect. The crux lies in the storage of volunteer activity history for each identity. GDPR creates challenges for distributed ledger systems that reference personal data [DP18]. Should volunteer activity history be stored in a permissioned blockchain, as I have suggested previously [AGT19], there are no means to implement Article 17 of the GDPR (the 'right to be forgotten') – because transactions on blockchains are immutable.

albeit one that requires a careful hand in the selection process.

[5]Though it has been noted 'that the power to expose oneself to perspectives from the other side in social media lies first and foremost with individuals' [BMA15, p. 1132].

[6]`https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32016R0679`, visited 2019/08/03.

Without going into a full legal evaluation of my designs regarding GDPR, several steps can be determined as required to achieve GDPR compliance in any case. Both the social media bot interface of the shared information space and the distributed ledger system for opportunistic affiliation will need to clearly communicate to the user which data is gathered and how it will be processed. Consent of the user must also be obtained in either concept. For the digital volunteer persona, this can be arranged during the initial creation of the digital identity. For the bot interface of the shared information space, the first message of the bot can be a request for the user's consent. It will be necessary to abstain from including participants' IP address, identifier, (user)name or other personal data in any system logs. The shared information space needs to support users' requests to extract all personal data belonging to the respective user and provide them in an adequate digital format. Likewise, users need to be able to inspect their own volunteer history in any computational system that supports opportunistic affiliation. All interfaces to the shared information space shall provide a function to delete a user's personal data – including not only the user's personal profile, but also posts and comments they have created[7]. This may compromise the sense-making of other users. To accommodate this in computational support for opportunistic affiliation will require either using a completely local volunteer history that is under the user's total control (introducing problems with verification) or using a central, always online registry service that supports erasure of entries. In conclusion, a cursory review of GDPR suggests that compliance can be achieved in the designs I have proposed. However, whether the measures discussed above are not just required, but also sufficient, will need further legal consultation that exceeds the scope of this thesis.

3.3 Caveats and Open Issues

Each of my publications individually discusses the caveats of the respective research results. However, I also have some reservations about my thesis as a whole, such as it was presented in this document. The theoretical foundation to my research was primarily derived from literature of *different cultural background* – namely, the U.S. American region. This is owed to the circumstance that research originating in the U.S. has been the foundation and predominant influence in disaster sociology since the formative first publication of Prince [Mül97, p. 26]. However, particularly the disaster sociology research conducted in the U.S. has been criticised [Jac11, p. 46f.]: for claiming general validity of conceptualisations from individual studies; for being under pressure to produce practical results quickly; and for being too focused on the community level, among other things. I will not presume to criticise the research outcomes of disaster sociology; my reservations do not concern its validity. Rather, my reservations are that I have only recently reflected on how my research has, from the beginning, been influenced by literature emanating from a different cultural context. This suggests an inadvertent, potentially precarious abstraction of my assumptions from social and cultural factors. That my conclusions are

[7] It may be sufficient to anonymise the author of postings if s/he has deleted her/his personal data; pending further legal examination.

largely based on such abstracted assumptions does not make my results inevitably wrong. I take solace in the fact that my conclusions are based on empirical data that originates from the same cultural context that my thesis is intended for; and that I have taken care to keep my conceptualisations of socio-technical dynamics grounded in that data.

Another caveat lies in that I was unable to attempt *empirical falsification* of the postulated socio-technical dynamics within the scope of this thesis. The first phase of my thesis was characterised by a complete, practically oriented development cycle of design, implementation and evaluation (i.e., the development of CrowdTasker). The nature of the resulting publications was descriptive. The second phase was overall more theoretical in its attempt to reconcile my understanding of volunteer management with new observations of emergence. It was primarily concerned with gathering first-hand reports, performing content analysis and addressing questions of taxonomy. The resulting hypotheses about socio-technical dynamics and the design implications that I draw from them remain theoretical in the scope of this work. Through the conceptualisation of socio-technical dynamics, the second phase of my thesis attempts to be more explanatory than descriptive; but as such also remains speculative about the viability of the technological designs. Empirical data, such as the field observations conducted for crowdtasking, are still required to corroborate or refute my hypotheses. I have to take on attempts to falsify them; by trying to refute that my designs do indeed lead to an increased efficiency in relief efforts.

Further, even those data that were obtained through direct observation in the field during RE-ACTA may be disputed. Challenges to my methodology may rightfully criticise that data was gathered in the context of an exercise environment – instead of a live deployment. However, it is difficult to obtain empirical, on-site data from live events in the same quality as during an exercise. The sudden onset and potentially hazardous nature are hardly compatible with structured research that has been planned in advance [Kil56, Sta97]. Requirements regarding rigidity and structural integrity of field research become difficult to adhere to in a live crisis or disaster context. Further, even if one managed to timely be in the vicinity of a disaster event and at the same time be able enough to obtain structured empirical data – would there not be some ethical conflict between gathering data and actively supporting relief to limit loss of human life? Exercises appear the best compromise between the field and the controlled laboratory environment. However, whether or not they are truly comparable to a real disaster environment appears questionable. It may not be the case that their 'stimulus was sufficiently distinct and meaningful' [Kil56, p. 10], as Killian postulates is required of events for a study of disasters.

Lastly, it should be noted that my work does primarily focus on the immediate response phase of crisis and disaster events. This stands to reason, insofar as that the response phase is when emergence of informal efforts is expected to happen. However, emergent efforts could also be addressed pre-emptively in the mitigation and preparation phase and may further require support in the recovery phase. The preparation phase may, e.g., be used by established organisations, to train such command structures or trusted

volunteer networks that can deal with the irregular influx of spontaneous volunteers or guidance for emergent groups. In the mitigation phase, we may further investigate ICT to inform citizens and volunteers about hazards or meaningful ways of participation, e.g., via micro-learning through the crowdtasking approach. Lastly, it appears promising and important to investigate ways in which ICT may support the care for informal volunteers in the recovery phase. Informal volunteers, in particular, are vulnerable with regards to their mental and physical health. They are unlikely to have the training, equipment or organisational support structures to cope with the stress of crisis and disaster situations. Ensuring the mental health of volunteers, through follow-ups in the recovery phase, is a key challenge in collaboration [Cla16]. ICT may offer support here by helping professional responders stay, or get, in touch with informal volunteers after the immediate response phase – the permanent, digital volunteer persona suggested in this work may be a good starting point for technological support.

3.4 Future Work

I have already discussed lack of *critical examination* of my postulations through empirical data. Correcting this shortcoming is also what I consider to be the highest priority for my future work. The first step in empirically researching computational support according to the postulated socio-technical dynamics must be an assessment of basic viability. I have taken care to ensure a grounding of my hypotheses in qualitative data during the analysis process (cf. [AT19, AGT19]). I continue to verify this grounding by conducting interviews with participants that are involved in community interaction and engagement in CDM; to test for deviations between my postulations and their experience. Cursory evaluation confirms continued grounding of postulated socio-technical dynamics, but detailed analysis results are pending.

At some point, the designs based on my theoretical framing will need to stand empirical examination in the field – to either corroborate or refute them, and to drive conceptualisation further through new insights. Empirical examination will require implementation of a testable system. Based on the design introduced in Section 2.4 (p. 41), I have implemented a prototype system that provides a subset of the proposed functionality. The prototype covers maintenance of perceived needs and comments on perceived needs ('Data Items', Figure 2.6) via a bot that is integrated in the group context. The prototype currently supports the Telegram messenger service; I intend to extend this support to Facebook Messenger and Whatsapp in future iterations ('Chatbot', Figure 2.6). Perceived needs captured through the bot are stored in a database that is also accessible to established organisations. Interfaces for established organisations are provided through a web platform for direct access, as well as an API and message bus for interoperability with legacy systems ('Custom API', Figure 2.6). These features currently constitute the shared information space and form a bridge between formal and informal response system. Technological feasibility of this approach has been demonstrated in a laboratory environment. The prototype system has also undergone a precursory field test under exercise conditions. This test further confirmed technological viability; however, it also

indicated that information overload on the side of emergent groups will be a primary usability issue.

In September 2019, the prototype system of the shared information space was deployed as one component in a three-day field test. This test was part of a European research project and included several technological solutions. My prototype system was used by active crisis managers of the Austrian Red Cross as well as teachers and pupils from a local school, who were taking the role of volunteers. The deployment of the system in a live exercise environment lasted two hours and included multiple interdependent objectives to be fulfilled under temporal and spatial distribution of participants. I have gathered data both through observation and *post hoc* group discussions with participants. The environment of a large-scale field exercise is arguably as close to a real crisis situation as one can get within the boundaries of financial and practical feasibility. Detailed analysis of the data that was gathered during this event is ongoing. However, a precursory sighting of observation material suggests that, despite my best efforts to introduce interdependencies and distributed working environments, my hypothesis that technologically intermediated coordination can improve efficiency could not be refuted. On the contrary, using nothing but the shared information space prototype, objectives of the field test were completed 30 minutes short of the expected timeline. This suggests that my approach is indeed viable; pending detailed analysis of the data.

Apart from an exploratory study of viability, there are some specific *aspects of articulation work* that I want to target in further research. Færgemann, Schilder-Knudsen and Carstensen have previously postulated a duality in articulation work, when actors conduct local articulation work, within the boundaries of one organisational unit which they know well, but must also participate in articulation work that spans multiple organisational units, creating a global context of which they have a lesser grasp [FSKC06]. Abraham and Reddy have dubbed conflicts that result from this duality as 'cross-boundary breakdowns' [AR13, p. 68]. Thus, both local and global aspects of articulation work need to be taken into consideration when designing for CSCW in large-scale, heterogeneous settings [FSKC06, AR13]; of which I consider crises and disaster to be exemplary. Yet my work so far has focused more on the global articulation work, and much less on the local, or how the two interfere with each other. I expect that cross-boundary breakdowns will be noticeable for emergent groups in particular: the proposed social media bot interface to the shared information space will mean global articulation work becomes necessary in the same digital space as the local articulation work is conducted in. The 're-coordination activities' [AR13, p. 68] that are necessary to handle cross-boundary breakdowns are likely to require further attention once I obtain field data.

Hughes and Tapia have suggested that established organisations revisit the *notion of trust* when it comes to information offered by volunteers [HT15, p. 392f.]. One way to revisit trust is to consider trust as trust in a person or group; as opposed to trusting information as an entity that is independent of its producer. The design implications I derive from both sets of socio-technical dynamics support this. Establishing emergent groups' digital representation on social media as artefactual, tangible entity in a shared information

space hopefully reveals reputable networks and credible sources. I hypothesise that this will facilitate trust in said groups (or networks of groups) instead of trust in isolated information that enters the formal response system through some unknown source [AT19]. Likewise, establishing a permanent digital persona for informal, opportunistic volunteers hopefully allows for trust in the natural person that corresponds to that persona; instead of starting from a 'blank slate' every time the volunteer comes in touch with the formal response system [AGT19]. Assumptions of trust being fostered in the shared information space and through digital personae in opportunistic volunteering will need to be examined in future research; this will likely require longitudinal studies and cannot be achieved over the course of a single exercise.

The use of conversational interfaces and *bots in the context of group or multipart interactions*, such as I have proposed for including emergent groups in a shared information space, is in itself not well researched [SLKH19]. Previous research suggests that bots are viable for task management in the group context [TMHC18], similar to what I have proposed for sharing perceived needs. However, this relatively new form of interaction still requires basic research regarding its viability in various contexts. To my mind, this starts with fundamental questions about the direct interaction with an automated interface in the digital information space of the group (i.e., their messenger group or social media page). Interacting with a bot agent will produce information, in the form of messages or posts, that is visible to all of the group; thus it can potentially contribute to the information overload that is always impending in crisis or disaster situations. Once such fundamental usability aspects are understood, we can start considering technological problems, such as handling multi-threaded conversations, natural language processing or transparent behaviour (cf. [TMHC18]). Apart from such basic reservations about viability and usability, there are latent aspects to the presence of a bot within a group. Seering *et al.* propose that chatbots can play several social roles as group members [SLKH19]. This elicits questions about the extent to which bots should embrace, or even aim for, such social roles in the context of CDM.

In conclusion, there are two general levels of future research as far as emergent groups in CDM are concerned. One level addresses the processes of technologically mediated coordination themselves. That is, whether or not this form of articulation work is viable, if sharing of perceived needs is an adequate coordination mechanism and if there is a detrimental occurrence of cross-boundary breakdowns. The other level concerns the usability of user interfaces for effectuating the coordination processes. This includes how fitting interaction with bots is for the context of CDM, whether a bot can constitute a coordinative protocol for creating digital artefacts (cf. [SS96]) in emergent groups, and how appropriate conversational interfaces are as direct group interfaces in general.

While the focus of my current efforts (and thus, future published research) lies on including emergent groups in CDM, integration of volunteers based on the socio-technical dynamics of opportunistic affiliation appears no less intriguing. My technological conceptualisation of support for this approach is less advanced and there is no prototype to show even technological feasibility. However, I am looking forward to submitting safety and security

research grant proposals to remedy this gap in the future. Research opportunities and necessities in this area are diverse. A digitalisation of the registration process of convergent volunteers on site will be a delicate matter. There is a need to design for reliable data entry and welcome procedures that support the established organisation in charge, while still retaining personal contact between volunteers and their liaison. I expect that finding a balance, between support for a high influx of people, and facilitating personal care and support for volunteers, will be challenging. When a digital volunteer persona is created during the registration process, there will be legal boundaries and risks to privacy and security (cf. Section 3.3, p. 54ff.). These are only the challenges that occur between spontaneous volunteers and one established organisations. There will further be the issue of finding appropriately interoperable procedures between organisations. The approach of using a permissioned distributed ledger as verifiable history of volunteer activity needs to be investigated for technological feasibility. The format and design of volunteer profiles needs to support the potentially diverse demands of many organisations of the formal response system. After that, verification procedures for digital volunteer profiles on site will pose a challenge. Verification of a volunteer's capacity will likely be not only technologically complex, but also require adaptation of existing procedures for welcome and registration. Digitalisation may hold the risk of curtailing the personal aspect of caring and supporting volunteers, when they are being reduced to their digital profile. The confluence of these factors in a stressful environment will make for a challenging socio-technical issue in future research.

3.5 Conclusion

There is a tension between the formal response system and the informal response system that is fundamentally organisational in nature. However, ICT appears to contribute to this tension, in that recent technological developments disparately benefit the informal response system. Both organisational and technological factors create a gap between the formal and informal response system. This gap decreases the efficiency of overall response efforts. The tensions between the formal and informal response system are an inherent part in crisis and disaster response. Emergent response by civil society is 'part and parcel' of disaster assistance [Dyn94b] – an inherent part of crisis response that cannot be suppressed [Qua94]. Effective, if not necessarily efficient, response is not possible without emergent efforts of civil society. Thus, I see two implications for CDM:

1. Between the formal and informal response, neither organisational paradigm is *per se* better suited for disaster response than the other. Disaster response needs both the professional structures of the formal response system and the emergent problem-solving capabilities of the informal response system.

2. The gap between the two necessary response systems is as inherent as they themselves are to disaster response. I suppose that it is neither possible nor expedient to completely close the gap between them.

If closing the gap is not feasible, then the aim must be to reduce it's detrimental effects as much as possible, without forgoing the advantages of either system. This is where I perceive the role of CSCW to be. However, reducing the gap is a challenge that goes beyond technological barriers and requires socio-technical changes (cf. [HS16]). The problem is not solved by providing software tools that collect social media information for established organisations; or by setting up a web platform where volunteers can register for participation. The socio-technical problematique lies in that incorporated ICT systems reflect organisational structure – either because they are designed according to the organisation's requirements, or because the ICT system itself shapes the organisational structure (cf. [SP13]). As such, an attempt at connecting the formal with the informal response via ICT solutions that are based one side's requirements only, is bound to fail; because it requires the opposite side to forgo its organisational culture. Designing a CSCW system that is based on the C2 approach is equal to asking actors of the informal system to join the formal system if they want to participate in coordination. Vice versa, asking actors of the formal response system to incorporate social media 'as is' requires them to adapt their formalised processes in order to align with the informal response's use of such technology. If we follow this argumentation, that coordination between the formal and informal response system should not rely on either party unilaterally bending its organisational culture to align with the other's, then the solution lies in creating such interfaces between them that allow to retain existing organisational structure as far as possible. In my thesis, I have explored technological support for this approach. I have investigated the socio-technical dynamics of the gap between formal and informal response for the case of emergent groups as well as highly spontaneous, individual volunteers. I have derived, from these conceptualisations, design implications that try to create technological interfaces that acknowledge the benefits and peculiarities of either side and attempt to preserve them. All designs discussed in this thesis are part of a larger system of functions that exist in the space of community interaction and engagement in CDM. Crowdtasking, technologically intermediated coordination, and opportunistic affiliation; all are parts of a larger frame. I have tried to grasp this larger context through taxonomical efforts as part of my work. The taxonomy that I outline shows both; where my hypotheses are situated in the larger context of interactions between the formal response system and civil society; as well as what still needs to be addressed in future work.

I consider this thesis to contribute to the field of CSCW (in the context of CDM) by conceptualising three different modes of interaction between the formal response system and informal volunteers; by designing novel technological support for each; and by highlighting the differences between them to illustrate the diverse requirements for coordination in the face of different forms of emergence.

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Appendix: Published Articles

The present, cumulative thesis is intended to be the frame for multiple publications, to which I was the primary contributor. While this thesis itself should provide an extensive discussion of my published and peer-reviewed research, the publications themselves form the core of my application for doctorate. Given their role, these publications shall be listed in full, to facilitate thorough and complete review. Below are listed, in chronological order, all of said publications. Each entry is complemented by a remark on the PhD candidate's contribution to the respective publication. Being first author of all of these papers, I was also responsible for their editing and submission process.

[**AGT15**] Auferbauer, Daniel, Roman Ganhör, and Hilda Tellioğlu. 2015. 'Moving Towards Crowd Tasking for Disaster Mitigation.' in Proceedings of the ISCRAM 2015 Conference, edited by L. Palen, M. Büscher, T. Comes, and A. L. Hughes. Kristiansand, Norway.

Share in the overall drafting work and paper's contribution: 60%.

[**ACT15**] Auferbauer, Daniel, Gerald Czech, and Hilda Tellioğlu. 2015. 'Communication Technologies in Disaster Situations: Heaven or Hell?' Pp. 25–32 in Security Research Conference: 10th Future Security Proceedings, edited by J. Beyerer, A. Meissner, and J. Geisler. Berlin: Fraunhofer Verlag.

Share in the overall drafting work and paper's contribution: 50%.

[**AGTP16**] Auferbauer, Daniel, Roman Ganhör, Hilda Tellioğlu, and Jasmin Pielorz. 2016. 'Crowdtasking: Field Study on a Crowdsourcing Solution for Practitioners in Crisis Management.' in Proceedings of the ISCRAM 2016 Conference, edited by A. H. Tapia, P. Antunes, V. A. Bañuls, K. Moore, and P. de J. Albuquerque. Rio de Janeiro.

Share in the overall drafting work and paper's contribution: 60%.

[**AT17**] Auferbauer, Daniel and Hilda Tellioğlu. 2017. 'Centralized Crowdsourcing in Disaster Management.' Pp. 173–82 in Proceedings of the 8th International Conference on Communities and Technologies - C&T '17. Vol. Part F1285. New York, New York, USA: ACM Press.

Share in the overall drafting work and paper's contribution: 80%.

[**AT19**] Auferbauer, Daniel and Hilda Tellioğlu. 2019. 'Socio-Technical Dynamics: Cooperation of Emergent and Established Organisations in Crises and Disasters.' Pp. 1–13 in Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems - CHI '19. New York, New York, USA: ACM Press.

Share in the overall drafting work and paper's contribution: 80%.

[**AGT19**] Auferbauer, Daniel, Roman Ganhör, and Hilda Tellioğlu. 2019. 'Opportunistic Affiliation in Spontaneous Volunteer Management.' in Proceedings of the 16th ISCRAM Conference, edited by Z. Franco, J. J. González, and J. H. Canós. Valencia, Spain.

Share in the overall drafting work and paper's contribution: 75%.

[**ARCG19**] Auferbauer, Daniel, Christoph Ruggenthaler, Gerald Czech, and Ivan Gojmerac. 2019. 'Taxonomy of Community Interaction in Crises and Disasters.' in Proceedings of the 16th ISCRAM Conference, edited by Z. Franco, J. J. González, and J. H. Canós. Valencia, Spain.

Share in the overall drafting work and paper's contribution: 70%.

Below, you can find appended the papers in their published version, in the same order as listed above.

Moving Towards Crowd Tasking for Disaster Mitigation

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ABSTRACT

Advancements in information and communication technology (ICT) offer new possibilities when dealing with crisis situations. In this paper we present the design for a crowd tasking tool (CTT) that is currently under development. We describe how the tool can assist disaster relief coordinators during a crisis by selectively distributing tasks to a crowd of volunteers. We also compare the CTT with an already existing ICT based solution for supporting volunteerism during crisis. The differences between these two tools are addressed and the implications for volunteerism are discussed. The paper concludes with an outlook on future work emphasizing a form of volunteer involvement that offers potential for gathering information that is more relevant and easier to digest for decision-making than information provided solely by self-organised volunteers through social media.

Keywords

Crowd tasking, volunteers, resilience, crisis informatics, community management.

INTRODUCTION

Recent years have seen the occurrence of several large scale disasters worldwide, such as repeated bushfires in the U.S. during drought season (e.g., California, USA in 2007 and Oklahoma, USA in 2009), the Haiti earthquake of 2010, the earthquake and following tsunami that hit Japan in 2011, hurricane Sandy in 2012, or the floods that affected multiple countries in the south-east of Europe in 2014. The increase of pervasive information and communication technology can offer new possibilities for improving resilience and mitigation of such events. This has been recognised and prompted investigations into how social media is being used (Starbird & Palen, 2013) and how the organisation of community efforts is affected (Soden, 2014). Examples for such activity that have been examined include the usage of micro blogging during wildfires and floods (Vieweg, Hughes, Starbird, & Palen, 2010), the utilization of an open mapping platform during the Haiti Earthquake (Soden, 2014) as well as a wide range of ICT being used during and after the shooting on Virginia Tech campus (Palen, Vieweg, Liu, & Hughes, 2009). The research testifies a willingness among people to provide help and

support. This could prove to be an asset to formal organisations concerned with disaster relief. For example, it is important for decision makers to have access to up-to-date information from a disaster site. Such information can be provided by volunteers that are already on site, yet the amount of information running through social media can be overwhelming (Hiltz & Plotnick, 2013; Hughes, 2014; Verma et al., 2011). Observing the interconnection between disaster relief organisations and volunteers seems a promising area for further investigation.

In this paper we present intermediate results of a project that is currently being conducted in Austria investigating the potential of volunteers supporting formal emergency services by means of information and communication technology. We discuss the preliminary results and compare them with a project that successfully attracts volunteers for disaster relief since its inception in 2007. Both projects attempt to lower the barriers for volunteers by utilising ICT, however, the degree of formalisation differs vastly.

This paper is organised as follows. First, we give a short overview of previous work that is relevant to this field. Second, two approaches to volunteerism during and after crises are presented; one that has been in use for several years and a second that is currently under development. Third, we discuss the differences between these two projects and the implications they have. Finally, we conclude with an outlook on future work.

RELATED WORK

The different forms of ICT usage by the general public during an extreme event have been subject to investigation for some time. Uses vary from purely self-organised grassroots approaches as described in (Palen et al., 2009; Starbird & Palen, 2011, 2013; Vieweg et al., 2010) to mediation between volunteers and official disaster relief efforts (Cobb et al., 2014; Hofmann, Betke, & Sackmann, 2014; Lanfranchi, Wrigley, Ireson, Ciravegna, & Wehn, 2014).

Apart from academic efforts, disaster relief organisations from various countries have also shown interest in accommodating the usage of new media to support and encourage volunteers. Most of them require a pre-registration for volunteers stating their availability for help during future crises. For example, the American Red Cross has launched a mobile application[1] for volunteers to provide helpful information during crises. Another example, *PulsePoint*[2], aims to notify pre-registered users in the area of an incident according to their skills. Other examples are: *Team CP*[3], which tries to educate convergent volunteers in advance, *Team Morava*[4], *Team MV*[5], and *Team Austria*, which is described in detail in the following section.

INVOLVING VOLUNTEERS IN DISASTER MITIGATION

Crowd tasking is defined as a process where certain tasks are matched to specific volunteers, thus, forming a more specialised form of the broad term *crowdsourcing* (Schimak, Havlik, & Pielorz, 2015). The challenge for the emergency service is the deliberate selection of volunteers and the distribution of tasks to these volunteers. We now discuss projects incorporating the concept of "crowd tasking" (Neubauer et al., 2013), allowing emergency services to make meaningful use of volunteers' efforts in a unidirectional manner.

Current Efforts – Team Austria

In August 2007 the Austrian Red Cross, together with a nationwide radio station, started organising a community effort towards disaster mitigation that was named "Team Austria". The aim was to engage the public in supporting emergency response teams and to improve resilience against the consequences of disasters by community building and preparedness. Through nationwide media campaigns approximately 24.500 volunteers were recruited – this number has increased to over 35.000 as of 2013. We analysed the current workflow employed by Team Austria by studying their emergency plans and supporting literature, conducting expert interviews and focus groups.

[1] http://www.redcross.org/mobile-apps/volunteer-app
[2] http://www.pulsepoint.org/
[3] http://www.roteskreuz.at/site/team-civil-protection/home/
[4] http://www.teammorava.cz/en/who-is-team-morava
[5] http://www.team-mv.info/

Team Austria pursues a closely governed approach in that the volunteers have a lot of face to face interaction with the emergency service provider, in that case the Austrian Red Cross. Once a volunteer has signed up via the project's website s/he receives an invitation to introductory courses that are hosted on a regular basis by the Austrian Red Cross. Whenever the Red Cross and public safety authorities decide to involve the volunteers of Team Austria during an emergency, text message notifications are sent to selected volunteers. The selection process is based on various parameters such as age or place of residence. The volunteers respond likewise via short message service. To avoid manual parsing by the emergency service the response is expected to be formatted according to a given template. Subsequently, detailed information about a pre-deployment briefing is sent to the volunteers that have responded. The process of notifying and inviting more Team Austria volunteers will be repeated, sensibly with an expanded target audience, until a sufficient number of attendees have responded. At the pre-deployment briefing volunteers receive further information about the current situation at the disaster site and the tasks they are going to fulfil. Attendees that are not members of Team Austria have the opportunity to sign up on the spot. Those volunteers who are actually taking part in relief effort have to sign a document stating their informed consent to legal implications of their actions. This document exempts Team Austria from punishment or regression whenever volunteers transgress the boundaries of law in the name of disaster relief. After the briefing has finished volunteers are split into groups and move out to execute their assigned tasks. They are supervised and guided throughout by representatives of the Red Cross. Work is done in shifts until the situation is resolved, at which point all participants gather again for a debriefing and are subsequently dismissed. For the duration of relief efforts the Austrian Red Cross organises transport, lodging, and provisioning for all attending volunteers.

Proposed Approach – RE-ACTA

"Resilience Enhancement by Advanced Communication for Team Austria" (RE-ACTA) started in 2013 with the goal of improving resilience in all stages of disaster management, utilising new media and mobile handheld devices. At the core of RE-ACTA lies a workflow to push sets of tasks to the mobile devices of selected, pre-registered volunteers. The workflow may be split into three distinct categories: the mobilisation of potential volunteers, the execution of crowd tasking, and visualisation of the data that has been gathered. In the following section these stages are described in detail.

1) Preparation and mobilisation: RE-ACTA hosts a website allowing volunteers to sign up by providing their names, skills, and place of residence. To take part in disaster relief efforts the volunteers have to download and install a mobile application (app) for their smartphone. The purpose of this app is to push situational and task related information to the volunteers. This information is created and distributed via a crowd tasking tool, operated by a trained member of an emergency relief organisation; we will refer to him/her as the "crowd tasking manager". After the official declaration of a crisis by the local or national government, the crowd tasking manager sets up a pool of volunteers by defining one or more criteria, such as a person's current location or skills. Persons fulfilling the criteria will receive a notification asking for their participation, which they may accept, decline or simply ignore. Ignoring a call for a pre-defined amount of time will be treated as if having actively declined. However, every volunteer who accepts the request becomes a potential recipient for tasks over the course of this crisis.

2) Task distribution and execution: The crowd tasking manager creates tasks consisting of one or more steps, each having a well-defined result. Possible result types for a step are: an image, a video, an audio recording, pre-defined text values (single or multiple choice), or free text. After tasks are defined the crowd tasking manager groups them into lists and pushes the lists to selected volunteers via the app. Recipients may select or deny a number of tasks to complete.

3) Analysis of results: The data that is submitted by volunteers is aggregated (where possible) and displayed on an interactive map. This feature is intended for the commanding members of the emergency response organisation, providing easily accessible intelligence about the current situation. The cycle of defining, completing, and processing tasks as well as the evaluation of their results continues until the crisis is declared resolved.

Designing the workflow for RE-ACTA followed an iterative user centred process, where the term "user" refers to the crowd tasking manager as well as the

volunteers that carry out the tasks. A first step in designing was to gather and analyse the requirements for a crowd tasking system. This requirement gathering included surveying existing best practices as well as conducting interviews and focus groups with experts and users. Based on the results a tentative design was developed in two iterations. As the compiled process model was rather extensive (containing almost six dozen pages of sequence diagrams, among others) and required knowledge about specific internal procedures it was illustrated utilising real-world examples. Furthermore, a devised scenario was provided to outline a frame for common use cases – the importance of scenarios has also been discussed in (Borglund, 2014; Florez, Charles, Lumière, & Lauras, 2014). Within the boundaries of our setting we exemplified each of the many sequence diagrams by "instantiating" it in the context of a situation that could occur during a real case of emergency. This approach was received favourably and provided two benefits. First, we managed to keep the participants engaged throughout the evaluation meetings. Second, it helped to attune all parties in understanding the intended usage of the system. Whenever certain functions were unclear they were explained using examples and real world scenarios.

DISCUSSION

Team Austria and RE-ACTA are two distinct applications for the same use case, complementing each other. The main difference between these two projects is the level of volunteer involvement. While Team Austria provides insurance, personal briefings, supervision and more, none of these services are present in RE-ACTA. Consequently they differ in the types of tasks that are distributed. The tasks within Team Austria often include physical work such as building protective barriers during floods, whereas RE-ACTA focuses on awareness and information distribution. In general, the latter allows faster, easier, and less time consuming participation. Volunteers in RE-ACTA do not need to attend training courses or assignment briefings to perform tasks. Additional information is available directly through RE-ACTA's mobile app, which we consider a main contribution in lowering the entry barrier for volunteers. Participation may start with the next mobilisation call – the frequency of which depends on the situation and varies between minutes and days. Tasks in RE-ACTA are not time consuming and do not require intense physical work, allowing a broader demographic to take part. We expect that Team Austria and RE-ACTA are appealing to different demographics; however, this is a research area for future investigations.

The decision to bundle several tasks into lists before pushing them out to volunteers was made to achieve a more even distribution of tasks among the recipients. It was noted by disaster relief experts that volunteers often tend to accept the first tasks and neglect others. To mitigate this uneven distribution, the mobile app randomises the order of tasks in the list pushed to a user. We also assume that offering users the ability to choose their tasks from a list could be preferable to making them decline or accept single items. In another attempt to achieve evenly distribution in crowd working, RE-ACTA avoids over-satiation of tasks through automated routines that rely on parameters such as an upper limit for accomplished tasks.

In contrast to existing grassroots approaches, RE-ACTA relies on emergency response entities coordinating the crowd tasking through all phases in a crisis. Thus, spontaneous contribution by volunteers is not supported. If there is no task defined by the crowd tasking manager, volunteers are not allowed to submit information on their own initiative. However, volunteers can try to bypass the rigid structure of the system by submitting unrelated information through task submissions. If and in what manner this happens will be subject to investigation at a later point. Not allowing ad-hoc contributions is a downside as it prevents potentially relevant information in reaching the crowd tasking operators. The emergency response entities in charge receive only intelligence they are specifically asking for, leaving out additional information identified by the crowd.

Formal channels of information distribution and communication are often regarded to be slow and inefficient (Lanfranchi et al., 2014). Crowd tasking can potentially improve the speed of information acquisition while maintaining the favourable aspect of filtering and verification by professional and formal emergency response personnel. This helps in preventing negative effects of citizen journalism as described in, e.g., . However, the challenge to identify the important and valuable information remains. Choosing a rigid workflow limits the amount and variety of information while improving its relevance and process-ability by automated systems.

FUTURE WORK

A proof-of-concept prototype for RE-ACTA is currently under development. An evaluation of this prototype is planned as part of a drill exercise in the spring of 2015 where we will observe the deployment of crowd tasking from both perspectives: that of the volunteers in the field as well as the coordinator in the operations centre. In this stage of development we will evaluate user uptake, acceptance of the general concept of crowd tasking as well as usability of the tools. We intend to focus on usability issues of the interface (both mobile app and crowd tasking tool), user behaviour during task execution, the level of user involvement, and entry barriers for volunteers.

Beside organisational aspects, legal concerns are currently being scrutinised. Due to the utilisation of user's location via GPS as an integral part of the software and process design privacy concerns are also examined. There is also the matter of liability and responsibility if a person is harmed during the execution of a task.

Technologically we rely on working communication channels such as cell phone networks. Jennex (Jennex, 2012) points out that the availability of such high-level infrastructure during a state of emergency is not certain. Mitigating power outages and bypassing incapable cell towers will be subject of further investigation.

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COMMUNICATION TECHNOLOGIES IN DISASTER SITUATIONS: HEAVEN OR HELL?

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Abstract

In this paper, we present two initiatives for volunteer management that are currently being conducted in Austria. By comparing them, we see a shift towards the use of Information and Communication Technology (ICT), which brings with it issues concerning the segregation of certain segments of the population. These, we wish to bring to the reader's attention and discuss their implications for the use of ICT in disaster situations.

Keywords: Crisis management; crowd tasking; resilience; communication technology; segregation.

1 INTRODUCTION

Disasters and the efforts to cope with them are not new to humankind. Historical reports of such events date far back, then being attributed to acts of deities and the stars, the later indeed being part of the etymological origin of the word "disaster" [12]. While the concept of catastrophes and their mitigation is certainly not new, we have technology at our disposal now that opens new ways for disaster management. Information and Communication Technology (ICT) is becoming ever more ubiquitous, permeating the lives of our society in Europe. The possibilities provided through this have been recognised and academia has given attention to the topic (compare section 2). Yet while the rise of ICT offers many possibilities, a selection of which will be discussed in this paper, it also brings challenges and possible pitfalls. Technology is changing and advancing at a very fast pace. What about those that are not comfortable with the new developments? Do we, by employing new options for disaster mitigation, foster segregation within our society? How may we prevent this and encourage inclusion, to improve resilience? We seek to explore and discuss these questions based on recent developments and efforts towards community management for raising disaster resilience in Austria.

This paper will proceed as follows: Section 2 introduces literature and prior work that is relevant to the topic of ICT in disaster management. Section 3 presents two approaches to community management in disaster situations that have been developed in Austria. Based on that, Section 4 discusses the differences between these approaches and the implications that this development has for segregation and inclusion in communities. Lastly, we present our conclusions in Section 5.

2 RELATED WORK

A lot of work has been done towards the investigation of ICT usage among the general public in case of extreme events. Palen *et al.* describe the usage of various forms of ICT for information gathering and collective sense-making during and after the Virginia Tech shooting in [11]. Starbird and Palen describe how the microblogging service Twitter was used in the Haiti Earthquake of 2010 to support self-organising of volunteers [15]. They also describe how various ICTs are used for collaborative work of volunteers to help, on their own initiative, remotely with relief efforts [14]. Vieweg *et al.* investigate the information distributed in Twitter during two natural hazard events [16]. Apart from these purely self-organised grassroots approaches, there are also works that report on collaborative efforts between relief organisations and volunteers. Cobb *et al.* describe in [6] how emergency response units use "digital volunteers", i.e. people that want to help from a remote location, to curate social media data in disaster situations. Hofman *et al.* introduced a mobile phone-based application called "Hands2Help" for coordinating volunteers by matching the demand for volunteer work with the nearest, available volunteers [7]. Lanfranchi *et al.* present a collaboration platform called WeSenseIt in [8], where citizens and authorities work together in flood management for the benefit of both parties. The concept of "crowd tasking", which will also play a role in this paper, has been described in [10] by Neubauer *et al*. It also features in [13], wherein Schimak *et al.* investigate the topic of crowd sourcing in crisis management.

3 APPROACHES IN AUSTRIA

Currently there are two approaches in Austria to engage volunteers in disaster relief efforts. In this section we will introduce both of them. This allows us to establish differences between the approaches. Thereupon we will base our discussion concerning ICT in disaster situations in Section 4.

3.1 Team Österreich

Team Österreich (TÖ) is an initiative for volunteer management and volunteer engagement for disaster mitigation currently being carried out in Austria. It was conceived in August 2007 as cooperative effort between the Austrian Red Cross (ARC) and a nationwide radio station. The idea came up after a flood disaster, which struck Austria in 2002. No one was able to cope with the supply of potential, spontaneous volunteers, that showed up in the affected regions [9]. As of 2013, the number of volunteers affiliated with TÖ had grown to 35.000[1]. As volunteer convergence may pose a real problem [7], one aim of TÖ is to manage and coordinate volunteers during disasters in such a way that their presence is indeed of help rather than an impediment.

Team Österreich mainly works with pre-registered volunteers. Initially, potential participants are required to sign up through a website. They are asked to provide contact information and information regarding their abilities and skills. TÖ does not require volunteers to be affiliated with the Red Cross in any way. After having completed the sign up process online, people are invited to attend introduction courses that are hosted on a regular basis by the ARC. In the event of a disaster, should the Red Cross be of the opinion that involving TÖ be advisable, invitations for participation will be sent out to volunteers. These will go out to selected recipients, the criteria being for example age or place of residence, and are delivered through the Short Message Service. The recipients are to respond to these messages with standardised replies, either accepting or declining the invitation. Replies that are not formatted according to

[1] http://oe3.orf.at/teamoesterreich/stories/2605842/ last visited 2015/6/7

the standard template cannot be parsed automatically and have to be sifted through by hand. The process of sending out invitations, with iteratively changing selection criteria, may be repeated until the number of confirmed volunteers is agreeable to the coordinating ARC staff. Once a sufficient number of potential participants have reported, information concerning the time and place of a pre-deployment briefing is passed along to all that had accepted. At this briefing, attendees are provided with detailed information about the nature of the deployment. Attending persons that are not yet members of Team Österreich have the opportunity to sign up on the spot. Volunteers that do still want to participate sign a waiver stating their informed consent to legal implications of their actions. This is the ARC's method of avoiding punishment or regression caused by legal transgressions of volunteers during the course of their work for TÖ. For the duration of the deployment, volunteers are split into groups. Each group is assigned a supervisor that is affiliated with the Red Cross. Transport to the disaster site is organised by the Red Cross, as are accommodations in case of deployments spanning multiple days. Tasks of TÖ volunteers mostly involve physical labour, such as helping to erect improvised flood barriers or cleaning up debris. Afterwards, the ARC arranges for the volunteers to be transported back and holds a de-briefing event.

With this approach, Team Österreich offers a closely governed and supervised form of crowd sourcing. Transport and accommodations for volunteers are organised by the ARC and supervision is provided throughout the operation. For participants, this offers a lot of "face time" with the relief organisation. This concept has been tried and tested: TÖ has been involved in the relief efforts during the 2013 floods, fielding 3.250 volunteers[2]. The concept has also been successfully implemented into other societies, for example in the Czech Republic as Team Morawa[3] and in Germany in Mecklenburg-Vorpommern[4] and Bayern[5].

3.2 RE-ACTA

"Resilience Enhancement by Advanced Communication for Team Austria" (RE-ACTA) is a current research project in Austria. As the name implies, RE-ACTA has been founded on the experiences gathered through the management of Team Österreich ("Team Austria"). The aim of the project is to improve resilience by utilising new media technologies, especially through mobile handheld devices (i.e. smartphones). RE-ACTA is a collaborative research and development effort between the Austrian Red Cross, the Austrian Institute of Technology GmbH (AIT), Frequentis AG, the Vienna University of Technology (TUW) and Inset Advisory. The core concept of RE-ACTA is to offer a workflow for the selective distribution of certain tasks and information to specific groups of volunteers. This concept we are referring to as "crowd-tasking" [10].

On the technological side, RE-ACTA is composed of three distinct parts: a tool for creating and distributing tasks for the crowd (Crowd-Tasking Management, CTA) as well as an interface for visualising data gathered from volunteers through these tasks (Task Feedback Evaluation, EVA). The third component is a mobile phone application, which enables volunteers to receive and execute tasks (APP). Through these tools, personnel responsible for managing crowd tasking (whom we will henceforth refer to as coordinators) may use RE-ACTA to selectively relay tasks and information to volunteers. Thereby, it is possible to use participants as human sensors or provide them with instructions for action.

[2] http://oe3.orf.at/teamoesterreich/stories/2591639/ last visited 2015/6/12

[3] http://www.teammorava.cz/ last visited 2015/6/7

[4] http://www.team-mv.info/ last visited 2015/6/7

[5] http://www.br.de/radio/bayern3/inhalt/team-bayern/team-bayern-100.html last visited 2015/6/7

The workflow of RE-ACTA's crowd-tasking approach may be roughly separated into three phases: 1) Preparation and mobilisation, 2) task distribution and execution, and 3) analysis of results. As with Team Österreich, RE-ACTA works with pre-registered volunteers. Potential participants first need to sign up via a webpage, though the amount of personal data required to be submitted during this process is lessened. Volunteers then receive their login credentials, which they can use to log into the RE-ACTA smartphone app. In the case of an emergency where the Red Cross decides that it requires the help of RE-ACTA volunteers, invitations for participation are sent out through CTA and displayed to the recipients via APP. Criteria by which the target audience for these invitations may be selected include: current position of the volunteer, place of residence or a number of skills and certifications like, e.g., driver's license or spoken languages. Users may react to the request by confirming, declining or accepting conditionally if they are available only for a certain timespan or at a certain location. Volunteers that have accepted are eligible to receive tasks for the remainder of the operation. This concludes the preparation and mobilisation phase.

During phase two, the task distribution and execution, coordinators may define tasks and select their recipients through CTA. As during the activation, it is possible to restrict the target audience of tasks by, e.g., their current position or a set of skills. Tasks are structured in such a way that they consist of an arbitrary amount of steps, where their exact number is at the coordinator's discretion. Each of these steps is of a certain type, defined through its end result (e.g., an image or selection of pre-defined answers). The coordinator defines tasks by selecting templates for these short steps, adapting them to his/her need and defining their order in relation to each other. Having done so, s/he may select a target audience (a crowd). The selected volunteers receive this task in their smartphone APP. They can decide to accept or decline each task individually after reading a short summary about it. Accepted tasks are completed sequentially, one step at a time.

During the last phase, the information that was gathered from the volunteers through tasks may be analysed and assessed. To this end, EVA displays an interactive map of the operation area. Data from the volunteers is displayed on this map at the position that it was transmitted from. Aggregation options for data are available where applicable – e.g. if the coordinator asked during one step for volunteers to check which infrastructure still worked in their household (electricity, water or gas) the answers of all volunteers will be aggregated rather than displayed individually to preserve clearness of the visualisation. These phases are of course not discrete and may run in parallel. The outlining of phases as used above is meant to depict one "lifecycle" of the RE-ACTA workflow to better illustrate the core concept for you, the reader. In a real world scenario, they are expected to be continuous processes, repeated until the situation is considered resolved.

The workflow described above constitutes the core, the main idea, of RE-ACTA. However, that is not the full extent of the proposed system. An extensive process model for RE-ACTA was designed in a collaborative effort of the involved partners, founded on best practices and lessons learned from Team Österreich. The design was an iterative and user-centred process. The Austrian Red Cross provided guidance and feedback in each iteration of the development, acting as the essential user and ensuring the practicability of the result. In the end, the process model consisted, among other things, of almost six dozen pages of sequence diagrams and is too extensive to be described here in detail. The main workflow as illustrated in this section was then implemented to demonstrate the viability of our approach, both technological and concerning the general principle of operation. The demonstrator was put to the test during a field exercise in February 2015. It passed muster in all aspects, receiving favourable feedback, especially from operators using CTA and EVA, as well as good acceptance from volunteers executing tasks through APP.

4 IMPLICATIONS

4.1 Differences: RE-ACTA and Team Österreich

The Team Österreich approach was invented to coordinate spontaneous volunteers flowing into the damaged areas after floods. It is a real-life organization with virtual coordination mechanisms. Team Österreich volunteers are doing physical work like shoveling, cleaning or filling sandbags, while being supported by ICT for coordination purposes. The REACTA process tries to use the organizational concept of Team Österreich to manage online and online-supported offline-volunteering as crowd tasking.

RE-ACTA is built upon the experience that the Red Cross has gathered with Team Österreich. This is evident in some aspects, most notable in how volunteers are mobilised: in Team Österreich, there is a two-step process of first sending short messages to potential participants and see who reacts, then tweak the candidate pool as required. In RE-ACTA, the principle remains the same, the only difference being the coordinator has more options available (such as real time positions of volunteers) and that volunteers are notified through APP. This procedure is a best practice that has proven itself for gauging how many people are at command's disposal for crowd tasking. Yet from there onwards, TÖ and RE-ACTA follow different paths.

Probably the most obvious difference between the two approaches is the expected level of volunteer involvement. This is closely coupled with RE-ACTA's goal to provide lower entry barriers. RE-ACTA works fast and provides easy access. Potential volunteers may sign up at any time through the web. As soon as that is done, they are eligible to receive mobilisation requests. There is no need to attend introduction courses or briefings. Tasks are supposedly shorter in RE-ACTA (compared to TÖ), as they are targeted at crowds local to the area of operation, meaning little to no travel time is required. In short, RE-ACTA offers low entry barriers by providing fast and easy access to volunteer work through ICT.

By taking into account only data that was explicitly requested through tasks, the quantity of information is lessened compared to crowd sourcing approaches that facilitate spontaneous volunteer contributions. However, we claim that its relevance and usability for automated processing is increased. During our evaluation of the demonstrator, coordinators (each of them experienced in disaster management scenarios) working with the system to gather data from the field were very positive towards to the possibilities it offered them. Especially the visualisation of content was received favourable. This would not be possible without defining a data structure that volunteers need to adhere to and at the same time limiting the amount of data by only consulting that which was specifically asked for.

So with RE-ACTA, we have seen a shift towards an ICT-centred form of volunteer management. It serves different needs than Team Österreich, being complementary rather than a rival or successor, and points out a new way to approach crowd tasking for disaster mitigation. Evaluation under exercise conditions in the field has shown the RE-ACTA approach to be valid and having good acceptance from users. However, this shift towards an ICT-focused process has implications we want to address.

4.2 Raising Resilience

Resilience is the ability of individuals, communities, organisations, or countries exposed to disasters, crises, and underlying vulnerabilities to: anticipate, reduce the impact of, cope with, and recover from the effects of adversity without compromising their long term prospects [17]. Resilience is a social function, which is more than just relying on good infrastructure. Raising resilience can be achieved by various measures, such as healthy living, disaster risk reduction, preparedness or first aid

trainings. Following the social theories of Pierre Bourdieu [5], resilience can be explained with personal and social skills, arising from wealth, education, and social recognition. They can be shared and used as (social-) network capacity in groups. In order to raise resilience within this project, it is important to provide support for particularly vulnerable target groups, or not to exclude these segments of the population through the choice of technology, language, or user interface.

Segregation as a social phenomenon

Segregation is a sociological process of rising inequality in society. In the narrower sense, it describes the inequality of opportunities and possibilities for different people. Groups of people who are socially excluded often do not only have fewer opportunities, but are particularly vulnerable, especially in the context of disasters and crises [1]. In modern societies the risk for crises and disasters seem to be the same for rich and poor, as Ulrich Beck [3] proclaimed, but the effects differ significantly depending on where in the world and in which milieu of the society a person is living [4]. This means that disasters, which affect a country or society as a whole, normally have more devastating effects in social groups which are more vulnerable. On the one hand, this happens because their resilience is particularly low. On the other hand, the ability to cope with those effects is also significantly lower. Both phenomena tend to raise segregation and the difference in opportunities and possibilities in disaster-prune societies. Sociologists are calling those phenomena perpetuating differences. One of the basic aims for the RE-ACTA tool, consequently, is to prevent any additional exclusion of social milieus by the use of certain technologies.

4.3 Inclusion as aim

As RE-ACTA fosters and relies on ICT to raise disaster resilience, we tried to implement the perspective of vulnerable groups within this technology. The main focus of these measures (survey, focus groups) has been preventing further segregation through this technology. Yet the decision to use mobile platforms for RE-ACTA is already the first exclusion of specific target audiences, namely people without the possibility to use these devices in the first place. Still this system design decision is to be seen against the background of ever-growing, global pervasion of mobile phones[6]. We expect this particular form of segregation to be temporary and have vanished in some year's time.

In the social sciences, there are large numbers of different approaches to the issue of social inclusion [2]. Especially in discourses on the topics of poverty, migration, health, and disability, but also in diversity, there are different conceptual and theoretical models for inclusion. Generally, it is about the ways to prevent social exclusion and to increase the possibilities of social participation. During the RE-ACTA project we tried to understand the concept of social exclusion and segregation, and the underlying phenomena, to include as many social milieus into the process as possible and to prevent building higher barriers towards vulnerable groups. We are in the process of establishing guidelines for user interface design and the language that is being used, in order to include as many social milieus as possible, thus avoiding the target audiences becoming a form of digital elite. For example, we aimed to provide all the tools necessary for executing tasks, bundled with the mobile app. This way, users do not need to know how to, e.g., use the camera app on their phone. Everything should be provided for them from within APP. This also includes interactive maps or even navigation, which we have found to be very important tools during an evaluation in the field. Furthermore, when designing for inclusion in disaster management, one should not stop with the technological aspects of crowd tasking; equally important is the way these tools are being used. Investigation, through focus groups, of potential issues

[6] http://data.worldbank.org/products/wdi, last visited 2015/6/8

regarding inclusion have shown the importance of using precise, understandable language when defining tasks for volunteers. Such a thing cannot be solved through technology, but rather awareness and training of operators.

Because RE-ACTA is still ongoing as of the time of this writing, we cannot yet provide a complete set of guidelines to avoid segregations and foster inclusion – this will be forthcoming in a future work. Furthermore, the concepts conceived from RE-ACTA as well as the insights gained from implementing and evaluating them will support and facilitate further research and development in the European FP7 project DRIVER[7].

5 CONCLUSION

In this paper, we have presented two initiatives for crowd management and community engagement that are currently being conducted in Austria. On the one hand, there is Team Österreich (TÖ), which has been active since 2007 and was born of the need to better manage volunteer convergence. On the other hand, there is RE-ACTA, an on-going research program that tries to use the organisational concept of TÖ and apply it to the use of new media for crowd tasking. This move has shown both the great potential of ICT, but also the importance and relevance of social phenomena like inclusion and segregation when using these technologies.We argue that, when designing for crowd tasking, it is necessary to be aware of the issues surrounding segregation and inclusion. Using ICT may be of great benefit to the population as well as relief organisations. Yet relying exclusively on any one technology, while helping one segment of the population, may be of detriment to those without access to it, who are thus excluded. This is even true in the broader scope of ICT usage in disaster management in general.

As far as disaster management as a whole is concerned, we should consider these issues for the long term, so that we do not create further divide and gaps among the population. We need to consider disaster management as the multidisciplinary, multi-stakeholder topic that it is. It cannot be approached solely by looking at it through one single perspective, from one single field of research. Aspects like inclusion and segregation cannot be solved by technology alone. Thus to finally answer the titular question, we conclude that communication technology in disaster situations can be heaven if used responsively – yet caution should be taken to not narrow our view too much on technological aspects.

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Crowdtasking: Field Study on a Crowdsourcing Solution for Practitioners in Crisis Management

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ABSTRACT

In this paper we elaborate on the concept of *crowdtasking* as a form of *crowdsourcing*. The paper describes the setup and boundaries of a first controlled live field test of a prototypical implementation of a possible crowdtasking workflow. The implemented workflow allows crisis managers rapid intelligence gathering due to direct and tailored task distribution. Practitioners of Crisis and Disaster Management and volunteer managers who were present during the field test made favourable comments on the approach and its implementation. The analysis of the records and the conducted interviews give new insights and ideas for further development.

Keywords

Crowdtasking, volunteers, community management, field study, crisis informatics.

INTRODUCTION AND PREVIOUS WORK

When disastrous events occur, we often hear of innumerable people who are willing to help, though they are not formally involved in disaster relief organisations. The coordination of these volunteers can vary between two extremes: on one side volunteers organise themselves in a grassroots approach while on the other side a formal organisation leads them tightly.

Both approaches have their assets and drawbacks: The grassroots approach allows volunteers to establish a decentralised organisation structure that is able to adapt to unforeseen incidents. At the same time a decentralised organisational structure can be ineffective as its separate units (volunteers) are not necessarily coordinated. Consequently, it is likely that tasks are carried out repeatedly and redundantly by different units while other, maybe crucial tasks, are left untreated. The presence of social media platforms offers a way to improve the organisation of help, the resilience and mitigation of disaster events (Palen, Vieweg, Liu and Hughes, 2009; Soden, 2014; Starbird and Palen, 2013; Vieweg, Hughes, Starbird and Palen, 2010). Professional organisations for disaster relief, on the other hand, have a high degree of formalised procedures. Under normal circumstances, this allows for efficient and effective help. However, the workforce of such entities is often limited, which in turn restricts the assistance they can provide.

Thus, official disaster relief organisations try to incorporate volunteers in various ways. A loose form of informal incorporation is established by monitoring and analysing social media streams (Hiltz and Plotnick, 2013; Hughes, 2014; Verma et al., 2011). There are also approaches that aim to mediate between formal relief organisations and volunteers to integrate them in relief efforts (Cobb et al., 2014; Hofmann, Betke and Sackmann, 2014; Lanfranchi, Wrigley, Ireson, Ciravegna and Wehn, 2014). A tighter form of incorporating

volunteers is practiced by the Austrian Red Cross (ARC) through their disaster management initiative "Team Österreich" ("Team Austria", TÖ). TÖ allows volunteers to help under the guidance and coordination of ARC. Volunteers sign up and are utilised according to their qualifications and their distance to the crisis area (Grunnan and Maal, 2014).

In this paper we discuss the crowdtasking approach that incorporates volunteers into the work of professional disaster relief organisations in a way that is a) more formal and more structured than the grassroots approach and b) less formal and less structured than the TÖ approach. The aim of this idea is twofold. First to increase the numbers of volunteers by lowering the barriers to contribute and, secondly, to increase the effectiveness and efficiency of the volunteers work by loosely coordinating their work by a professionally trained employee of a disaster relief organisation.

This paper is organised as follows. We start with a brief overview of previous work that is relevant to this field. This is followed with a presentation of our approach and how we implemented it. Then we discuss the evaluation setup and outcome. Finally, we give a critical review of our work and conclude with an outlook on future work.

CROWDTASKING

Crowdtasking is defined in (Schimak, Havlik and Pielorz, 2015) as a request for concrete and well-defined actions within a limited temporal and spatial scope, resulting in the performance of micro-tasks with no further obligations. This is not limited to online activities and puts an emphasis on the aspects of space and time of a task. In terms of crisis and disaster management, crowdtasking means: Tasks are selected and provided by a professional organisation allowing volunteers with specific skills or physical location to contribute to a disaster or crisis relief operation. We classify crowdtasking as a form of crowdsourcing. To give the reader a way of categorising crowdtasking, we use Liu's crowdsourcing framework (Liu, 2014):

Why – Identify information problem to determine crowd task	To provide instructions for preparation before a disaster as well as coordinate volunteer efforts and receive information from the site during a disaster.
Who – Types of crowds to target for the task	Individual, pre-registered volunteers without discrimination and including as many social milieus as possible (Auferbauer, Czech and Tellioğlu, 2015).
What – Interaction flows for engaging crowds	The term "crowd-seeding" used in (Liu, 2014) fits the crowdtasking interaction: an active, one-way request, strategically targeting members of a crowd.
When – Temporal aspects in relation to the disaster management lifecycle	Primarily intended for mitigation / prevention, preparedness, response and recovery.
Where – Spatial aspects of the crisis, crowds, and crowd tasks	Applicable for mitigation, prevention and preparedness at potential disaster sites. Not intended for use inside hazard areas during response.
How – Social, Technological, Organizational, & Policy (STOP) interfaces	Technological. CrowdTasker, an implementation of the crowdtasking approach, provides a web interface for professional responders and a smartphone application for volunteers.

Table 1: An attempt at classifying crowdtasking with the help of Liu's crowdsourcing framework

As we only have a limited amount of content volume available, we refer the reader to (Flachberger, Neubauer, Ruggenthaler and Czech, 2015; Havlik et al., 2013; Neubauer et al., 2013) for a more in-depth description of crowdtasking. Implications are discussed in (Auferbauer, Czech and Tellioğlu, 2015; Auferbauer, Ganhör and Tellioğlu, 2015).

In 2013 a joint research effort started with the aim to implement a prototypical crowdtasking workflow. The project "Resilience Enhancement by Advanced Communication for Team Austria" (RE:ACTA) utilises new media and mobile handheld devices to support professional decision making and on-site resilience. The design of the workflow, interaction mechanisms and interface design was based on an iterative user centred process that included crowdtasking managers and volunteers. It culminated in a demonstrator implementation of the crowdtasking workflow called "CrowdTasker". This prototype realised the core functionality of crowdtasking: defining tasks, distributing them to selected volunteers (based on their skill and/or location) and visualising the results for crisis managers.

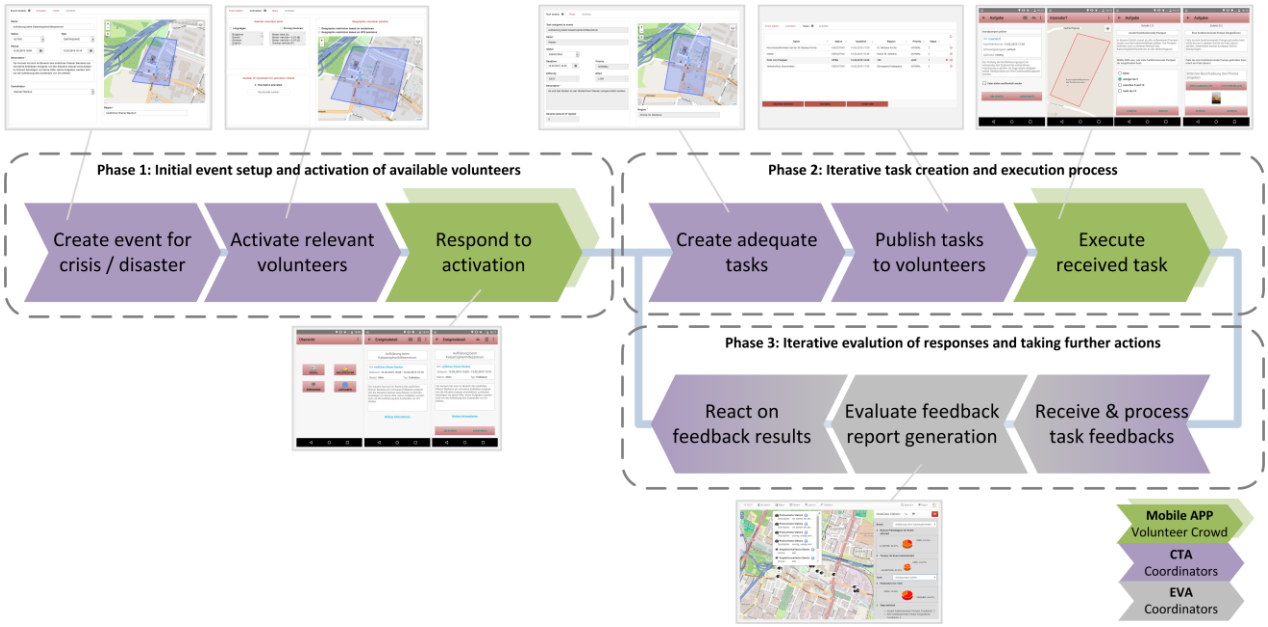

Figure 1. Crowdtasking Workflow for Crisis and Disaster Management

The workflow supported by the prototype is depicted in Figure 1 and can be summarised as follows:

1. An event is compiled; a volunteer crowd is selected based on skills, current location or home address.
2. Requests for participation are sent out to the selected volunteers.
3. Volunteers accept or decline the participation request, resulting in a list of active volunteers.
4. Active volunteers receive, choose and execute tasks as they are published by volunteer coordinators.
5. Task results (photos, text, selection of predefined answers, etc.) are visualised for crisis managers.
6. Repeat steps 4 and 5 until incident is resolved.

A detailed technical description of the prototype would exceed the volume limitations of this paper, but will be forthcoming in future publications. We refer you to (Auferbauer, Czech and Tellioğlu, 2015; Flachberger, Neubauer, Ruggenthaler and Czech, 2015) for slightly more detailed accounts of that system.

FIELD STUDY

To evaluate the crowdtasking approach and the implementation "CrowdTasker", a field test was arranged during project RE:ACTA. This field study was a coordinated effort between the Austrian Red Cross, the Austrian Institute of Technology, Frequentis AG and the Vienna University of Technology. The goal was to assess the acceptance on both sides: that of volunteers and that of volunteer managers (referred to as "coordinators"). Methods used during the field study were observation and recording on the one hand and semi-structured interviews on the other.

The Austrian Red Cross provided the facilities for the exercise. Their disaster relief centre at the outskirts of Vienna is used during actual crisis and disaster management situations. Similarly, it served as a command and control centre for volunteer management during the field study while volunteers executed predefined tasks in the vicinity of the premises. We consider participants to have been "in the field" as they were not in a controlled environment during the exercise.

Altogether 12 participants were involved in the field study. Nine of them had the role of volunteers and three acted as coordinators. All participants were in some way affiliated with the Austrian Red Cross. All coordinators had been trained previously in volunteer management by TÖ. The volunteers consisted of two adults with prior experience as volunteers in TÖ, two young adults (age 18-20) in the service of ARC, one volunteer paramedic (age 24) and three members of the ARC youth group (age 16-18).

All tasks executed during the field test revolved around gathering intelligence in the field with the help of volunteers. Examples include determining the volume and density of traffic at a nearby intersection, verifying

the functionality of several emergency pumps located nearby, reporting fuel prices in the area or checking the weather conditions. These tasks were designed in cooperation with the Red Cross to ensure that they reflect the needs in actual emergency situations. At the beginning of the field test each of the three coordinators was given a total of four tasks in written form. As none of the coordinators had had any prior experience with crowdtasking, instructions and hints were very detailed for the first task. However, the amount of information and help was gradually reduced with each task and the last one was to be carried out without any descriptive help. The coordinators at the command and control centre were observed by one author during their sessions.

Participants acting as volunteers in the field were given no introduction to the tools at all, as would presumably be the case in a real disaster event. We wanted to test how well they would cope with the smartphone app and workflow without preparation. Volunteers were organised in groups of three, each being observed by a member of the Vienna University of Technology. Each volunteer was equipped with a small microphone, which was connected to the smartphone s/he was running the mobile crowdtasking application on. This provided the authors with audio recordings for each participant, allowing an analysis of events even when direct observation was not possible. After a session the volunteers returned to the command and control centre and each group had a discussion with their respective observers. The discussions were held in a semi-structured manner and aimed to investigate how the participants perceived the workflow in general and the usability of the implemented tools in particular.

INSIGHTS

The field test showed the feasibility of crowdtasking (via the prototype implementation) for rapidly gathering relevant intelligence from the field. We also found several opportunities for improvement and challenges that need to be met in future implementations. Here, we want to discuss selected topics relevant for practitioners in information and communication technologies and crises and disaster management.

Providing status updates: During the field test we noticed prominently and repeatedly the participants' need for status information and updates. Volunteers grew impatient shortly after receiving the first notification about an active event while waiting for further notice. They remained stationary for a few minutes, then grew increasingly restless, expecting to be called upon and given further instructions. Predictably, not being informed about the current status of their assignment resulted in frustration for all volunteers. To mitigate this, a status indicator may be implemented in the CrowdTasker app, informing volunteers about their assignment status. Due to this addition volunteers can be informed that a coordinator has received their acknowledgement of participation, but currently does not have any tasks available. Another issue is the lack of a connection status indicator in the app. Several participants suspected a bad network connection to be the reason for not receiving tasks immediately. This resulted in them repeatedly checking settings and connectivity, possibly causing unnecessary battery drain.

Notification overload: A design decision for the mobile app was to keep volunteers informed about all events, even if they are not immediately relevant for them (e.g., they took place in other parts of the country). However, none of the participants reacted favourably to this, questioning why the application was showing items that did not require action on their part. At best the information was just ignored. At worst it resulted in verbalised annoyance and subsequently less enthusiasm for messages that actually did concern the participant.

Guiding volunteers: Relying on volunteers' navigation skills proved to be insufficient. A purely textual description of the target location did not reliably guide volunteers to the desired location. Most of the volunteers encountered uncertainties even when the (textual) task description was factually correct and unambiguous. Three of the participants became lost on their way to the target location at least once. Providing an interactive map with each task that shows the location of the current objective in relation to the user's current position could possibly solve a majority of such problems. Participants also stated that displaying the current distance to the target location is helpful information when first skimming over a task description. Two participants claimed that this (distance to target) would be the most important information for them when deciding whether or not to accept a task.

Splitting tasks: Splitting task execution into smaller, discreet steps worked well. Participants were intent on fulfilling the individual steps one at a time and never gave the impression of being overwhelmed. They were able to easily pick up again on a task step after being distracted – something that happens frequently in the mobile context (Oulasvirta, Tamminen, Roto and Kuorelahti, 2005). None of the participants gave negative remarks regarding the workflow of task execution.

Cooperation, communication and initiative: During the field test we observed that especially young adults sought a more active role for themselves. For example, they voiced their irritation about only being able to provide information that was specifically asked for. Instead, they would like to send information about subjects of their own choosing at any time. They complained about not being able to call for help from the coordinator or from other volunteers. These views were mostly shared by three participants of the youth group. The remaining participants also expressed their wish for a direct channel of communication to the coordinator, but to request clarification on objectives rather than personal support.

CONCLUSION

We deem this first field test of the crowdtasking approach to have yielded promising results. Due to the small sample size, we do not consider this a full validation. However, the results indicate that "traditional" crowdsourcing can be complemented with the novel crowdtasking approach. The prototype was able to rapidly provide relevant information at the request of coordinators. Even though none of the participants have had any prior contact with the idea or its implementation they were able to quickly gather intelligence from the field in a joint effort.

Acceptance of the crowdtasking approach was high among coordinators using the system and crisis managers of the Red Cross observing the exercise. The workflow of task definition, distribution and result visualisation was received well. Acceptance among volunteers was also good, especially among those that had previous experience in volunteer work with TÖ. These volunteers opined that crowdtasking was a preferable way of receiving instructions and tasks. However, additional efforts will have to be made to engage younger audiences. The authors have noticed their wish to communicate with others through the app as well as to report about subjects they find useful or important.

Accommodating and fostering volunteers' urge to form networks and report information on their own initiative will be a challenge for future development. The challenge can be approached in different ways:

1. Ignoring the volunteer's needs. This could easily drive volunteers away towards platforms that better fulfil their needs, e.g., social media like Twitter or Facebook, where information is less accessible and harder to filter out and process for first responders.
2. Providing the demanded communication channels. Even though it would not be a problem from a technological point of view, this would cause issues with the intended crowdtasking idea. Unsolicited information from volunteers can reduce the quality and relevance of data received, possibly negating one of the distinguishing points and advantages of the crowdtasking concept. Volunteers requesting help from headquarters via direct communication further puts a serious strain on personnel requirements.
3. Use third party tools to provide the communication channels and volunteers to cope with the additional influx of information. Crowdsourcing solutions like GDACSmobile (Link, Hellingrath and Groeve, 2013) or Ushahidi (https://www.ushahidi.com/) could be used to complement crowdtasking. Volunteers can review the so obtained flood of information and pick out important bits. Likewise, volunteers at command and control could be used to take care of direct communication requests from volunteers in the field.

The following best practices for crowdtasking will likely be relevant for other crowdsourcing and micro-tasking approaches: First, split tasks into discreet steps on mobile applications. Second, provide volunteers with visible status indicators about their assignment and connection status. Third, reduce notifications to items that actually require the user's attention, skip informative messages. Fourth, provide guidance for reaching the target destination from within the mobile application.

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Centralized Crowdsourcing in Disaster Management: Findings and Implications*

Full paper

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ABSTRACT

Computer supported cooperative work (CSCW) has become an important aspect in crisis and disaster management. Volunteers undertaking relief efforts in affected areas are increasingly using information and communication technologies to coordinate their work. Relief organizations are recognizing this trend and have started to adapt new communication channels to interact with citizens. In this paper, we describe the crowdtasking approach, a centralized form of crowdsourcing for crisis and disaster management. We present a prototype implementation of the approach and report on our findings from the system's first field trial. We conclude by discussing implications of this approach for CSCW and community building in crisis and disaster management. Lastly, we give an outlook on future research based on our experience with crowdtasking.

CCS CONCEPTS

• **Information systems** → Crowdsourcing • **Human-centered computing** → Computer supported cooperative work; Empirical studies in collaborative and social computing

KEYWORDS

Crisis and disaster management; volunteers; crowdsourcing; crowdtasking; computer supported cooperative work

1 INTRODUCTION

The ever-increasing pervasiveness and availability of Information and Communication Technology (ICT) in our society heavily influences the way we communicate. This is also true in the context of Crisis and Disaster Management (CDM). Citizens utilize new technologies in order to share information and organize themselves into grassroots movements for disaster relief. This has led to the emergence of informal, self-organized groups of volunteers during disasters and crises. Formal relief organizations are also beginning to see these new ICTs as a useful channel and look for viable ways to integrate them into their volunteer management efforts. These socio-technical developments of communication technologies become especially important when seen in the light of an on-going shift from traditional forms of long-term commitments to a more short-term and situational community engagement (the so called "project-oriented volunteering").

The increased use of ICTs in CDM enables new approaches and solutions when it comes to cooperation in times of crises and disasters. Accordingly, Computer Supported Cooperative Work (CSCW) has become the subject of research efforts in CDM. CSCW research topics in the CDM context include: reasons and applications for the use of social media in volunteer organization and orchestration, enabling interoperability between organizations in times of need as well as the utilization of volunteer potential through new communication technologies. This subject was not dealt with in the CSCW literature so far, especially not with the focus on topologies and crowdtasking workflow in the preparation, activation and execution phases of crisis management.

In this paper, we evaluate "crowdtasking", a new crowdsourcing approach to manage volunteers and community engagement. Crowdtasking was co-designed by the Austrian Red Cross, Austrian Institute of Technology, TU Wien (Vienna University of Technology), and Frequentis. We explain the notion of crowdtasking for CDM and present a prototype evaluation that was used in field-testing. We discuss the benefits and disadvantages that the prototype has exhibited during evaluation. We try classifying crowdtasking as a crowdsourcing solution and compare it to other crowdsourcing approaches. Based on our observations, we take a look at possible drawbacks when using ICT solutions for volunteer management that adhere primarily to command and control principles: a lack of support for lateral communication, and thus community building. Finally, based on our results with crowdtasking, we describe plans for future work on the topics of community building and CSCW between informal groups and formal organizations for disaster relief.

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2 VOLUNTEERS, TECHNOLOGY AND COOPERATIVE WORK

Coping with crises and disasters requires the cooperation of many different actors. One category of such actors is that of volunteers: people who wish to contribute to relief efforts on accord of their own, personal motivations (as opposed to, e.g., employees of formal relief organizations). They may be directly affected by the event that necessitated relief efforts or come from surrounding areas to help their neighbors. Volunteers may organize relief efforts amongst themselves, something that we refer to as "grassroots" movements, or offer their help to formal relief organizations, if present. During the last decade, the rise of (mobile) ICT has changed the way that volunteers collaborate and organize. CSCW is now an inherent part of many grassroots relief efforts. Relief organizations are also increasingly looking to employ new technologies to cooperate with volunteers.

In this section, we give an introduction to volunteering in CDM and how it is influenced by technology. We discuss three aspects that are relevant to the remainder of our paper: 1) the different types of volunteer we distinguish, 2) previously observed adaption of ICT by volunteers for disaster response, and 3) previous research into the collaboration with or among volunteers through ICT. This provides a setting and context for the reader, in order to better classify the subject matter of our paper later on.

2.1 Differentiating Volunteers in CDM

It would be inaccurate to speak of *the volunteers* in CDM as if they were one, homogeneous group. People of many different backgrounds, skillsets and motivations come together in a disaster situation, accompanied by the emergence and adaption of social networks and organizational structures [7]. Volunteers differ in their motivations, their level of integration into organizations, their capabilities and remoteness to the affected area. For the purpose of this work, we mainly differentiate between degrees of volunteer's integration into existing formal structures.

We consider volunteers to be *formal* (sometimes also referred to as *traditional*) if they are part of a pre-existing, hierarchical organization that is concerned with disaster relief efforts, first response or humanitarian aid. They do service with formal organizations on a regular basis and are familiar with emergency procedures. Common examples of formal volunteers are, e.g., voluntary paramedics or firefighters. Traditionally, formal volunteering has a high significance in many parts of Europe, most notably Central Europe and Scandinavia [24]. On the other hand, there are also volunteers that arrive at affected areas on their own initiative and try to provide support where they feel that it would be most useful. They receive (or take) no orders from formal organizations. We refer to them as *unaffiliated* volunteers. In between exist several shades of grey, the two most relevant being *pre-registered* and *pre-organized* volunteers. Pre-registered volunteers are those that would be willing to sign up on a platform to support relief efforts, but do not seek to become part of an organization, while pre-organized volunteers are already part of an organizational structure, but one that is either not permanent or not primarily concerned with CDM [21]. Fig. 1 visualizes these distinctions.

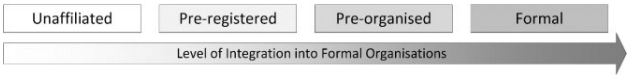

Figure 1: Types of volunteers categorized by affiliation with formal organizations.

Apart from their integration into an existing formal structure, another dimension to differentiate volunteers is their physical presence at the time of need. Where they are during the mitigation, preparation, response and rebuilding efforts dictates which types of task a volunteer can execute. We have found that, for the discussion of crowdsourcing in CDM, distinguishing between the following three location-based categories of volunteers is useful: *On-site volunteers* are located in the crisis or disaster area and are likely themselves affected by the event. Those able and willing to help may conduct search and rescue, evacuation or mitigation. *Off-site volunteers* are able and willing to support relief efforts outside of the immediate disaster area. Such volunteers can help by sorting commodity donations or preparing shelter for those that are being evacuated. *Virtual volunteers* participate in relief efforts solely through ICT. They may gather, aggregate, filter and forward information, translate or help in matching supply and demand. They are not physically present during relief efforts [5,12,30]. Virtual volunteers are one manifestation of the increasing pervasiveness of ICT during crises and disasters.

A third perspective by which to differentiate volunteers is their motivation. The reasons, which members of the public to participate in the relief efforts for, vary. There exist multiple models to explain the motivation of volunteers. One possible approach would be to apply Herzberg's two-factor theory [13], thereby classifying volunteers into those with intrinsic and those with extrinsic motivations. A more detailed classification could be based on Self-Determination Theory [6,9]. Other viable options for classification include, e.g., the Volunteer Function Inventory [4].

For the purpose of this work and the research project it is based on, we differentiate volunteers only by their level of integration into existing organizations and their physical location relative to the site of the disaster or crisis. The third dimension, motivation, was not extensively considered during the research that yielded the subject matter of this paper. We hope to address this aspect more thoroughly in future work.

2.2 Volunteer Convergence

The combination of volunteers being both unaffiliated (acting independently) and on-site has implications for CDM. The phenomenon of convergence, whereby a large number of unaffiliated volunteers are drawn to the immediate disaster area, can cause complications in relief efforts. The fact that people gather to provide aid and relief to disaster victims is neither new in itself nor a blank page to research [25] and the behavior has been subject to research since at least the middle of the 20th century. Since that time, however, the effects have been amplified by new media technologies – causing an increase of the speed at which information travels and, consequentially, convergence happens.

The sheer number of people converging on a disaster site can impede relief efforts of formal organizations. "Mass assault" is one term that has been used to describe the initial collective response to an emergency situation [7]. This quickly becomes a challenge, as local responders are overwhelmed, making collaboration with unaffiliated volunteers, an important topic to mitigate potential problems caused by convergence. The challenge is twofold: to make use of the potential that (a possibly large number of) volunteers provide and to avoid local authorities being overwhelmed by the influx of new volunteers on site.

2.3 Volunteers Using Existing Technologies

It has been observed and studied that citizens take to existing online communications channels such as social networks (like Facebook), micro blogging platforms (like Twitter) or collaborative online tools (like Google Documents) to share information and distribute work in times of need. The implications of ICT for crisis settings (and vice versa) have been discussed for some years now [22]. In an early work on this topic, Palen et al. investigated the use of multiple online tools for information sharing and collaborative sense making during and after a shooting that occurred in April 2007 at the Virginia Tech campus [23]. They report, "peer production of accurate information" and "self-organization around a well-defined task". Relatedly, Vieweg et al. describe the use of the Micro blogging service Twitter during the Oklahoma Grassfires in April 2009 and the Red River Floods in March and April of the same year [31], investigating it regarding improved situational awareness. Meier describes several case studies of "crisis mapping", whereby volunteers supplement interactive online maps with their own, local knowledge, aiding humanitarian response [20]. Starbird and Palen give another example of volunteers using social media: they describe the formation and ultimately formalization of the purely virtual organization "Humanity Road" by digital volunteers via social media [30]. Also on the topic of self-organization of volunteers, Kaufhold and Reuter describe the use and importance of social media for independent self-organization of volunteers during the floods in Germany in 2013 [14].

As you can see by the (non-exhaustive) list of previous work summarized above, ICTs and their influence on volunteers in crisis and disaster situations have been a topic of research for several years. In these works, investigation has focused on volunteers using existing communication channels and adapting them for their needs in the crisis and disaster context. There have also been proposals and implementations of new approaches that are specifically designed for these needs.

Hofmann et al. have designed and implemented a mobile app-based system, which enables volunteers and response organizations to advertise or request relief capacities [11]. Their system was developed in response to mass convergences of volunteers during flooding in Germany, overwhelming local authorities. They define criteria for IT-based coordination of volunteers on site. Lanfranchi et al. describe their approach towards "citizen observatories" that aim to improve situational awareness of communities and authorities by encouraging citizens to provide information to authorities, who in turn selectively provide information suited for consumption by the public [15]. Link et al. describe a solution for disaster management professionals and affected populations to share situational reports, which are relevant for decision-making on both ends [16]. Current observations are submitted by volunteers through smartphone apps or Twitter, then moderated by trusted users and, if appropriate, shared with all users of the system. In contrast to many other works, which revolve around online smartphone applications and social media, Ludwig et al. recently described an approach using public displays [19]. They place displays showing current needs and required help at locations with high visibility to better inform and direct volunteers on-site. Thus, adverse effects of volunteer convergence may be mitigated. Soden describes an approach to geographic data collection that is not purely technological, but also takes into account growth and sustainability of local communities to increase resilience – adding the important aspect of community building for resilience [29].

3 "RE-ACTA" AND CROWDTASKING

The subject matter of this work is the approach of crowdtasking. This approach was originally designed, implemented and evaluated in the scope of a national research project called "Resilience Enhancement by Advanced Communication for Team Austria" (RE-ACTA, http://blog.roteskreuz.at/reacta/das-projekt/). The project was funded by the Austrian security research program KIRAS of the Federal Ministry for Transport, Innovation and Technology. RE-ACTA started in 2013 and was finished in 2015. Involved in the project were the TU Wien (Vienna University of Technology) (also the first author of this paper was in the team of TU Wien), the Austrian Institute of Technology (AIT), the Austrian Red Cross (ARC), Frequentis AG, and Inset Research and Advisory. The aim of the project was to investigate the use of ICT for volunteer management. ARC at that time already operated a tried and tested volunteer management initiative called "Team Österreich" (Team Austria, TeamA). RE-ACTA would investigate the use of new media technologies to enhance this community engagement effort. The ARC in cooperation with a nationwide radio station in August 2007 has instigated TeamA. Its inception was a response to observing and having to manage the large number of unaffiliated volunteers at disaster sites. It has since grown to over 40.000 members. The experience gathered by community managers in TeamA provided the basis for RE-ACTA and *CrowdTasker* to build upon.

3.1 Approach

The project was initiated by doing an analysis of existing literature, previous work and related solutions. Project partners compiled a list of crowdsourcing solutions that were already in use at the time of writing, analyzing them regarding their features and workflow. Based on this list, partners extracted a set of functional requirements for volunteer management in CDM. This list was iteratively trimmed, refined and categorized into must-have, nice-to-have and out-of-scope features. To achieve this, the TU Wien conducted two focus groups together with the ARC. TU Wien also

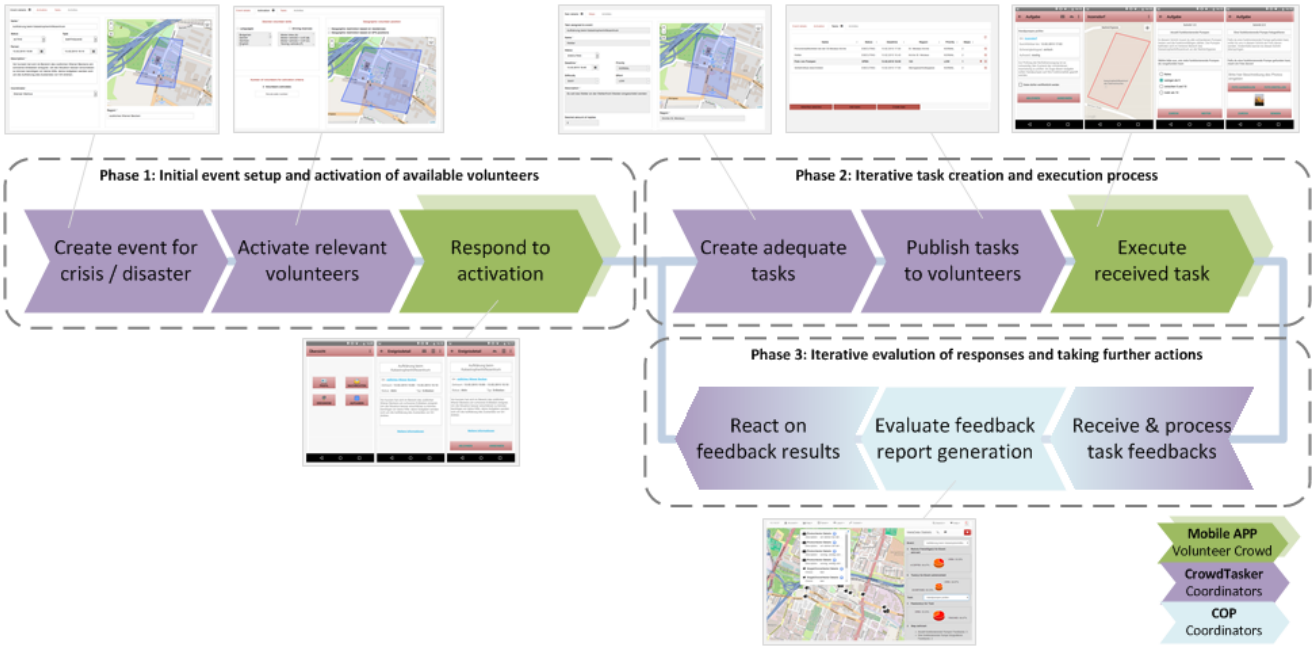

Figure 2: Simplified version of the crowdtasking workflow.

analyzed the workflows of TeamA and formalized them during these focus groups.

The refined list of functional requirements and insights into TeamA served as a basis for the next step of the project: defining a formal process model. This was done by Frequentis AG and yielded an extensive catalogue of UML process models. Due to the substantial nature of the diagrams, we will refrain from discussing them in their entirety. The entire process model was discussed with representatives of the ARC (who had previous experience with community engagement in the context of TeamA) and refined iteratively. The last phase of project RE-ACTA was concerned with implementing and evaluating the process model for crowdtasking.

AIT engineered a prototype called *CrowdTasker*, which incorporated the central workflow and main features (but not the entire process model), consisting of a web interface and smartphone application, while Frequentis AG provided a common operational picture tool to analyze data gathered with *CrowdTasker*.

The web interface of *CrowdTasker* was evaluated as a paper based prototype first. The evaluation of all components of the actual prototype took place in the form of a field test. Evaluation methods and outcomes are discussed in more detail later.

3.2 Crowdtasking

The approach of crowdtasking contains a request for concrete and well-defined actions within a limited temporal and spatial scope, resulting in the performance of micro-tasks with no further obligations – not limited to online activities, thereby putting an emphasis on the aspects of space and time of a task [28]. In the context of CDM, crowdtasking is a workflow between trained crisis/disaster managers and volunteers. More specifically it is aimed at unaffiliated volunteers on-site, off-site or virtual. From this point onwards we refer to trained personnel of a formal relief organization that use crowdtasking to distribute tasks as *coordinators*. Unaffiliated volunteers that receive tasks and execute them will simply be referred to as *volunteers*. The crowdtasking workflow can be summarized in the following steps (Fig. 2):

(1) *Create event for crisis/disaster*: The highest level of information artifact in crowdtasking is an *event*. The event represents any cause for which a coordinator might want the support of volunteers. Examples for such an event include: flooding of an area, impeding draughts or heat waves. Any coordinator might define such an event, providing a name for reference as well as a description and geographic boundaries.

(2) *Activate relevant volunteers*: For an event, the coordinator defines which volunteers s/he wants to ask for participation. To do so, s/he defines several criteria such as the current physical location of the volunteer, his/her home address or the volunteer's skills (e.g., languages spoken, driver's license, medical skills, etc.)

(3) *Respond to activation*: Once the coordinator has defined criteria for an event to his or her satisfaction, a request for participation is sent out to all volunteers that fulfill said criteria. This process is referred to as *activation*. Volunteers may accept or decline the activation. If they decline, they will receive no further messages pertaining to the event. If they accept, they become eligible to receive tasks connected to the event. In this way, a pool of volunteers is defined.

(4) *Create adequate tasks*: The second level of information artifacts in crowdtasking is the *task*. Each task is part of an event and any event can have an arbitrary number of tasks. Any coordinator can define tasks for an event by giving a name for reference and a description of what the task will entail. He or she also must define an arbitrary number of task steps, which is the third and lowest (atomic, if you will) level

of information artifact. Each step consists of an assignment for the volunteer and has a well-defined end result, which dictates the type of response the volunteer can give. Each task may have an arbitrary number of steps and combination of step types. Step types (as defined by the nature of information being submitted) include:

a. Choosing one of several pre-defined answers
b. Choosing multiple of several pre-defined answers
c. Making a photo
d. Responding with a number
e. Responding with free text

(5) *Publish tasks to volunteers*: Once a coordinator has defined a task to his/her satisfaction (by defining assignments in the form of steps), s/he can choose a crowd of volunteers to execute it. Only such volunteers that have accepted the activation are eligible. This pool can further be restricted based on volunteer attributes such as current location, place of residence or skillset.

(6) *Execute received task*: Volunteers receive the task published by the coordinator (previous step) and execute it by following the task steps. Once all task steps are finished, the user input for each step is sent back to the coordinator. We will refer to this data received from volunteers as *feedback*.

(7) *Receive and process task feedback*: Volunteer feedback is received at the crowdtasking backend and saved for later visualization and interpretation. The crowdtasking system may make the data available for trusted sources (e.g., systems of other response organizations).

(8) *Evaluate feedback and generate report*: Crisis managers visualize volunteers' feedback for interpretation. This is done by, e.g., a common operational picture system, where feedback may be handled as one of multiple data sources. Analyzing and aggregating feedback may generate reports. Processing data in this way is made possible and facilitated because it is known in advance which type of data will be returned for each task.

(9) *React to feedback results*: After the feedback of volunteers has been analyzed and assessed by crisis managers, they may decide to take further actions pertaining to volunteers. This may lead to a feedback cycle, where the workflow starts again at step 4, with the creation of additional tasks. Steps 4 through 9 may be repeated until the crisis/disaster event is resolved and the help of volunteers is no longer needed.

3.3 Prototype

The crowdtasking workflow we have described in the previous section has been realized in the form of a prototype implementation. The prototype consists of three components, as shown in Fig. 3:

(1) Web interface where coordinators define events and tasks. (CTA)

(2) Smartphone application for volunteers to accept activations and execute tasks. (APP)

(3) Web interface where crisis managers can view visualizations of volunteers' feedback. (EVA)

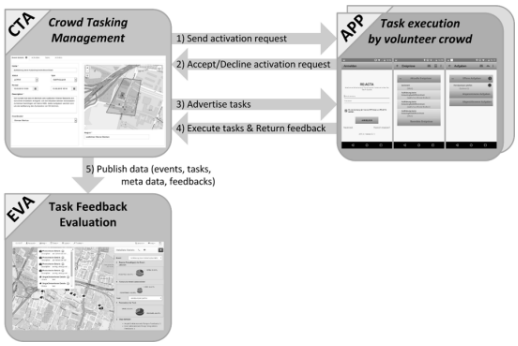

Figure 3: Components of the crowdtasking implementation.

The component CTA and APP were implemented by AIT (*CrowdTasker*[2]). Frequentis AG developed the component EVA, a common operational picture system. This system is used to aggregate and visualize data that was submitted by volunteers in response to tasks. Together these components implement the main workflow of the formal approach of crowdtasking for CDM: defining, distributing, executing and analyzing tasks and their feedback. This system is functional and has had multiple trials in the field under realistic conditions, including qualitative and quantitative evaluations.

As such, the workflows bear obvious similarities. In TeamA, potential volunteers can sign up through a website and then receive an invitation for an introduction course (hosted regularly by the ARC). In case of an emergency, selected volunteers receive text messages from ARC, which they reply to with text messages of their own that have to adhere to a certain formatting template (this is equivalent to the activation in crowdtasking). If they accept, they receive information about the time and place of a briefing event. If they attend the briefing, agree to participate and sign an informed consent sheet, they become part of the relief efforts. Such volunteers are split into groups, which are supervised by trained representatives of ARC. Tasks are relayed through group supervisors and work is done in shifts until the relief efforts have run their course (the equivalent of crowdtasking's task phase). Afterwards, all TeamA volunteers gather again for debriefing. Crowdtasking has obviously inherited its two-step approach (activation vs. tasking) from TeamA. During our interviews and focus groups with community and crisis managers we found this to be a best practice for them. It facilitates better judgment as to how big the initial pool of volunteers would be before sending out invitations and tasks.

We wish to stress that for us, crowdtasking and crowdsourcing are *not* synonymous and that we treat crowdtasking as a specialized form of crowdsourcing. In our most recent paper we have attempted to classify the crowdtasking approach for CDM using Liu's crowdsourcing framework [3]. The result is included in Table 1.

[2] https://crowdtasker.ait.ac.at/

We hope that this will clarify what crowdtasking is supposed to represent with regards to CDM.

Table 1: Categorizing crowdtasking using Liu's framework [18], in [3].

Why – Identify information to the problem to determine crowd task	To provide instructions for preparation before a disaster as well as coordinate volunteer efforts and receive information from the site during a disaster.
Who – Types of crowds to target for the task	Individual, pre-registered volunteers without differentiation and including as many social milieus as possible.
What – Interaction flows for engaging crowds	The term "crowd-seeding" used in [18] fits the crowdtasking interaction: an active, one-way request, strategically targeting members of a crowd.
When – Temporal aspects in relation to the disaster management lifecycle	Primarily intended for mitigation, prevention, preparedness, response and recovery.
Where – Spatial aspects of the crisis, crowds and crowd tasks	Applicable for mitigation, prevention and preparedness at potential disaster sites. Not intended for use inside hazard areas during response.
How – Social, Technological, Organizational & Policy (STOP) interfaces	Technological. *CrowdTasker* provides a web interface for professional responders and a smartphone application for volunteers.

3.4 Relation to Other Crowdsourcing Approaches in CDM

Compared to other crowdsourcing solutions for volunteers, crowdtasking uses a more centralized and one-sided form of interacting with the crowd. While the Hands2Help concept also works via an online smartphone application, it allows for every user of the system to publish requests and needs [11]. In contrast, assignments in crowdtasking and the *CrowdTasker* implementation are published only by a single source – the relief organization operating the volunteer network. *CrowdTasker* also seemingly targets a different kind of assignment, whereby volunteers are asked to fulfill a series of micro tasks that they should be able to complete quickly and easily.

GDACSmobile also allows every user (volunteer) to submit information about the situation in a dedicated area [16], which is published after it has been reviewed by a trusted operator. To alleviate the problem of having to verify large amounts of submitted data a semi-automated approach, based on the GDACSmobile workflow, has been proposed by Link et al. in a recent publication [17]. GDACSmobile focuses on gathering information about the situation on site by asking users to submit data about relevant occurrences and conditions, where the judgment of what is relevant for submission lies with the volunteer. The crowdtasking approach and *CrowdTasker* implementation, on the other hand, are meant to ask volunteers about very specific data, such as the availability of electricity at a certain address. We will later in this paper touch upon the implications of quantity and extent of data as opposed to relevance and depth.

The approach of utilizing public displays to share needs and commitments described by Ludwig et al. follows a similar route [19]. Users share equal permissions, where any user may create content on the public display and indeed control the display itself for up to five minutes. The main advantage of these displays, then, is to make apparent the needs of citizens at a location with high visibility. The local crowd is encouraged to serve the immediate, local requests – unlike in crowdtasking, where tasks come from a central location that is most likely removed from the actual disaster area. It is unlikely that the tasks in *CrowdTasker* will represent the needs of citizens on site, rather serving a tactical purpose for relief organizations. Unlike *CrowdTasker*, GDACSmobile or Hands2Help, these public displays, as they were proposed, work without Internet connection, by broadcasting a local WiFi network.

4 Evaluating Crowdtasking

The output of RE-ACTA was evaluated by TU Wien together with crisis management professionals of the ARC at several stages of the project, resulting in iterative improvements. Through this evaluation we have gained insights we wish to share. For additional details and discussion of these evaluation efforts, which would exceed the boundaries of this paper, we also refer to our previous publication [3].

4.1 Methodology

The first evaluation was done in the context of a focus group, to discuss and refine the list of functional requirements for a volunteer management system. Participants consisted of officers of the ARC concerned with community management/engagement on the operational and tactical level; they represented the primary target group of potential users. The second evaluation was to be concerned with the process models defined as a result of these functional requirements. Due to the large amount of data represented in the process model, the straightforward approach of sending all diagrams to our experts and requesting feedback was considered impracticable. Instead, we took a different route. We compiled a scenario to serve as framework and instantiated each of the UML diagrams within this scenario by giving the actors, actions and data exchanges non-abstract names and background. We also drafted a short story for each sequence diagram, describing what would happen in our presumed scenario. All this served us well in anchoring very abstract diagrams in a context that appeared more relatable to disaster response of professionals. Even though the work involved in the preparation was quite substantial, we were able to evaluate the entirety of the process model with experts in no more than three hours.

RE-ACTA was concluded with an evaluation of the prototype implementation. The insights we have gained from it have also been the topic of our most recent work [3]. This evaluation took place in the form of a field test. The purpose of the trial was to assess the acceptance of both professionals and volunteers towards the general approach of crowdtasking, as well as the usability of the specific prototype implementation. Because this was the first test and evaluation of a live crowdtasking tool, there was no experience for us – the evaluators and researchers – to build upon, making it difficult to define specific hypotheses to test against. Instead, we opted for an exploratory approach, using qualitative methods, to assess the topic with an open attitude. We opted for non-

participatory observation during the actual field test and interviews as well as group discussions directly afterwards.

The field trial was conducted at the premises of ARC's disaster relief center at the outskirts of Vienna. This facility is used by the ARC for actual CDM activities, which made it especially suitable to serve as command and control center for our exercise. The trial involved 12 participants, nine of those acting as volunteers executing tasks in the field and the remaining three taking the role of coordinators at the control center. All participants were contacted and recruited through internal calls for voluntary participation by ARC. "Volunteer" groups were comprised of two adults with prior experience in the volunteer initiative TeamA, one adult who had previously served as volunteer paramedic, two young adults in the service of the ARC and three members of the ARC youth group. "Coordinators" were comprised of disaster management professionals of the Red Cross who have had training and experience in volunteer management as well as crisis relief efforts.

The field trial proceeded as follows: All participants were gathered at the control center and given an introduction into the research being conducted, how this event fit into that and how their participation contributed. They were asked to voice their thoughts about workflows and device interaction during the coming exercise (thinking-aloud method). All participants were informed about which data we would collect during the event, how we would handle that data and that they had the right to opt out of participation at any time. After this, we split participants into three groups consisting of one coordinator and three volunteers each – meaning that one coordinator was to be responsible for three volunteers. Each volunteer was given a smart mobile device (smartphone or tablet with the *CrowdTasker* app pre-installed) and wired with a microphone connected to said device. Each group of three volunteers, after being outfitted, was sent to a specific starting location in the vicinity of the control center (none of them more than four blocks away). In the meantime, coordinators took their positions at workstations in the control center. They were given a short introduction to the *CrowdTasker* system of no more than 10 minutes. Then each of them was provided with a sheet of tasks to solve with the help of *their* volunteer group. The tasks were of increasing difficulty (for coordinators) in that each one provided less hints on how to use the *CrowdTasker* system. All tasks had been designed in advance in cooperation with crisis managers of the ARC in an effort to provide realistic assignments. They revolved around reconnaissance, clarification of situations in the field or acquisition of commodities. For example, the tasks of one group were to: 1) check the operability of water pumps at a nearby Red Cross training ground, 2) determine current fuel prices at a specific petrol station, 3) check for an electricity outage at a given address, 4) acquire a specific amount of fuel reserves, and 5) determine the number of operational response vehicles at a nearby Red Cross station. The two other groups executed tasks of a similar nature. The events and tasks were to be entered into the system by the coordinators unassisted. While doing this, they were observed by members of the TU Wien and recorded by video cameras. Volunteers, in the meantime, executed the given tasks in the field (also unassisted). Each group was observed by one member of the TU Wien. Additionally, audio recording software was activated on the smart devices used by volunteers to capture thinking-aloud. In combination with the connected microphone, this provided audio recordings of sufficient quality for later analysis.

4.2 Crowdtasking Workflow

To practitioners that consider implementing a crowdsourcing or crowdtasking approach, we can recommend two aspects of crowdtasking that worked well in our experience: the activation phase as well as the step-by-step nature and execution of assignments. Task steps are an integral part of the crowdtasking workflow and were carried by using the smartphone application. When executing a task, the volunteer is only shown one task step at a time and only progresses to the next once he has finished the current one. Through this workflow, the coordinator can define each assignment as small and manageable as he or she considers necessary.

The other aspect we like to highlight is the activation phase of crowdtasking. We are aware that this approach seems counter-intuitive at first – indeed, it also did for the participants of our field trial, both coordinators as well as volunteers. Both parties had difficulties during their first event: coordinators where unsure of the purpose of activations whereas volunteers where confused about the difference between tasks and activations. The approach has, however, proven useful once the coordinator grasps the approach and how to use it to advantage. This became more apparent in later field trials of the *CrowdTasker* system, which involved a larger audience of up to 200 participants and 9 coordinators. By generating a pool of eligible volunteers through activation, crowdtasking provides a way to estimate the number of recipients for tasks a priori. This knowledge influences which types of task are viable in a given situation. For example, it would be unwise to task a crowd of 500 people to bring spare warm blankets for one displaced family or to task a crowd of only 5 volunteers with searching a large area. Thus, activation constitutes a trade-off: a more difficult learning process for coordinators and volunteers during their very first event (due to having to understand the differences between tasks and activations) versus relevant a priori knowledge about crowd size (because activations allow for a relatively precise estimate of volunteers that will be addressed with each task request). Our current opinion is that this benefit outweighs the detriments, which may be further alleviated by user interface design and training.

4.3 Usability Aspects

If you design a workflow that heavily features geographic information, the user interface element of the corresponding (mobile) application should be a map and be positioned at the centre of the screen. The interface of the *CrowdTasker* mobile application during the field test revolved around several lists for open and closed tasks and activations. While this made sense from a developer's point of view, it quickly becomes cumbersome as the number of items increases. According to volunteer's statements, distance to target location and finding tasks near them were

important factors in choosing which tasks to accept. Item lists are not the best suited way to display this type of information. The majority of volunteers furthermore exhibited difficulties in finding target locations, despite accurate textual descriptions. Instead of item lists, an interactive map showing assignment location(s) in relation to the user's current position would likely have alleviated this. We advise making such an interactive map the centerpiece of location-focused crowdsourcing applications.

We also recommend, based on statements and observation during the field test, to reduce system-wide notifications issued by the smartphone application to items that are actionable by the user. In the first iteration of the *CrowdTasker* smartphone application, we notified volunteers about events in their vicinity, even if they required no immediate input by them. The goal was to make them aware of upcoming events and tasks. This was received badly by all participants. The purpose of the application being that of distributing tasks set expectations in such a way that participants were irritated by not being able to act upon items they received through the app. We believe similar assumptions can be made for other crowdsourcing mobile applications: If you decide to distribute purely informative content and assignments through the same application, it is advisable to only notify the user about items that require his/her input. In *CrowdTasker*, we have since changed application behavior to only display items that are actionable by the volunteer.

Lastly, we noticed that, most likely also due to the expectations set by the applications context, volunteers became restless very quickly when idle. In our field test, after receiving and accepting the initial activation, volunteers did not receive any new assignments for some time – due to coordinators still learning how to use the *CrowdTasker* web interface. This led to increasing unrest among volunteers who were unsure as to why they received no further instructions. Most started wandering around, checking the GPS and connection status of their device or restarting the application multiple times. As time went by, they increasingly voiced their dissatisfaction with being in the dark about the current status. Because of these observations, we recommend integration status indicators into similar mobile applications to assure volunteers that their connection is working, they have GPS signal and their application is up-to-date with central servers. All of this has been implemented in the *CrowdTasker* mobile app since the field test.

4.4 Caveats

We want to point out the caveats of our research, most of which we assume are apparent to the reader by now. Our evaluations involved a very limited number of participants. We did not test with enough participants to make a general statement on the validity of crowdtasking for disaster management. Further, though we took care to select representatives from different age groups to get a wide variance in feedback, not all relevant social milieus were included during the evaluation. Most notably, no evaluation of RE-ACTA was done with representatives of ethnic minorities or elderly – though these aspects were certainly taken into consideration during the design process, as were gender aspects.

5 DISCUSSION

Having introduced crowdtasking and the *CrowdTasker* implementation and describing our evaluation of the approach, we wish to discuss aspects that we found to be of note during the field trials and de-briefings of participants.

5.1 Communication Structure

Firstly, when comparing crowdtasking to TeamA, which can in many ways be considered a predecessor, one may observe a clear shift towards ICT – a topic that we have previously addressed [2]. The evaluation of *CrowdTasker's* field trial has made clear for us that one specific aspect that is lost by this move is community building. TeamA offers much face-to-face interaction with supervisors and fellow volunteers. In the strict one-to-many communication of *CrowdTasker* lateral communication is not included by design. Yet a demand for this form of group building was clearly indicated by participant feedback in field-testing. Especially younger volunteers sought to communicate with their peers to request help and band together. They opined that, if there was no option to get in contact with headquarters, at least they should be able to request help from their friends. Some stated that they would like to coordinate their travel to the target destination with other volunteers to facilitate, e.g., car sharing. One participant asked where in the app he could see his friend list or whether there was any way to find other volunteers through the application. All of this hints at a demand for lateral, social interaction and coordination between volunteers, aside from having a centralized command and control entity. The lack of social features seemed frustrating for young adult participants to the point where one of them asked what the application was even good for, i.e., questioning the added benefit of the application. We believe this dissatisfaction is the result of crowdtasking's heritage: being based on a hierarchical organization, but removing the aspect of face-to-face communication without compensation.

The young adult participants also wanted to show more initiative than offered by the crowdtasking workflow. They were disappointed at not being able to submit any information that they considered important, instead having to rely on receiving the right tasks. They asked what they should do in case they encountered situations that were potentially relevant to relief efforts (they cited, namely, collapsed houses) but had received no corresponding tasks. While this question is reasonable from the volunteer's perspective, such a workflow was purposefully not included in crowdtasking. Crowdtasking deliberately trades off quantity of data in the hope of increasing relevance and quality. The idea behind this was to acquire manageable amounts of information that is of higher interest than if volunteers were allowed to submit anything that they considered important. These explanations aside, it would be unwise to disregard the volunteer's point of view, who wants to show initiative. For such demands, a hybrid solution could be found by combining crowdtasking with, e.g., the GDACSmobile approach, which specifically allows for these activities. A possible scenario could be to use the GDACSmobile approach for discovering critical situations and crowdtasking to verify and mitigate them.

5.2 An Approach for community building and coordination

In the previous sections, we have discussed that there was, during the field test of *CrowdTasker*, a demand for supporting communication and coordination between volunteers. *CrowdTasker* works well for rapid acquisition of data from the field and directing volunteers as well as facilitating learning through small, informative tasks. But it does not, by design, take into consideration citizen's tendency for self-organization. Even though this is not the role of *CrowdTasker* in its current state, we believe it would be ill-advised to ignore this drive of people to band together and improvise coordination for problem solving. Based on our experience with *CrowdTasker* so far we consider the integration of existing communities and facilitation of self-organization to be two important topics that have to be tackled in future developments of the crowdtasking approach.

Building communities and establishing networks is an important part of improving societal resilience to crises and disasters. They increase chances of rescue and survival for individuals, provide encouragement to take preventive action and motivate volunteers to provide labor for disaster mitigation [8]. This provides us with a new direction for further research regarding the crowd-tasking approach. Armour argues that "new communication media can help formal systems – institutions and organizations – connect through informal systems – faith and community based organizations – with individuals and neighborhoods" [1]. He goes on to highlight the importance of engaging such communities and that formal and informal systems must work together.

Dynes argues that communities possess "social capital" through their existing connections and networks that is resilient to physical and even human capital loss [8]. He further states that authority structures that exist pre-crisis do (and indeed should) remain in place in the response phase. It is thus preferable that existing social structures – be they sports clubs, choirs or university departments – should not be broken up and forcefully fit into authority structures that are alien to them. It would therefore be important to try and make such existing communities visible to other actors in crisis and disaster relief, in order to enable cooperation and connection. Eventually, this could be taken one step further by not only investigating the integration of existing communities, but also to facilitate the emergence of self-organized volunteer groups. Similar views seem to be shared by Reuter, Heger and Pipek who have also investigated emergent volunteer groups and self-help of volunteers [26]. In their study of virtual activities during the 2011 tornado crisis (USA), they notice that there is a great variety of websites being circulated, but no central point for self-help activities and a lack of coordination platforms designed for volunteers.

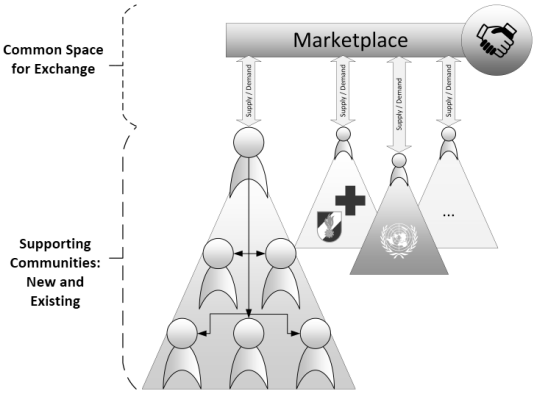

Figure 4: A combined approach for community building and coordination.

Command and control structures, similar to those that inspired the crowdtasking workflow, have their traditional place in CDM. They operate under the assumption that the principles of "command" and "control" are the means to reduce disaster situations to manageable proportions [10]. They allow formal organizations to coordinate and cooperate efficiently in times of need. However, they are not unconditionally applicable when dealing with citizens and communities of the public. Indeed, some informal groups actively distance themselves from formal relief organizations and do not want to be part of existing volunteer initiatives. Rather, they opt to retain their egalitarian structure. It seems unlikely that such communities would take part in a communication structure like crowdtasking. To connect them with other relief efforts a different approach will be necessary. Dynes has stated, regarding the utilization of the social capital of community organizations, that "rather than attempting to centralize authority, it is more appropriate to structure a coordination model" [8].

These notions, together with our observations, have convinced us that crowdtasking could bring together informal volunteer efforts and formal relief organizations better by expanding the approach to support existing and emerging social structures. In the wake of the recent migration crisis that has affected Europe, we have witnessed the rise of self-organized groups of volunteers that aim to provide humanitarian aid and social integration to migrants. To us, they represent the most recent example of citizen's tendencies to self-organize during crises and disasters. Citizens with similar goals, to assist incoming refugees or help them integrate into society, found together through social media and town hall meetings. They organized collective efforts with online communication tools, forming an emergent structure over days and weeks. We are in the process of talking to founding members of such initiatives (seven interviews were conducted as of the time of this writing). They use various forms of ICT for CSCW to conduct their internal affairs, yet seldom for cooperation with other grassroots initiatives or formal relief organizations. Preliminary findings indicate that all of them have formed consistent and sustainable structures for their daily operations, mostly revolving around working groups and a central committee for steering decisions. Crowdtasking, as a way to address individual, unaffiliated volunteers, is not the right approach to cooperate with solidified community structures. Therefore, new forms of

cooperation are required to interact with emergent communities that have already formed internal structures. The research field of CSCW, in our opinion, offers excellent opportunities to establish collaborative efforts between grassroots volunteer communities and formal organizations in CDM. We envision the modification of crowdtasking towards a common space where all parties – relief organizations, formal and informal communities – can request and offer goods and services for relief efforts, thereby providing an added benefit to *all* participants, which is currently lacking in the crowdtasking workflow. In such a space the stakeholders would be equal and focused on solving supply/demand related problems rather than being occupied with enforcing structures in an effort to prevent chaos. We have provided a visualization of our envisioned approach in Fig. 4. How crowdtasking can sensibly be modified to accommodate this vision will be part of our future research on the topic.

6 CONCLUSIONS

In this paper, we have described how ICT has changed the way volunteers organize for CDM. We provided examples regarding how these new forms of emergent volunteer communities use CSCW to handle their relief efforts. We have discussed how crowdsourcing is used as another form of CSCW connecting individual, unaffiliated volunteers and relief organizations. In this context we introduced crowdtasking, a centralized form of crowdsourcing for volunteer engagement and management. We discussed our findings from a field trial of a prototype implementation. Based on the insights gained from this evaluation, we have proposed a modification of crowdtasking towards community building (Fig. 4). It is our hope that the introduction of these aspects will increase the added value for volunteers through the support for emergent communities, while maintaining the possibility of coordination as desired by formal organisations and crisis managers.

In conclusion, we would like to say that the topic of voluntarism in CDM is an exciting and challenging topic for CSCW. Technological advances have altered the nature of how communities and structures emerge during crises and disasters. The use of ICT is prevalent before, during and after crisis and disaster situations, influencing cooperative workflows and information exchange. This opens promising avenues for building bridges between actors in times of need. The context of CDM is especially challenging for research due to its unforeseeable, hard to replicate nature and the upheaval of everyday structures and routines. The approach of crowdtasking that we have presented herein is one tool in a box of many that can be used to tackle the task of disaster mitigation. We have touched on other approaches with different approaches and aims, which also try to facilitate CSCW with and between volunteers. All of this research is, to our knowledge, still very much ongoing. It is also topical, in the face of a large humanitarian crisis, as we see forced migration rise to its highest point since World War II and an increase in the number and scale of natural disasters [27].

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Socio-technical Dynamics: Cooperation of Emergent and Established Organisations in Crises and Disasters

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ABSTRACT

Increasing ubiquitousness of information and communication technology exerts influence on crisis and disaster management. New media enable citizens to rapidly self-organise in emergent groups. Theoretical framing of their interactions with established organisations is lacking. To address this, we conduct a thematic analysis on qualitative data from the European migration crisis of 2015. We draw on context-rich material from both emergent groups and established organisation. To represent our findings, we introduce the notion of socio-technical dynamics. We derive implications for computer supported cooperative work in crises and disasters. These insights contribute to the efficient involvement of emergent groups in established systems.

CCS CONCEPTS

• **Human-centered computing** → **Computer supported cooperative work**; Empirical studies in collaborative and social computing; • **Social and professional topics** → *Computing / technology policy*.

KEYWORDS

Crisis and Disaster Management, Community Engagement, Volunteers, Technology Support, Qualitative Study

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1 INTRODUCTION

The field of *crisis and disaster management* (CDM) exhibits inherent tension between actors of differing backgrounds. On one side, established emergency organisations carry out their response efforts. They have precisely defined roles, clear responsibilities and need to orchestrate staggering amounts of personnel and material. On the other side, citizens come to help in any way they can. They form a heterogeneous group that offers much, yet has little preconception about the nature of emergency protocols or relief procedures. This dichotomy is 'part and parcel' of disaster relief [15]. It is necessary for effective, if not always efficient, relief efforts.

Information and communication technology (ICT) exerts influence on the disparity between formal organisations and citizens acting as volunteers. Citizens use online social media to organise as digital volunteers [52, 53] and for collaborative sense-making [59]. Orchestration of volunteer efforts is done with increased visibility, reach, and rapidity [35]. Citizens use ICT to form *ad hoc* groups in the physical world that have not existed prior to the disaster event [26, 28, 42]—so-called *emergent groups* [38, 58]. Their appearance in the context of the European migration crisis of 2015 has drawn the interest of academia [27, 48, 63]. However, explicit conceptualisation of their relation with established organisations is lacking.

We address this shortcoming through a thematic analysis of original, qualitative material gathered from both established and emergent organisations during the migration crisis. We introduce the notion of socio-technical dynamics as a means to identify characteristics of interaction in complex settings. We define six socio-technical dynamics that affect the interaction between emergent groups and formal organisations in crisis and disaster management. From these we derive implications for computational systems to support cooperative work. Lastly, we discuss how our findings contribute to the design for intermediation between emergent and established organisations and what open issues remain.

2 VOLUNTEERISM IN CRISES & DISASTERS

We highlight two developments that affect the interaction between established organisations and emergent groups: first, a perceived change in the nature of volunteerism itself and, second, the use of new media.

Formal and Informal Response

There is an increasing awareness about citizens who provide aid outside the formalised emergency management system [6, 18, 40, 62]. We will refer to them as *spontaneous volunteers*. After the onset of a crisis, spontaneous volunteers have been reported to self-organise into groups [26, 28, 42], which we term *emergent groups*. Opposite emergent groups are agencies that have existed before the event, who's regular activities pertain to CDM. We will refer to them as *established organisations*. These definitions confirm to previous categorisation under the same moniker [16]. The efforts of emergent groups form an *informal response*. It contrasts the *formal response system*, made up of established organisations and their institutionalised procedures. Our differentiation between 'formal' and 'informal' corresponds to the axis of 'regular' and 'non-regular tasks' used by Dynes and Quarantelli in their categorisations of organisations [16]. We consider an organisation part of the formal response system if it has been included in institutionalised CDM procedures before the onset of the event.

The origins of the formal response system can often be linked to wartime matters [38]. Thus, established organisations predominantly follow the *command and control* doctrine. They are meant to cope with the chaos and disorganisation of disaster situations [13, 14]. The assumption in this paradigm is that citizens are not capable of collating factual information on their own and cannot take care of themselves [19]. Indeed, spontaneous volunteers can pose challenges for formal response [6, 40, 58]. Lack of socialisation and familiarity with formal processes can disrupt established procedures [49, 58]. Massive informal response can impede relief efforts [6, 15] or overwhelm formal organisations [13]. Through unwanted convergence of people and goods [2, 62] and freelancing activities [9], informal response comes to be seen as a complication, rather than a potential asset [40, 49].

Nontheless, the assumption that citizens are not capable of independent response to disasters does not fit empirical evidence [13, 19]. On the contrary, the fast and unbureaucratical actions by informal response are the reason that effective emergency response is possible in the first place. This paradoxical relation between formal and informal efforts is an inherent part of disaster management [15]. It has been dubbed 'involvement/exclusion paradox,' due informal response being simultaneously needed and unwanted [18].

Contrasting Paradigms and Technology Adoption

ICT appears to contribute to the disparity between formal and informal response. Social media enable citizens to engage in collaborative sense-making, where online activity to collate information leads to accurate, peer-produced information [36]. This activity results in distributed, decentralized

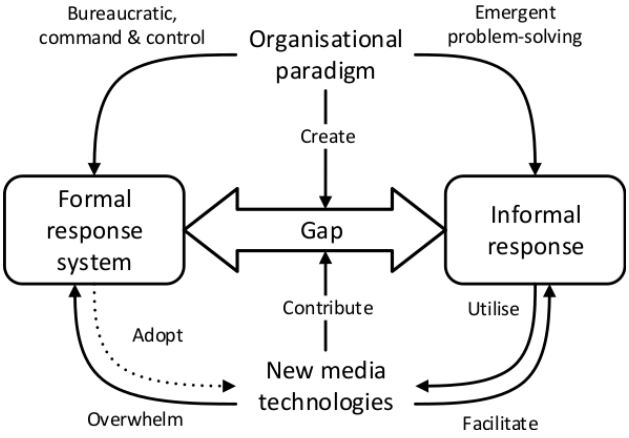

Figure 1: Gap between formal and informal response

problem-solving [59] and may happen without the awareness of official incident commanders [26]. Citizens appropriate social media as means of self-organisation [53, 60, 61]. They use shared ICT tools to mediate activity and match demands and offers for help [23, 26]. Such 'digital volunteers' show a tendency to form communities that offer particular services, such as mapping or social media monitoring [23].

Established organisations try to accommodate this use of new technology [21, 35], but verifying and processing information on social media is challenging [20, 46, 56]. The sheer volume of information makes it difficult to process in a timely manner [20, 42] and puts additional strain on the resources of the formal response system [35, 46]. Additionally, information obtained from social media is seen as untrustworthy [23, 56]. Wide-berth strategies for social media integration remain an exception [50]. Still, established organisations situationally adapt social media use. They may overrule standard protocols and establish temporary solutions for dispatch and two-way communication [22]. This hints at a gradual decrease in the technological gap. Eventually, the sheer magnitude of adoption by the public will mandate incorporation of social media in the formal response system [1].

In summary, the gap between formal and informal response is caused by differences in organisational background. Established organisations follow institutionalised procedures, while emergent organisations form *ad hoc* and are highly flexible. The gap is increased by the introduction of new ICT with unilateral benefits (Figure 1). In this context, it was contended that the inclusion of emergent groups into the overall response planning requires a different approach than the integration of spontaneous volunteers [3, 5]. This constitutes the departure point for the present paper.

The Case

Emergent groups became a tangible factor in Austria, during the migration crisis[1] that hit Europe in 2015. The country's main reception center for incoming migrants was already overcrowded at the onset of the crisis [12]. On August 27th, 2015, 71 migrants died while being smuggled into Austria [54]. This led to protests by immobilised migrants in *Budapest* [24]. Protests continued until, on September 4th, a large number of migrants set out from *Budapest* towards the Austrian border on foot. This became known as the 'March of Hope' [24]. It pushed the Hungarian state to organise buses, transporting migrants to the Austrian border [24], in turn prompting Austria and Germany to grant entry to migrants from Hungary [55]. Migrants received care and temporary shelter near the border at the municipality of *Nickelsdorf*. Many were transported by train onwards to Vienna's *Westbahnhof*, the terminal for western train routes. Both locations saw substantial volunteer efforts to welcome and supply approximately 9000 migrants travelling further to Germany [34]. Volunteers engaged as part of non-profit organisations or in a self-organised manner, expressing the urge to help and a lack of trust in public bodies to handle the situation [47]. By September 6th, approximately 15.000 people had passed the border to Austria. Around 6000 would follow daily, most in transit towards Germany, until Hungary completed its border fence ten days later, effectively shutting down the hitherto primary migration route into Austria. Vienna's main rail station, the *Hauptbahnhof*, had meanwhile become a destination for migrants arriving by other routes, making it a second crisis hotspot; one that was not planned for by the Austrian Railways, unlike *Westbahnhof*. In a remarkable development, operational command at *Hauptbahnhof* lay not with an established aid or emergency organisation, but with the volunteer movement Train of Hope [27]. Media saw the the area 'in the hands of civil society' [33]. Until the end of December, approximetely 600.000 persons transited the country en route to other EU member states while 87.655 applications for refugee status were filed in Austria itself (compared to 28.027 in 2014 and 17.503 in 2013) [17]. This required ongoing efforts by aid organisations and civil society to provide accomodations, care and administrative support for applicants to refugee status. In February 2016, Austria announced that it would enforce limits on the number of migrants being allowed into the country. By that time, 'normalisation' had taken place with regards to role definitions between organisations and daily challenges they faced [47].

[1]The usage of 'migrant' versus 'refugee' has been subject to debate [10]. The respective terms were, at times, purposefully employed to pursue political agendas. In this work, we will use the term 'migrant,' not for the purpose of classification in contrast of 'refugee,' but because we understand it to be the most general term for a person that moves to another location.

3 METHODOLOGY

We formulated two research questions to guide our investigation of the gap between formal and informal relief efforts:

- **RQ1** What are the current challenges regarding the interaction and collaboration between emergent, self-organised groups using new media technologies and formal organisations for crisis and disaster relief?
- **RQ2** What reasonable contributions can ICT make to mitigate challenges determined in RQ1?

Data

We started to gather data shortly after the height of the migration crisis. We held two group discussions with a total of six representatives of established organisations that provided humanitarian aid. All participants had been active in tactical or operational roles during the migration crisis. We used these group discussions to gather impressions on the involvement and activity of citizens from the viewpoint of established organisations.

To investigate the perspective of informal response, we conducted interviews with emergent groups that had formed in response to the influx of migrants. We contacted 18 groups in and around Vienna. A total of nine participants from seven different groups agreed to be interviewed. All but two participants had been present since the formation of their respective groups and held central positions. We interviewed them regarding the formation of their group, their internal organisation, cooperation with other organisations, and usage of ICT. Our data is rounded by two interviews with representatives of state-funded intermediating agencies. They worked to connect volunteers with established organisations. We interviewed them about how their work had changed during the migration crisis and which issues in collaboration they had experienced between formal and informal efforts.

Audio recordings of all interviews and group discussions were taken with the permission of participants, resulting in roughly 14 hours of data. All recordings were transcribed for analysis. The composition of our data is summarised in Table 1. Individual participants will be referred to by shorthand, comprised of one letter denoting their stakeholder group and a running number.

Analysis

We employed thematic analysis [7] to construct themes with firm grounding in our data. Our approach was inductive: we intended a strong link to the data, without fitting them into existing categories. Themes were built 'bottom up' in multiple iterations. Constitution and 'keyness' of a theme are given by the data's relevance to either research question. An abstract illustration of the phases and artefacts of our analysis is shown in Figure 2.

Table 1: Breakdown of acquired data and participants (n=17)

Stakeholder Group	Role	Method	Date	Denotation
Formal response system	Operation and tactical	Group discussion	Dec. '15, & Feb. '16	*<f-1>...<f-6>*
Emergent groups	Board or founding member	Semi-structured interview	Jun. '16 to Dec. '16	*<i-1>...<i-9>*
Intermediary Agency	Head of operations	Semi-structured interview	Oct. '16 & Nov. '16	*<m-1>*, *<m-2>*

During the first phase of analysis, we coded the entire data set (all transcriptions) according to RQ1. Multiple data items (preferably from different participants) that addressed a common issue were grouped by establishing a new *topic*. As such, topics are purely semantic artefacts. An example for a topic would be grouping all mentions of a lack of networking between volunteer groups. Phase one yielded 49 topics.

In the second phase, we constructed overarching *themes* from topics. This was the first step not based on the semantics of verbatim data items, but on the meaning of the collated topics. Many topics of phase one exhibited inter-connectedness. By following and unravelling the links between them and comparing their relations with each other, we found overarching themes that addressed broader scopes than their individual topics. Example: we had established one topic on the difficulties of finding the right person to contact in unknown organisations, another one for hindsights on offering a dedicated reception point, and a third on information exchange through informal, social contacts. They were related to each other in that they all (partially) addressed the need for—and difficulties in—finding someone to contact for information exchange. For us, this constituted a theme we dubbed 'The Point of Contact'. Phase two resulted in 20 *candidate themes* with a fair level of abstraction from data items.

Our candidate themes provided a new lens from which to view data items. In the third phase, we checked and refined our themes by looking at the data set through this new analytical lens. We checked if they were still grounded in the original data and tried to discover items that only now showed their relevance. Some themes exhibited variances within them that led us to adapt the thematic landscape by splitting, merging, or discarding themes to reduce their inter-connectedness until they were reasonably distinct and coherent. This yielded 12 *final themes* at the end of phase three. Each final theme consists of a narrative (verbatim data items), the theme's relation to its topics (i.e., how it was constructed) and to the other themes, as well as an analysis pertaining to the research questions. Being the result of RQ1, each final theme entails consequences for the cooperation between emergent and established organisations. By analysing for these consequences, we defined socio-technical dynamics that influence cooperation.

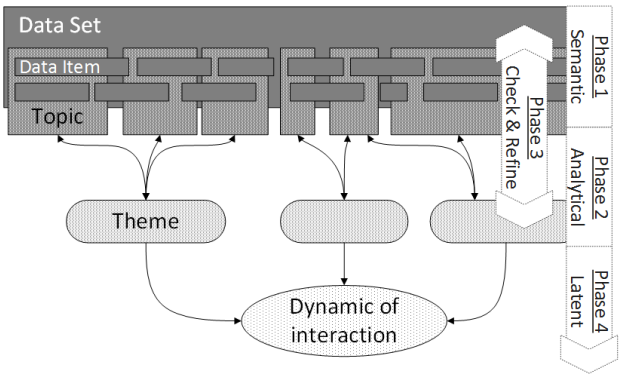

Figure 2: Methodology used for thematic analysis

4 SOCIO-TECHNICAL DYNAMICS

Themes do entirely capture the implications present in our data. To address this, we establish how participants' actions impact each other. In doing this, we create dynamics. We consider them socio-technical in nature, in that they exhibit organisational particularities that are inescapably entangled with technological influences and describe a socio-technical dichotomy (Figure 1). The representation as *socio-technical dynamics* is not another level of abstraction—rather, it shifts our analytic lense to pursue RQ2.

The boundary for our dynamics is marked by a citizen's decision to remain unaffiliated with the formal response system (rhombus element, Figure 3). Thus our scope excludes integration of citizens into the formal response system and the resulting *expanding organisations* per the classification of Dynes and Quaranatelli [16]. Such integration is sought through volunteer registers or programmes [4, 41]. This volunteer management warrants a distinct set of dynamics, which we reserve for another publication.

D1: Contributing in a Self-Determined Manner

In the early response phase, concerned citizens wanted to provide help and contribute rather directly, potentially disregarding the larger context of relief efforts. *<m-1>* recalls that 'volunteers saw a need and did not bother about any contextual parameters or what [non-governmental organisations] might need, instead they just acted'. Participants from all backgrounds noted spontaneous volunteers' apprehension

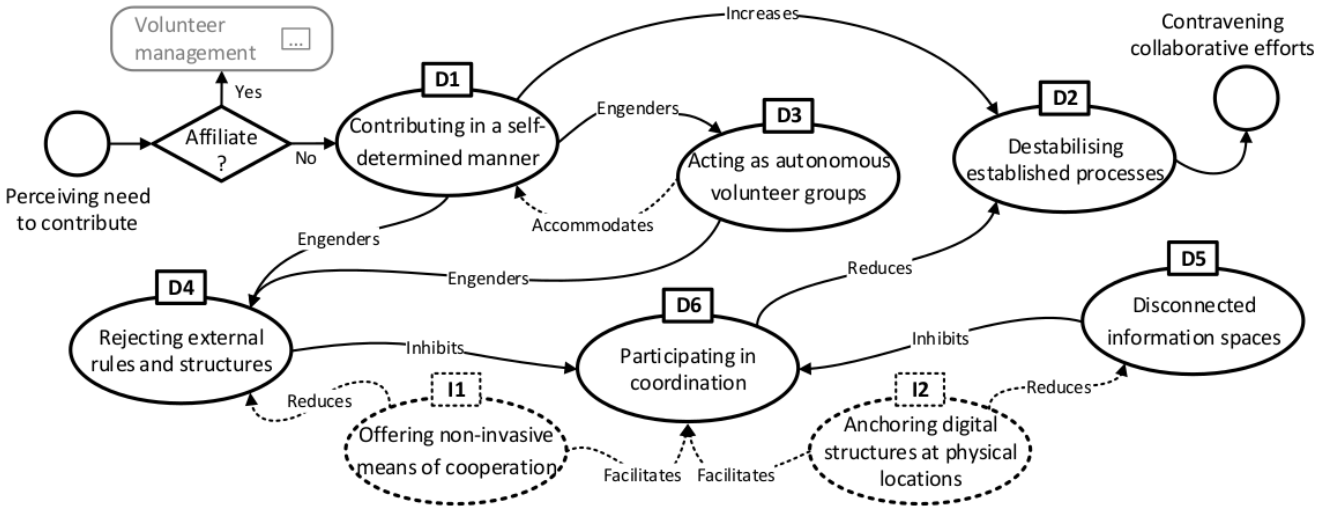

Figure 3: Socio-technical dynamics between formal and informal relief efforts, adding implications for computational systems.

for lengthy registration processes and long-term affiliation. One participant summed it up:

> Sure we want to do something. But I care nothing about [the formal organisation's] eight-page registration form. We'll get it done faster by ourselves! [...] I also don't want to attend a lecture in order to be allowed to do that. It was somehow necessary to do something and people did that, without any hierarchical structures. They checked what was needed and that was done. *<i-7>*

Increasingly 'project-oriented' volunteering (*<f-1, f-5>*) exacerbates the formal response system's difficulties in accommodating spontaneous volunteers:

> They elected, for themselves, that 'I want to help there' and 'I can help with that'. [...] They appear and declare 'I just dropped my kids off to school, I have about two hours now'. *<f-1>*

This is in line with previous findings about self-organised efforts [29]. ICT plays an inherent role in this process, as it influences the perception of needs, the catalyst for action, in a way that may not reflect the actual situation [1]. *<m-1>* recalls that 'everyone emptied their houses' when scrambling to answer an unverified call for donation on social media.

D2: Destabilising Established Processes

Civil society's self-determined contributions (D1) may have a destabilising effect on established rules and processes—especially in the formal response system (c.f. [9]). The edge D1 → D2 thus reflects tension between formal and informal relief efforts (c.f. Section 2) in our own data. Destabilisation is not the result of malicious interference, but rather a side effect of the strive to contribute quickly, directly, and unmediated.

The approach of 'just doing' may result in actions contrary to other relief efforts, due to a disregard for the overall operational picture (likely for a lack of information). *<f-6>* gives the 'extreme' example of volunteers arriving on site and handing over all their donations to the first affected person they meet, an act that 'ultimately results in more problems than fulfilled needs'. Further, the apprehension of volunteers towards regulations of formal organisations, which in their eyes represent bureaucratic inhibition to effective help, can undermine established processes. For example, health regulations prohibited that formal organisations accept home-cooked dishes as donations, which was met with incomprehension; 'a volunteer does not understand that. They just want to help!' (*<f-1>*). The case of a volunteer group that ran a storage jointly with a formal organisation sheds a different light on the same dynamic:

> It basically just works because we somehow solve it informally. [Formal Organisation] insists on very strict structures and lists, depending on the person in question: who received what and when. The club sometimes defies that, saying: 'just take that [item] and I won't record it right now'. *<i-7>*

The conundrum lies in that enforcing health regulations and book-keeping on storage items is quite sensible—as the frustration of volunteers is understandable from a different point of view.

Lastly, the use of personal relations to 'get things done' leads to the injection of information into the formal system that is hard to trace or verify:

> [Informal organisations] just arbitrarily latched onto the system, based on their existing contacts in organisations. Acting inside the system, this made it much, much more difficult for us; because suddenly, information pops up from somewhere. It was not verifiable and the source of it was in some cases totally obscure. *<f-3>*

<f-3>'s statement also reflects the technological aspect of this dynamic: new media are inadvertently used to circulate inaccurate information that takes effort to check. *<m-1>* recalls how difficult it was to persuade citizens of the inaccuracy of needs perceived through social media or television (hence D1 → D2). 'Just doing' based on such information led to counter-productive convergence that took additional effort to mitigate, adding to the stress of established processes.

D3: Acting as Autonomous Volunteer Groups

Consequential to civil societies reservations about becoming affiliated (D1) or lack or trust in the formal response system and state [27], emergent groups address perceived needs in a self-organised manner (D1 → D3). Approximately one year after the onset of the crisis, we found a high amount of organisational structure in groups that had emerged during the migration crisis. Some had founded clubs as legal entities (*<i-1, i-2, i-3, i-5, i-7>*) with an offical board for reasons regarding finance and liability. This central board is responsible for strategic decisions and has personal meetings at least once a month, while several working groups with a high degree of freedom, devised by topic of activity, are instated around it. One person of each working group acts as link to the central board (*<i-1, i-3, i-5, i-6>*). The board provides the long-term frame of work, while working groups take over the detailed activity planning. This corresponds to what Liao *et al.* referred to as 'distributed leadership' and 'local leader roles' [28] and is in accord with the division of labour that Kornberger *et al.* have described [27].

New media plays a deep-seated role in this self-organisation of emergent groups. Most participants work full-time jobs, making their volunteer activity highly distributed. With one exception (*<i-3>*), all participating emergent groups used social media for internal organisation or outreach. Multiple participants consider new media technologies an absolute necessity for their activity (*<i-1, i-2, i-4>*). This corresponds to reports of social media use for recruitment and mobilisation [27] and the alignment of such tools with the needs of collaboration in crises [61].

The emphasis in the title of this dynamic lies on the word *autonomous*. While we noted no aversion of emergent groups to collaborate with the formal response system, this does not extend to becoming subject to it. 'Deliberately provocative', *<i-6>* paraphrases the sentiment of volunteers in their group such: 'Well I'm not going to be a servant to those that think they know what's going on'. This stance is bolstered by past achievements of a group:

> [Volunteers] really organised all of it themselves. And they insist on that; that they have achieved everything they did on their own and really don't need those NGOs. It's rather difficult. [referring to their role as intermediaries] *<m-1>*

In acting autonomously, emergent groups form an identity that gives them coherence (c.f. [27]) and distinguishes them from an ephemeral gathering of spontaneous volunteers. This includes identities formed and represented on social media.

D4: Rejecting External Rules and Structures

From the endeavour to provide aid immediately and unbureaucratically (D1 → D4) and the identity that groups form in their autonomous activity (D3 → D4) stems a rejection of rules imposed from 'outside.' The entire genesis of emergent groups engenders this dynamic: they formed to directly address a perceived need (to do better than established organisations [27]) and, consequentially, will not forgo their own organisational structure and procedures for cooperation with the formal response system. Simsa *et al.* already remarked on the delicate balance between providing stable elements for coordination and offending spontaneous volunteers through interference [48].

<f-5> recalls a case where they tried to establish structures as mundane as paper-based attendance lists at a location run by volunteers. The latter beheld such measures as form of external control and argued that everything worked well enough as it were. Only the suspected case of a highly contagious disease provided enough leverage to establish an attendance registry. Another case:

> Early on, needs were covered through volunteer efforts. Afterwards, full-time aid workers moved in and more or less established the structure. And there were some tensions there. Because volunteers did develop something there and things were not always how they are supposed to be. Then we did it by the necessary rules, and there were lots of discrepancies. *<f-1>*

This account, especially the term 'necessary rules,' is a good summary of the tension involved: one side requires formal rules for operation, while the other considers them a hurdle to providing help. Participants from the formal response system (*<f-1, f-2, f-5>*) agree that an early establishment of rudimentary formalisation could have increased acceptance.

Autonomy is also sought in matters of decision making. <*i-2*> calls it their group's 'foremost directive' to not be branded through local politics: to not include any councilmen of the municipality in their board and to take no money from the local administration. Similarly, <*i-7*> recounts that the municipality tried to dictate the board of their newly founded club. This imposed board was not accepted by the club's base and ousted, to be replaced by members from within the group.

Autonomy is interwoven with emergent groups' utilisation of ICT. They appropriate existing communications infrastructure that fits their needs [53, 60]: social media, which are well suited for self-organisation in disaster relief [61]. Emergent groups build their working processes around these tools. Requiring participation on an established organisation's digital volunteer platform for the sake of contributing is then no different from imposing structures through rules *in esse*. Hence, the same response of emergent groups is to be expected, also with regards to remaining autonomous in their communication media (D3).

D5: Disconnected Information Spaces

The use of diverse infrastructures to host digital representations of groups means a fracturing of connectivity between actors. Contacting emergent groups and retrieving verifiable information can be a non-trivial task, considering the lack of any central point for information exchange (c.f. [39]) and rapid re-formation of emerging structures (c.f. [18]). It can be a considerable effort to compile information on which emergent groups are active at all in an area (<*m-2*>). This aspect is especially relevant for intermediary organisations and the formal response system. If the identity of an emergent group is known, established organisations still face difficulties when trying to get in contact (<*f-1, f-2, f-3, f-4*>). An example:

> <*f-4*>: Did you have contact with them? We once tried to reach out to them, because they sent people—well, a convoy, carrying commodity donations. And it blocked the highway and access roads. And that was not possible, because they only provided an E-Mail address and Facebook page.
> <*f-1*>: Yes we do have contact. There is this-
> <*f-3*>: [name redacted]
> <*f-1*>: [name], exactly. She was well connected.
> <*f-3*>: [...] [name] constitutes the structure there.

This example highlights three issues that affect cooperation: first, that it can be difficult to find the right contact person in an emergent group. Second, that the 'right' contact point does not necessarily mean the person in charge (if any), but rather someone that knows the group's capabilities and can relate received information back to the right address, internally (<*f-6*>, <*f-3*>). And third, that having such a contact point may be insider knowledge.

Emergent groups exhibited varying degrees of interest in connecting with similar groups (<*i-2, i-3, i-4, i-6, i-7, i-8, i-9*>); to exchange experiences, stories and structured practical information regarding their work (e.g., best practices, frequently asked questions). <*m-1*> confirms this demand from their experience in organising networking events for volunteers. However, emergent groups lacked the resources to establish and maintain an extensive network for information exchange, in addition to their volunteer and jobs.

D6: Participating in Cooperation

When probed, none of the participants from emergent groups were averse to cooperation with other parties—either formal or informal. Three volunteer groups explicitly emphasised the importance of information exchange and aimed to avoid conflict (<*i-1, i-6, i-8*>), indicating an understanding that they need such cooperation for successful operations. Others expressed a need for central coordination of 'all actions' (<*i-6, i-7*>) and to 'establish a bridge between volunteers and professional [...] organisations,' because 'currently these are two parallel structures' (<*i-3*>). This supports the observation of Simsa *et al.* that spontaneous volunteers appreciate stable elements and coordination in self-organisation efforts [47].

Likewise, representatives of the formal response system expressed a need to work together with emergent groups. However, they exhibited some reservation as to the reliability of this cooperation. If contact can be established (c.f. D5), communication schemes used in the CDM context are often unfamiliar outside the formal system (<*f-6*>). Information that is essential for effective involvement of other organisations, regarding the nature of their contribution, the range of services they provide, or how much personnel they can call upon (<*f-3*>), was considered lacking. These issues notwithstanding, involvement of emergent groups in overall efforts is expected to be necessary (<*f-1, f-6*>):

> I can only emphasise that communication is important. Because, even if people don't know what is going on, they will do something themselves, somehow. <*f-1*>

The implication is that it would be prudent to establish communication to prevent uninformed efforts (also see [18]). We conclude that the participation of emergent groups in coordination efforts decreases the destabilising influence self-determined contributions can exert on relief efforts (D6 → D2). It would enable informed decisions on the side of emergent groups and make information flows more transparent.

Having established the general willingness for cooperation and that there is a benefit to including both established and

emergent organisations, we contend that D4 and D6 constitute two inhibiting dynamics that can be addressed through technological solutions.

5 IMPLICATIONS FOR DESIGNING TECHNOLOGICAL CONTRIBUTION

As the dynamics we postulate are socio-technical in nature, so are their implications for CDM (Figure 3, dotted ellipses). However, we will focus on design implications for technological solutions in the present paper.

The inhibition of cooperation due to the rejection of rules by emergent groups (D4 → D6) is due to the expectations of the formal response system—that control needs to be established and civil society's self-determined actions are disruptive [13, 19]. While this appears as inherently organisational problematique, we have argued in D4 that it is interwoven with technology. It has been established that volunteers are well capable of organising with the digital tools at hand. Requiring registration on digital platforms offered by the formal response system is in that respect similar to imposing rules and operating procedures at the disaster site. We propose a set of corresponding implications in I1.

The inhibition of cooperation through fractured information spaces (D5 → D6) is more obviously technological. The problem takes three forms: firstly, being unaware of who is active in an incident; secondly, being unable to contact them reliably; and thirdly, lacking the time and resources to filter information flows from multiple (global) channels. Our view on the resulting implications is given in I2.

I1: Offering Non-invasive Means of Cooperation

In D4, we have discussed that establishing rules and imposing processes on emergent groups causes tension and can have a detrimental influence on cooperation. This rejection concerns interactions which a group perceives as interference with internal affairs or unbureaucratical aid: rules and procedures, or their digitalisation in the form of registration on platforms (c.f. D4). It is, however, not a general refusal of collaboration with the formal system (c.f. D6). Even *<i-6>* and *<i-7>*, who were vocal in their disapproval of influence exerted through the municipality and rules imposed by established organisations, called for central coordination and voiced appreciation for early mayoral support.

To address this from a technological perspective, we propose to establish a digital mediator that allows both parties to *retain their preferred solution* for internal coordination, as well as the corresponding protocols. Placed between social media and solutions of the formal response system, it should allow the creation of a shared information space directly from the respective tools for internal coordination. For emergent groups in particular, this means treating their social media presence as the permanent representation of an organisation. Thereby we make social media groups an artifactual part of a shared information space. We increase transparency by eliminating the need to rely on individual, personal relations for information exchange. We further make the origin of information more transparent. This is paramount, as the diverse strategies employed in relief efforts necessitate a continuous process of (re)assessing validity of information for cooperative decision-making. To achieve that, knowing the origin of information is crucial [43]. Our data and analysis confirms this (c.f. D2).

Organisationally, interfacing with emergent groups on their terms (i.e., social media) allows them to retain structural integrity. It further increases acceptance by not requiring them to establish additional personae on another platform. The difference is subtle, but we argue, based on the relation chain D3 → D4 → D6, that it is an important one: emergent groups no longer 'sign-up' for something on (another organisation's) platform—they *participate* in information sharing with their own, established, digital identity. In doing so, we decouple actors' organisational structure and procedures from digital artefacts used to articulate activities pertaining to cooperative work—the intended result being that neither party has to submit to the other's conception of CDM when exchanging information. This allows emergent organsiations to keep their work practices and avoids 'designing out' flexibility and adaptability [8].

I2: Anchoring Digital Structures

In D5, we have elaborated on the disconnect between information spaces of actors. However, statements of participants suggest that connection between groups is formed naturally when their efforts concern the same subject; e.g., when migrants were transferred between shelters, emergent groups at both locations established and retained contact (*<i-4, i-8>*). In these instances, groups shared an objective and responsibility (to care for someone in need). In I1 we have discussed the inclusion of volunteer groups in a shared information space, where they could establish such shared responsibilities in the form of perceived needs. However, we suggest refraining from establishing one central, global information space. Such would produce a large volume of data that is difficult to filter. Instead, multiple smaller instances can be created and *anchored at important locations*. To strain a contemporary term, currently *en vogue* with the Internet of Things domain, we propose creating a 'Digital Twin' of locations, such as points of convergence, and the relief efforts pertaining to these places.

By entwining an information space with a physical location we address requirements from our own analysis: firstly, we implicitly suggest to users a reduction of information shared, to such items that are related to the location of the

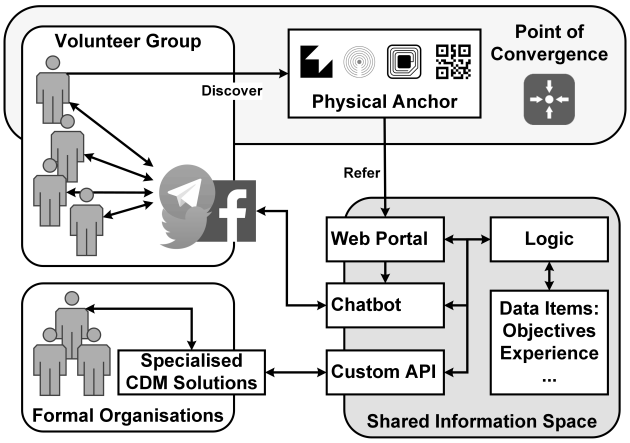

Figure 4: Example architecture combining I1 & I2

information space's anchor. Thus, we reduce the overall volume of data and increase information relevance and accuracy with regards to any incident at said location [11, 45] (c.f. D5). Secondly, emergent groups that participate in this information space implicitly show interest in activity at the site it is tethered to. We may thus consider these groups 'active' on site and make them more tangible to the formal system ($c.f.$D5). Thirdly, placing a prominent tether at points of convergence or infrastructure nodes, e.g., volunteer reception centres [37] or train stations [30], offers formal organisations a way to establish a fixed point of contact for arriving or returning volunteer groups. This could be used to provide guidance or communicate 'house rules' early (c.f. D4). Lastly, a locally oriented information space is a way of finding community and increasing the cohesion of community response through shared concerns for the locale [45]. We contend that a strong link between a location and an information space can help to create a semi-bounded environment [23], where physical vicinity is used as (part of the) vetting process.

Effectuating Implications

We are aware that the implementation of design implications outlined above will entail technological issues (e.g., replication, consistency, and redundancy of data). Detailed discussion of such is beyond the scope of this paper. However, to invite criticism of our notions and future work on the topic, Figure 4 shows an example architecture that accommodates our socio-technical dynamics. At the core, it constitutes a shared information space. In accordance with I2, this shared information space is tethered to a location by providing a physical anchor, *in situ*. This can be achieved in several ways. Bluetooth beacons, for example, afford us to notify digitally enabled volunteers in the vicinity about the information space's web portal, where they may receive further guidance. The tether may also be as simple as a large sign that spells out the portal's website address.

With regards to I1, an increasing adoption of conversational interfaces and 'chatbots' on social media affords us to implement a technological mediator that integrates emergent groups' digital representation as artefact in the shared information space. Simple workflow-based chatbots can be added to groups on social media, to relay information they wish to share (by 'talking to' the bot). Vice versa, they may receive updates from the shared information space directly in their group's established communication infrastructure. Moreover, even a simple bot can serve as part of a coordination mechanism. We contend that, used for guidance in creating a perceived need as artefact in the information space, it can constitute a coordinative protocol [44] with stipulations pertaining to the artefacts' description.

Perspective

It has been argued that the central issue of supporting cooperative activities with the help of computational systems is the question of how to aid in the articulation work required to restrain their distributed nature [43]. The boundary between established and emergent organisations is especially suited for the study of this articulation [23]. Activities there are distributed in the sense of time and actors' socialisation in the field of CDM. To support their participation in cooperative work, we proposed the basis for a coordination mechanism: a *modus operandi* for accessing and modifying artefacts that can bridge the distributed nature of their work. We hope that a shared information space, thus created, can be developed into a *common information space*[2] through further research on a computational system that implements I1 and I2.

The necessity of such a common information space is underpinned by four notions from recent publications: Kornberger *et al.* derive the concept of a *sharing economy organisation* [27] from the case of Train of Hope, which unites aspects of platforms with a social movement to channel the flow of resources though appropriation of communication technologies onto the physical location of the incident. Such an organisation, with its capability to accommodate contributions of all manner, offers an attractive alternative for participation. This supports the proposition of Zettl *et al.*, that self-organised groups can act as *intermediary organisations* between individual spontaneous volunteers and the formal response system, providing a 'social and cultural bridge' [63]. The *Virtual Operations Support Team* (VOST) is a digital pendant to the intermediary organisation: trusted agents remotely support formal response agencies by managing and monitoring social media interaction [51]. VOSTs build a

[2]Being understood as more than a shared database, in that it requires interpretive activity and a shared understanding of artefacts [43, 44].

tentative bridge across the technological gap we postulate (c.f. Figure 1). Digital volunteers operating in this manner perform articulation work that is required by the increasing volume of new media data [23]. However, while emergent groups are quite capable, they also need structures and management to enable their efficiency [32]. A careful balance is required to avoid depriving them of the space for their own organisational structure—Simsa *et al.* refer to this as *structured self-organisation* [47].

In all four concepts, we see a need to design for the inclusion of emergent groups in a way that departs from current approaches. The sharing economy organisation, the intermediary organisation, VOSTs, and structured self-organisation—all require room for spontaneous volunteers to contribute through their own procedures. While these concepts have implicit consequences for the design of ICT, we consider it imperative to formulate an explicit conceptualisation of the relation between established and emergent organisations. In this way, we can lay a solid foundation for the development of a computational system that offers the room emergent organisations require, while supporting cooperative work with established organisations. Ultimately, such a computational system would model the articulation work of cooperation on the basis of perceived needs. By making articulation visible, we may facilitate policy changes as the articulation work becomes institutionalised [23].

Open Issues and Considerations

The design we propose has technological and social implications that require consideration in future work. The integration of social media personae entails issues pertaining to privacy and security. I1 leads to a public forum, which engenders accountability of formal organisations [22]. Accepting this accountability is inconsistent with current operating procedures of the formal response system.

There also remains the issue of trust in data derived from social media, which we do not explicitly address with our approach. However, making the local activity of emergent groups known to formal responders through a common information space may implicitly foster trust, in the sense of revealing reputable tertiary networks [57]. Then, trust would be placed in networks instead of context-free information. Others have argued that this view on trust serves as filtering system and facilitates articulation work [23].

Regarding transferrability of our results, we expect them to apply also to pre-existing groups that take over new tasks as part of informal crisis response—so called *extending organisations* [16]. We base this assumption on reports of participants regarding their experience with managing corporate volunteering (see [62] for corporate volunteering as extending volunteerism). Problems pertaining to spontaneous participation (D1) and finding the right contact person (D5) appear less pronounced; otherwise, extending organisations are seemingly regarded similar to emergent groups as far as coordination is concerned. We further surmise applicability to natural disasters and rapid onset events. Previous discussion of emergent groups in such events does not contradict our postulations [13, 25, 29, 31, 61]; the reservation being that we cannot use historical data to establish transferability, either. Indeed, empirical verification of our results is owing. Therefore, we will implement a functional prototype, based on the implications of this paper, and use it to verify our postulates by deduction.

6 CONCLUSION

The relationship between established organisations and emergent groups in crisis and disaster management is shaped by their contrasting paradigms. This contrast is accentuated by the rise of ubiquitous information and communication technology. Yet to be effective, response efforts require both the flexibility of the spontaneous volunteer and the established procedures of the formal response system. The task, then, lies in reducing the inefficiencies in their cooperation as much as possible.

We conclude that it is feasible to implement a design pattern where the virtual representations of emergent groups, formed in online social media networks, may be integrated more seamlessly into a shared information space than was previously attempted. Additionally, such a shared information space shall be anchored to a physical location, e.g., a point of convergence or central infrastructure node. Thus, we may fulfil the prerequisites for the creation of virtual artefacts to support the articulation necessary to mitigate the distributed nature of the cooperative effort between emergent and established response organisations.

Others have published on spontaneous volunteers' self-organisation [27, 48] and how these emergent groups can support relief efforts by acting as intermediaries [51, 63]. In the present work, we add to this corpus an explicit conceptualisation of interaction between established organisations and emergent groups in the form of six socio-technical dynamics. By representing our findings as socio-technical dynamics, we can provide a foundation for the design computational systems that aim to integrate emergent groups into established environments in complex settings.

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Opportunistic Affiliation in Spontaneous Volunteer Management

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ABSTRACT

Spontaneous volunteers influence crisis and disaster relief efforts as both an effective aid and a stressing factor for emergency organisations. Managing the negative impacts of spontaneous volunteering has thus become part of command and control deliberations. In this paper, we take a closer look at integrating spontaneous volunteers into the formal response system to mitigate negative impacts. Working with participants from formal response organisations, we gathered qualitative data regarding the management of spontaneous volunteers during the European migration crisis in 2015. Through thematic analysis, we extracted topics to systematically describe the interaction between emergency organisations and spontaneous volunteers. As implication thereof, we propose how computer supported systems can be applied to better manage spontaneous volunteers. In our discussion, we focus on the registration process and *ad hoc* verification of spontaneous volunteers to better integrate them in the formal response process.

Keywords

Crisis and disaster management, spontaneous volunteers, command and control, volunteer management

INTRODUCTION

Volunteers have a considerable impact in Crisis and Disaster Management (CDM), which is particularly true for spontaneous volunteers. Spontaneous volunteers have no affiliation to formal organisations and participate to address sudden, urgent needs. The nature of their role, and whether their activity should be supported or suppressed, is subject to debate. On the one side, proponents of a top-down approach, leaning towards the command and control paradigm, at times consider spontaneous volunteers a hindrance or nuisance (Cone et al., 2003; Sauer et al., 2014; Whittaker et al., 2015). On the other side, spontaneous volunteers are often the first, and a very important, form of relief in the immediate aftermath of an incident (auf der Heide, 2003; Twigg & Mosel, 2017; Whittaker et al., 2015). Whatever side one may prefer, research has shown that the appearance and convergence of spontaneous volunteers at the disaster site can have negative side effects for organised relief efforts (Dynes, 1994b; Fritz & Mathewson, 1957; Sauer et al., 2014). As the presence of spontaneous volunteers is a common aspect of CDM (auf der Heide, 2003; Drabek & McEntire, 2003; Twigg & Mosel, 2017; Whittaker et al., 2015), response efforts should incorporate spontaneous volunteers in their decision making (Barsky et al., 2007). However, the rather static and bureaucratic command and control model is not well suited for spontaneous and loosely organised relief efforts (Drabek & McEntire, 2003) and needs adaptions to lessen negative effects of spontaneous volunteering while strengthening their problem-solving capabilities.

In this paper, we present the results of our research on the necessity and nature of adaptions to the command and control model, to better accommodate spontaneous volunteers. These results were abducted through thematic analysis on qualitative research data: interviews and group discussions were conducted in the context of the European migration crisis in 2015. The contribution of our work is the systematic description of four distinct dynamics that affect spontaneous volunteer management. Further, we describe and discuss possible technological approaches implicated by these dynamics.

RELATED WORK: CIVIL SOCIETY IN CRISIS AND DISASTER RELIEF

The importance of citizens' initiative in relief work, especially in the early phase, has been emphasized repeatedly, starting with one of the earliest works in disaster sociology (auf der Heide, 2003; Dynes, 1994b; Helsloot & Ruitenberg, 2004; Prince, 1920; Twigg & Mosel, 2017; Whittaker et al., 2015). However, from the perspective of formal organisations for crises and disaster relief such initiatives are not always seen positive, as they are hard to control and difficult to plan for (Sauer et al., 2014; Skar et al., 2016). Formal organisations have previously been reported to primarily follow procedures aimed at establishing order after the chaos of a crisis or disaster (Dynes, 1994a). Yet research does not support the need to control antisocial and destructive behaviour in the face of a crisis (Drabek & McEntire, 2003; Helsloot & Ruitenberg, 2004). On the contrary, researchers have considered informal activities essential for effective, if not necessarily efficient, relief (Dynes, 1994b). This creates a situation where civil society provides the required resources, yet in a form of response that is inefficient (Dynes, 1994b). Harris et al. (2017) describe the role of spontaneous volunteers as *paradoxical*, in that they are simultaneously needed and not wanted by crisis managers. This conflicting situation results in a need to manage the activities of citizens in a way that reduces inefficiency, while allowing flexibility.

Spontaneous Volunteers and Convergence

Formal organisations in CDM use the term *volunteer* primarily to describe persons that contribute through predetermined structures of an official response body (Whittaker et al., 2015). This definition makes volunteers part of the formal response system, where they act in accordance with established procedures. Through regular service volunteers get socialised in the field of CDM. This form of volunteerism is traditionally popular in Central Europe and Scandinavia with levels of participation in voluntary or charitable organisations regularly exceeding 50% of the population, reaching 67% in Norway (Plagnol & Huppert, 2010). Britton (1991) refers to such organised and affiliated volunteers as *permanent disaster volunteers*.

A trend contrary to permanent disaster volunteers has been noted at the turn of the century: volunteering 'decreasingly corresponds to strong identification and long-lasting membership' with organisations (Hustinx & Lammertyn, 2003). Indeed, there has been a noticeable number of publications addressing volunteers that contribute to disaster relief without joining an official response organisation. Various terms have been used for such participation, including: *informal* (Whittaker et al., 2015), *unaffiliated* (Barsky et al., 2007; Zettl et al., 2017), *episodic* (Hyde et al., 2014; Starbird & Palen, 2013), *freelancing* (Cone et al., 2003) or *spontaneous* (Harris et al., 2017; Sauer et al., 2014; Simsa et al., 2018; Twigg & Mosel, 2017). While these terms are not mutually exchangeable, they all describe volunteers who are active outside the formal response system; even though they occasionally are integrated into formal efforts (Scanlon et al., 2014). Spontaneous volunteers (as we refer to them in this paper), who may lack both training and equipment, pose an issue for official response organisations, as they may endanger their own health and disrupt organised response (Whittaker et al., 2015).

One phenomenon of spontaneous volunteering is *convergence*: the physical movement of persons or material towards the disaster site, as well as the transmission of information and requests towards communication centres of a disaster site (Fritz & Mathewson, 1957). In our research, we are primarily interested in the convergence of persons[1]. Spontaneous volunteers are motivated to render aid and offer support, and so they will mobilise and move to the incident site (Dynes, 1994b). This individual and unorganised mobilisation can cause congestions of persons and vehicles, posing an additional logistical challenge for official crisis management (Drabek & McEntire, 2003). Convergers may 'overrun' local infrastructure (Fritz & Mathewson, 1957), deplete resources (Cone et al., 2003) or overwhelm those trying to coordinate response (Drabek & McEntire, 2003). An over-abundance of helpers in the disaster area may even engender more victims (Dynes, 1994b). Emergency and relief organisations have adopted concepts to address personal and material convergence. Examples are the Volunteer Reception Center of the US Federal Emergency Management Agency or the Operations Coordination Centre, employed by the United Nations Office for the Coordination of Humanitarian Affairs. Both are concepts intended to cover the reception of individuals or whole organisations, respectively. While (some) organisations have procedures at hand to handle physical convergence, Waldman and Kaminska (2015) propose virtual reception centres, which could yield benefits for both volunteers and formal relief organisations. However, little literature is available on digitalisation of volunteer reception on site.

If spontaneous volunteers' convergence on a disaster site is inevitable, then their participation in relief efforts should be actively managed – to prevent injury or damage, to reduce disruption of organised response, and to

[1] The convergence of goods and information impose their own. separate problems; relating to supply chain management and information management, respectively. Even 'official' convergence is problematic (Dynes, 1994b; Fritz & Mathewson, 1957).

increase effectiveness of CDM (Sauer et al., 2014; Whittaker et al., 2015).

Efforts of Civil Society during the Migration Crisis in Austria

September 4th, 2015, saw the beginning of the 'March of Hope', which heralded the height of the migration crisis for Central Europe: over 500 people, on their way westwards to seek refuge, broke their immobilisation near Budapest's main train station by proceeding on foot towards Austria (Kallius et al., 2016; Kornberger et al., 2018). This led the Austrian state to open its borders. Subsequently, efforts of the civil society played an essential role in providing aid and shelter for newly arriving migrants, thereby averting a humanitarian catastrophe (Simsa, 2017). A lack of response from state institutions prompted collective action of citizens – for example, humanitarian relief at Vienna's main train station was operated by a volunteer movement that had not existed before (Kornberger et al., 2018). This was a highly visible, if just one of many, examples of citizen activism to cope with the influx of refugee seekers. Approximately 300,000 would cross the borders of Austria (population 8.7 million) until the end of the year, posing a continuous humanitarian and logistical challenge (Kornberger et al., 2018).

METHODOLOGY: STUDY

This study was set up immediately following the extensive efforts of civil society during the migration crisis in 2015. We investigate the following research questions from the viewpoint of the formal crisis response system:

RQ1 How was the spontaneous volunteer effort during the recent migration crisis perceived by representatives of the formal response system?

RQ2 What organisational structures, measures, or tools were in place to integrate spontaneous volunteers into formal relief efforts?

RQ3 What were the obstacles encountered in the integration of spontaneous volunteers into formal relief efforts, if any?

To address these questions, we conducted two group discussions and two complementary interviews. Both group discussions were held with representatives of formal organisations that provided disaster relief as part of their ongoing work. Interview partners were representatives from public agencies, mediating between formal organisations and volunteers. The participants and their referential identifications are given in Table 1.

Affiliation	Participants	Method	Denotation
Formal relief organisation	CDM professionals from tactical and operational levels who worked with volunteers over the course of the migration crisis.	Group discussion	*<f-1>...<f-6>*
Mediation agency	Persons in leading roles who work to conciliate formal organisation's open volunteer positions and citizens who want to become active as volunteers	Semi-structured interviews	*<m-1>,<m-2>*

Table 1. Study participants

While group discussions examined the challenges that the formal response system experienced in the involvement of untrained citizens, the interviews investigated mediating agencies and how the crisis changed their work routines. Group discussions and interviews were of semi-structured nature. Detailed questions and guidelines were prepared in accordance with our research questions. However, participants were encouraged to speak freely and were allowed to deviate from the original topic to some degree.

The group discussions and interviews yielded a total of 6.2 hours of audio data. This audio data was transcribed entirely; forming our data set. Eventually, we conducted a thematic analysis (Braun & Clarke, 2006) on this data set. This approach was abductive, i.e., the themes were derived from the data (as opposed to fitting data into pre-existing themes). Coding of the data set was done according to our research questions. Encoded text passages constituted our initial data items. Data items were arranged into *topics* on a semantic level; an exemplary topic is the collection of data items addressing the use of pen and paper to register volunteers on site. Topics can exhibit a high level of inter-connectedness, forming over-arching *themes*. Identifying and describing these themes was the first analytic step not directly based on the original data set.

As themes became entangled with each other, adaptions were needed to disentangle them, while asserting their grounding in the original data set. Some themes were discarded for lack of proper grounding in the original data set, others were merged or split to account for internal variances or contradictions of existing and emerging

themes. For our analysis, themes provide both a layer of abstraction from original data and a lens through which to view and interpret topics and data items. Thus, the analysis process becomes iterative: as we discover new themes in the original data set, we can look at and interpret previously identified topics and themes from a different perspective. Sometimes this led to adaptions of existing themes. We reiterated this process until individual themes were sufficiently distinct from each other.

Our themes captured organisational and technological aspects of the interaction between volunteers and formal organisations. Themes held answers to our research questions, but did not offer a satisfactory amount of insight about their effect on relief efforts. We introduced the concept of a *dynamic view* to help us derive implications that our themes have; implications for the integration of spontaneous volunteers as an effort by command and control to conduct efficient relief. The dynamic view offers a new lense on our analysis, by asking how each theme affects relief efforts. We ensure a continued relation to our research questions by not changing the themes themselves, but aggregating them based on their meaning for the integration of spontaneous volunteers.

ANALYSIS RESULTS: DYNAMICS OF INTERACTION

Figure 1 is intended to guide the reader through our work via four dynamics (elements III, IV, V and VI). They will form the basis of discussing eventual technological support (elements A and B). The dynamics are rooted in a perceived need to contribute (element I) and affect the efficiency of relief efforts (element VII).

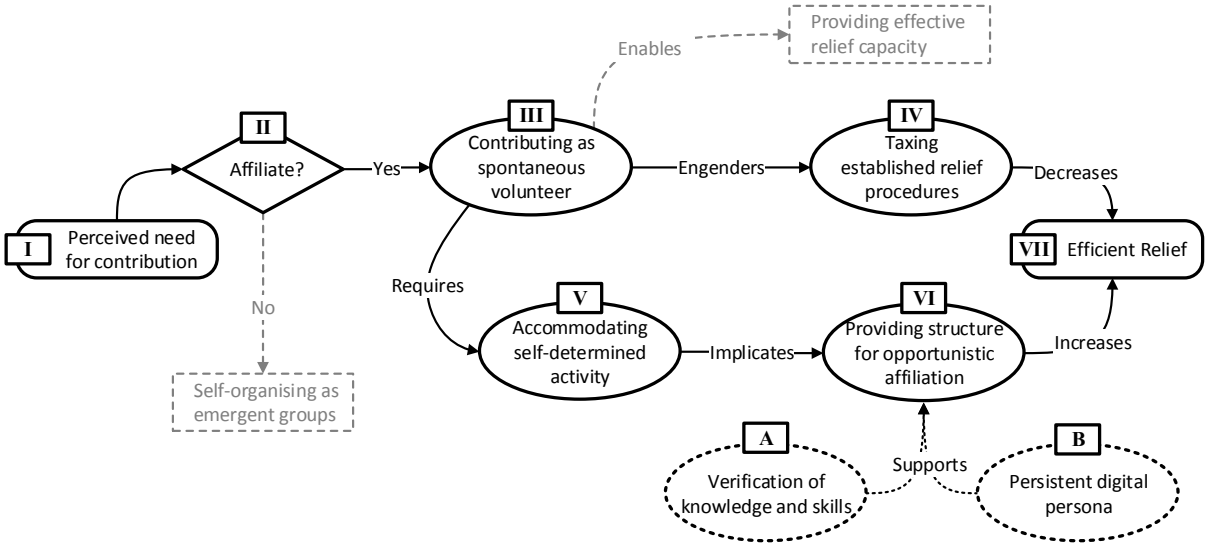

Figure 1. Dynamic view of interactions between spontaneous volunteers and emergency organisations

Motivation to Volunteer (Figure 1, I)

Volunteers in CDM are, per definition (Plagnol & Huppert, 2010; Whittaker et al., 2015), conducting relief efforts of their own free will, without coercion. Thus, their motivation must be intrinsic, i.e., be the result of their own initiative. The actuator, purported by literature (Dynes, 1994b; Lowe & Fothergill, 2003) and affirmed within our own data, is the perception of a need for one's own contribution – to 'do something'. The focus of this paper is on spontaneous volunteers (who are not affiliated with any formal organisation), in contrast to affiliated volunteers (who have registered with a formal organisation).

Becoming a Spontaneous Volunteer (Figure 1, II)

After a volunteer perceives a need for contribution and decides to 'do something', we make a distinction between two forms of volunteer activity. This was articulated by representatives of formal relief organisations in our own data.

> *Like spontaneous volunteers that came to [incident site] and said, 'I have two good hands, put me to work where you need me'. That's a different approach than going 'I drive over there with some soup and then I'll decide where to distribute it, without coordinating'. In my opinion, those are two different demographics. (<f-4>)*

Does a citizen become a volunteer, approach a formal organisation for guidance, or even for orders, or does s/he

pursue activities of his or her own choice? Deciding for the latter, for whatever reason[2], entails a whole different set of problems, which exceeds the scope of this paper. Instead, we focus on citizens that intend to approach formal organisations, at least for guidance in their efforts, if not outright tasks or orders.

Contributing as Spontaneous Volunteer (Figure 1, III)

Spontaneous volunteers contrast affiliated volunteers (Whittaker et al., 2015) or permanent disaster volunteers (Britton, 1991) in three aspects, as far as our own data is concerned. Firstly, the volunteer decides time and place of their contribution. <*f-1*> recalls that many volunteers chose to participate for a limited time on very short-term notice; giving the example of someone showing up to help for two hours because they missed their train.

Secondly, a 'project-related' <*f-1, f-5*> form of volunteering, whereby volunteers choose the circumstances of their contribution, instead of entering a long-term affiliation with an organisation. <*f-1*> notes how 'the classical volunteer' will disappear over the next decades, while project-related engagement will rise – a trend they increasingly noted during the migration crisis. <*f-5*> concurs by stressing the difficulties in dealing with it.

> *This realisation that you [<f-1>] mentioned, that there are more project-based volunteers, is also noticeable for us and now there is this reflection: how do you handle that, how can you integrate that reasonably? (<f-5>)*

Thirdly, confirming previous research by Hustinx & Lammertyn (2003), <*f-5*> states how project-oriented volunteers often relate less to the organisation that provides the frame for their activity:

> *There are many volunteers at work in [relief organisation's] facilities that have basically no relatedness to [relief organisation]. Indeed, it was the case that some people, primarily with migratory background, who worked as translators, told me they never heard of [relief organisation], asking me what that is and if it's a new thing. (<f-5>)*

It stands to reason that the migratory background of volunteers was the reason they never heard of that specific relief organisation. The point, however, is that, in line with the more transitory nature of participation, volunteers may pay less attention to which organisations provides the frame for their contributions. Overall, data gathered from representatives of the formal response system suggest that there is a decreasing socialisation of volunteers in the emergency system.

Taxing Established Relief Procedures (Figure 1, IV)

Spontaneous action of individuals may lead to stress in the formal response system, decreasing relief efficiency through increased administrative overhead or contravening other efforts by unfocused action (Figure 1, IV → VII). Without guidance or information concerning the overall operational picture, spontaneous volunteers may inadvertently undertake actions that contravene other relief efforts (<*f-6, m-2*>). This includes the donation of commodities, the handling of which binds further resources (<*m-2*>). Lack of guidance may be caused by shortage of commanding personnel as well as unawareness (<*f-1, f-3, m-2*>) or unwillingness (<*f-2*>) of volunteers to integrate into command and control structures. A second stressor stems from the administrative overhead when registering newly arriving spontaneous volunteers. Formal organisations require volunteers-to-be to formally register for legal coverage and insurance. This is done mostly on premise, using pen and paper (<*f-1, f-2, f-4*>), binding resources at various levels.

To mitigate the stress of spontaneous volunteer participation, programmes for pre-registration of volunteers had previously been established and technological support attempted, c.f. (Auferbauer et al., 2015, 2016). <*f-1*> states that the purpose of such pre-registration, then, was to not have spontaneous volunteers on site, yet the situation was different during the migration crisis:

> *You couldn't put people to good use if they just showed up then, because they caused more trouble than they were helping. […] But that is different now, because now we need people who come [to shelters] directly. […] Today, in running operations, when someone comes over, they are welcomed and invited to start immediately (<f-1>)*

It appears that volunteers who were already enrolled in the organisation's volunteer programme (i.e., pre-

[2] Including: dissent regarding the objectives set or the way they are to be achieved; a lack of presence of visibility of formal organisations; or personal preference to work apart from hierarchical structures.

registered volunteers) also queried information in advance; to be briefed where to go and whom to report to (<*f-2, f-4*>). This indicates that even pre-registered volunteers will not necessarily wait for orders and can be part of unwanted convergence.

Accommodating Spontaneous Participation (Figure 1, V)

Formal relief organisations try to accommodate spontaneous participation through their existing organisational structures. Yet sometimes the volume of participation outgrows the expansion capacity of these structures:

> *<f-4>: I hope [regional command] drew experience from this. That we need to educate and train more people for leadership positions.*
> *<f-3>: Yes, those were lacking-*
> *<f-4> Because helpers we had in great numbers.*
> *<f-3> […] That's because we in Austria, with our column-oriented system, expect a fixed number of required leadership positions. But that this system is suddenly expanded and additional leaders are required for the newly added structures, well …*

A 'column-oriented system' refers to an organisational structure with more depth than width; where a leader is responsible for the 'column' (of persons) behind them. The more volunteers participate, the more columns (and leaders) are needed, which can ultimately lead to a shortage on persons in commanding (leading) positions. <*f-2*> and <*f-3*> argued for greater scalability of existing structures, to better accommodate large numbers of new volunteers. <*f-1*> suggested using the time between incidents to qualify volunteers for leadership positions.

A faster and more flexible registration process for newly arriving volunteers is one possibility to accommodate spontaneous volunteers (<*f-1*>). In contrast to previous volunteer programmes, where *a priori* registration and training was required, spontaneous volunteers have the option to sign up on premise and subsequently contribute immediately. Registration was done with pen and paper to enable *ad hoc* data collection, due to the easy availability and high reliability of the medium (<*f-1, f-4*>). However, the paper-based medium has issues:

> *<f-2>: But the data of these contributors, do you submit them [into the established volunteer programme database]?*
> *<f-1>: No, that is currently not planned. At the moment, it is a mountain of paper that awaits digital inventory.*
> *<f-2>: That is exactly the challenge, yes. Well, such a sheet of paper, that has been signed, with some data on it – that just piles up somewhere.*

This suggests difficulties in information management and later analysis. Low interoperability of registrations forms between organisations aggravates this issue, as volunteers must repeat the registration processes at every organisation or site they wish to become active at. This, in turn, can lower the acceptance towards the process.

As spontaneous volunteers are not familiar with the nomenclature, procedures, and rules in CDM they need a form of leadership that varies compared to that of affiliated or pre-registered volunteers. Formal response organisations can benefit when allowing the creativity of spontaneous volunteers to manifest. As <*f-6*> puts it: 'Very good ideas come from that [inclusion of spontaneous volunteers], ones that we have not thought about before'. However, they must allow for inclusive styles of leadership.

> *And it worked best with [an inclusive] form of leadership. He [spontaneous volunteer] would probably have despaired with any commander that first instructs him on how to park so that the car is pointed toward the direction of escape and that the tank needs to be three quarters full (<f-6>)*

Providing Structure for Opportunistic Affiliation (Figure 1, VI)

The logical continuation of the accommodation of spontaneous volunteering leads towards providing a framework for what we have named *opportunistic affiliation*. Opportunistic affiliation is the act of utilising the participation structures provided by formal organisations on an *ad hoc* basis. The volunteer decides to 'do something' and acts on this decision by registering with a formal organisation on site. Both the decision and execution happen in a short timeframe. Management of opportunistic affiliation requires corresponding organisational structures. Answering <*f-3*>'s question as to the extent of the term *volunteerism*, <*f-6*> puts it thus:

> *I think you have to look at it as something larger. And that is a task for us as commanders.*

> *To not think of volunteers only as those who are overly socialised in our field anyway. Those don't need a lot of instructions. They are in the know anyway. It's more difficult with people that joined recently, that come spontaneously or especially the convergent volunteers who are there. For them, I have to provide structures of meaning[3]. (<f-6>)*

The statement implicates that volunteers can exist without formal structures and that structures can exist without a standing corps of volunteers. This represents an empathic view on volunteer management, compared to a traditional command and control approach. It holds formal organisations accountable to provide meaningful structures for spontaneous volunteers.

Participants found it worthwhile to address persons that are not actively looking for participation as part of the formal response system. <*m-2*> points out that many opportunities to participate are simply not noticeable. <*f-1*> mentions that 'a lot is being left out on the street. Potential, you know?' and <*f-4*> adds: 'because nobody asked them.' For this, <*f-3*> proposes a standardised symbol to signal volunteer opportunities *in situ*. The goal, from the authors' perspective, is not so much to attract persons that would otherwise not have become volunteers; rather, it is to make spontaneous volunteers aware that there are opportunities to become active as part of a larger organisation, instead of on their own.

A clearly visible point of contact for arriving volunteers can help formal organisations to both, distribute information and gain overview. <*f-3*> describes the need for a distinct point of reception to lower the entry barrier for spontaneous volunteers:

> *And then I'd go in and there'd be someone who is clearly visible as the person, I don't know, by wearing a hat or something, you know. I'd talk to him, he is my contact person now and knows what is going on. (<f-3>)*

<*f-1*> agrees that this could work well for small operations. However, they add that this concept would need scalability in case of major events. One person would be overwhelmed, with crowds of volunteers arriving. <*f-4*> states, with <*f-3*> affirming, that a single point of contact has been lacking during the recent crisis. Such single point of contact should also relay volunteers to their contact on site (if the contact point is not working as *liaison* outright), inform them about their insurance status, and their tasks while volunteering.

<*m-1*> reports that volunteers expend much effort at the beginning of the crisis; burning off most of their energy and over-exerting themselves. The problem of burn-out is especially prevalent for spontaneous volunteers as emergency organisations have no appropriate tools in place to oversee spontaneous volunteers on site. <*f-1*> speaks of 'helper syndrome':

> *Volunteers are in a grey area; they are allowed [legally] to work as long as they want. We had volunteers who were-- helper syndrome, they were there for 24 hours. Or longer. And they believe they must save the world and they are the only ones that can help. And you have to protect them from themselves. That is our task as organisation. (<f-1>)*

Apart from the aspect of over-extension, representatives of emergency organisations also ask for some procedure to debrief volunteers. A debriefing must include an offer for post-service support, or as <*f-3*> puts it: 'somewhere they can go if they suddenly aren't able to sleep anymore. You know, because 24 hours [working] in an emergency shelter? Hats off to them'. <*f-2*> states that, while they provided support for their equivalent of permanent disaster volunteers, they failed at reaching out to spontaneous volunteers:

> *We did not manage that so well. To reach [spontaneous volunteers] and tell them: 'listen, if you go home now and find that things are affecting you, longer and more frequently – we appreciate that you were here and helped us, but we can help you too!' (<f-2>)*

<*f-1, f-2, f-3, f-4*> agree that support structures must also include ways for volunteers to reflect on their experience and give feedback to the formal organisation.

> *<f-3>: It becomes easier for the people if they have the option to provide feedback.*
> *<f-1>: And the people want to talk about it. They are glad if they can talk about it. […]*
> *<f-2>: One can clearly see that now, when the focus lies on humanitarian help […], that people are much more affected emotionally and on the whole. […] Now, on this matter,*

[3] This is difficult to translate unambiguously. The original statement was, '*Weil denen muss ich Sinnstrukturen geben*'. The term 'Sinn' in 'Sinnstrukturen' can indicate both 'sense' and 'meaning', to be interpreted as 'sense of belonging' or as 'contribution with meaning'.

> *people write to us all the time, ceaselessly, page after page.*

Feedback can also be used by the formal organisation to draw an adequate picture of the situation for themselves and the public (<*f-1, f-3*>).

INTERPRETATION OF RESULTS AND IMPLICATIONS FOR TECHNOLOGICAL SUPPORT

Regarding *RQ1* (the perception of volunteer efforts by formal organisations), we encountered a generally positive stance on the side of formal organisations. Formal organisations tried to receive and integrate individual spontaneous volunteers, rather than attempt to suppress spontaneous contribution. With regards to *RQ2* (measures put in place to integrate spontaneous volunteers), we identified a need for rapid registration processes. The overhead of sign-up procedures and the timeframe between registration and volunteer activity are reduced; by providing reception (sign-up) on site and facilitating quick contribution. Even though measures for pre-registration had been put into place several years prior to the event, impact on preventing spontaneous contribution seems limited. Regarding *RQ3* (the obstacles encountered in the integration of spontaneous volunteers) we see challenges in the unpredictable influx of volunteers. These challenges are in part organisational, and in part technological of nature: in the organisational part, there is a lack of scalability in command structures and a need to adopt appropriate leadership styles. In the technological part, paper-based registration does not scale well over time or with an increasing amount of arriving volunteers. We discuss the implications of *RQ3* in the following section.

Implications for Command and Control Studies

While successful pre-registration programmes for volunteering are in place in Austria, the extent of self-determined contribution during the migration crisis is unprecedented in recent memory. We surmise that pre-registration programmes do not preclude a large amount of spontaneous volunteers. This assumption is based on the formation of large, self-organised volunteer groups, as described in literature (Kornberger et al. 2017; Simsa 2017; Zettl et al. 2017) and documented by high media coverage. Therefore, we propose a complementary *modus operandi*. The chain of dynamics (III) → (V) → (VI) implicates an evolving approach to spontaneous volunteering. The spontaneous nature of contributions and decreased identification of volunteers with formal organisations (III) have necessitated that the formal response system adapt to accommodate it by providing fast registration processes (V). This points towards a more fleeting form of affiliation, eventually leading to what we have named *opportunistic affiliation* (VI). Using opportunistic affiliation, citizens sign up on the spot (*ad hoc*) to conduct spontaneous participation through mature structures provided by formal organisations. Opportunistic volunteers often are (initially) indifferent to an organisation's identity and do not necessarily plan to become socialised within the organisation, or join it formally. Later, they potentially shift their affiliation to another organisation, to contribute towards a different project or perceived need.

Supporting opportunistic affiliation poses an organisational challenge to command and control structures. Two organisational changes appear crucial. First, a change to the prevailing traditional meaning of 'volunteer'; where they are affiliated with, and part of, a formal organisation (Whittaker et al., 2015). In the traditional understanding, a volunteer always exists, epistemologically, as part of *one* organisation; put differently, the system in which the volunteer exists is limited to one formal organisation. If volunteers affiliate with a different organisation, they become a different volunteer – their experience, capacity and skills not proven in the new system, thus facing a 'legitimacy hurdle' (Barsky et al., 2007). To support opportunistic affiliation, it is necessary to understand the volunteer as an entity that exists independent of any formal organisation. Second, command and control structures require surge capacity to manage the unpredictable influx of opportunistic affiliates. We hypothesise that pre-registered, trusted volunteers can be trained *a priori* for leadership positions in expanding command structures, as suggested by <*f-1*>. In this scenario, pre-registered volunteers would be deployed not only to support the relief efforts through direct contribution; but also to cope with the influx of spontaneous volunteers. Further operational requirements to support opportunistic affiliation are: visibly indicating participation options, offering a single, well-marked point of reception on-site, fast registration processes and support structures to prevent overworking.

Based on the organisational implications of opportunistic affiliation and the technological challenges in volunteer reception, we propose two applications for computational support that can help to the integrate spontaneous volunteers: 1) verification and long-term storage of digital volunteer data and 2) selective digitalisation of reception and registration processes to provide scalability.

Digital Verification of Experience (Figure 1, A)

Cone *et al.* (2003) have previously stated that 'without a means of real-time validation, [unknown individuals] are irrelevant to an incident commander' while Barsky *et al.* (2007) described how volunteers can become 'side-lined' because their capacity, background, and knowledge are difficult to verify. Quick and reliable verification of a volunteer's background and previous interactions with the formal response system could help to identify volunteers to fill gaps – or determine who is granted access to the incident area at all.

One technological implementation of this could be achieved through a distributed, permissioned ledger system, consisting of a complete list of a volunteer's previous experiences and activities in CDM. Whenever a volunteer participates in CDM, the formal response organisation adds the participation to the ledger (transaction). The transaction is verified by the organisation that enters it. Metadata can enhance transactions detailing the skills shown or gained of the volunteer. Finally, a body of formal response organisations (forming a trusted consortium) participating in the distributed ledger verifies every transaction. Therefore, any identification that is linked to transactions in the ledger enables a volunteer to immediately present a certified history of prior involvement with the consortium. To ensure privacy, read access needs to be restricted to the consortium and trusted individuals (e.g., the volunteer that is concerned by transactions). The concept of a distributed ledger implicates a persistent digital persona for volunteers, which we will discuss in the next section.

Persistent Digital Persona and Reception (Figure 1, B)

Computer supported registration processes can provide the scaling required when coping with opportunistic affiliation. While dedicated areas for registering, briefing, verifying, and tasking arriving volunteers have been proposed (Sauer et al., 2014), a digital counterpart has not been established (Waldman & Kaminska, 2015). We will discuss computational support by means of a three-stage process:

1) Registration: While digitalising the management of pre-registered volunteers has been addressed by researchers (Auferbauer et al., 2015, 2016), the registration of volunteers is still primarily done by pen and paper.

> *Now, [the registration protocol] is simply a sheet of paper. And the people at the other shelters, they don't know if this sheet has been submitted already or not. This is very important, so that [the volunteer] has insurance. We managed to make people internalise this: if there is uncertainty, fill out the form again. We can always discard it later. (<f-1>)*

Pen and paper are obtainable under most conditions and highly reliable. However, their scalability and sustainability are limited. Participants themselves suggested that this could be solved by *a priori*, digital registration 'as a self-service' (e.g., a smartphone application) while a volunteer is still on their way to the site (<*f-1*>). As part of the self-service registration process, volunteers should be linked to their contact on site (<*f-1, f-3*>). The last step, even in a digitalised registration process, has to be a personal check-in to brief the volunteer and not completely devoid this process of human interaction (<*f-3*>). From a process-oriented, technological perspective, this would be the step where a unique identifier is created and verified for the volunteer, based on the data they have entered digitally. This unique identifier is a prerequisite for the stage 2.

2) Digital Persona: if a digitalised registration process is implemented, a persistent digital persona for volunteers can be generated. There are two options for introducing a digital persona. The first option is to let the entirety of a volunteer's previous participation, as registered in a distributed ledger system, constitute the persona. The second option decouples a volunteer's personal data from their activity and implements a locally stored 'volunteer passport'. This way, each volunteer stores their profile locally on their own smartphone. Such a local volunteer profile is created during registration and is verified and digitally signed by the registering organisation.

3) Check-in / Check-out: Cone *et al.* (2003) pointed out that spontaneous volunteers are not part of any formal accountability system. This makes it difficult for official response organisations to contact them or track their presence. Such accountability would be necessary to prevent overworking (<*f-1, f-3*>), for debriefing (<*f-3, f-4*>) or for support requests (<*f-2, f-3*>).

> *It is not certain that in all cases that [volunteers] will come out of the shelters again [on their own]. Because they could get into a situation where I, representing an organisation, need to know: did they leave at all? (<f-3>)*

A computer supported, digitised check-in and check-out point can be supplied for volunteers that already have a digital persona. To find suitable locations that serve as such checkpoints will require further research. Technologically, there are multiple options for digitalised check-in and check-out points: near field

communication (NFC), radio frequency identification (RFID) or Bluetooth appear viable for fast data transmission between mobile devices and situated checkpoint terminals.

DISCUSSION

This paper presents a systematic description of the mutual effects between spontaneous volunteering and the formal response system's endeavour to accommodate it. Building on top of this description, we identified areas for improvement and gave indication for technical backing and assistance. There are two aspects about (technological) support for opportunistic affiliation that we will discuss in detail.

Privacy and Human Factors in Digitalisation

Throughout our research project, participants – emergency organisations and mediating agencies – emphasised the importance of human interaction. All participants highlighted human beings over web portals or information kiosks or billboards, when referring to contact points or volunteer receptions. Thus, even though we propose technological support, we would stress the importance of face to face interaction.

Creating persistent volunteer personae entails transparency that can both: foster trust and harm personal privacy. Volunteers must, at all times, have sovereignty over their data, the procession thereof must be transparent and data procession must not happen without explicit permission. However, even data that is shared willingly has implications when recording a volunteer's activity. If a volunteer's data becomes public (as the result of a data breach, policy change, etc.), it can have unintended societal effects. Volunteers may experience negative backlash, as during the migration crisis, or receive retro-active benefits for their past volunteer activity. Especially the latter can encourage misuse of the system, e.g., tempering with digital profiles.

Temporal Event Progression and Relation to Emergent Groups

Figure 1 shows a model of the interactions between formal response organisations and spontaneous volunteers during the response phase of an event. However, these interactions are embedded in larger temporal and organisational context. Figure 2 depicts said context. Elements related to opportunistic affiliation are represented by shaded elements.

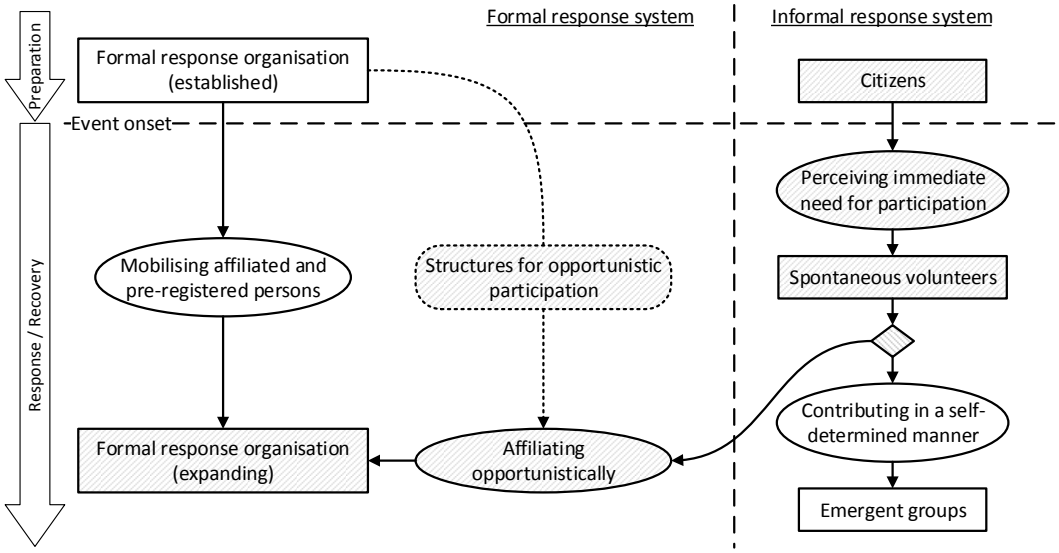

Figure 2. Temporal and organisational context of spontaneous volunteering and opportunistic affiliation

As depicted by the right-hand side path of Figure 2, citizens that do not become affiliated (opportunistically or otherwise) may participate through their own devices in an informal response system. When unaffiliated citizens collectively address perceived shortcomings in response efforts, if demands for relief are not met or existing structures are insufficient, self-organisation will result in *emergent groups* (Drabek & McEntire, 2003; Quarantelli, 1994). Emergent groups do not exist before a disaster and form new structures *ad hoc* in the power vacuum that may occur in the event's immediate aftermath (Lowe & Fothergill, 2003; Simsa et al., 2018). Research on emergent groups in the context of the migration crisis has been carried out by others. Simsa et al. (2018) link the formation of emergent groups to the inability to flexibly incorporate spontaneous participation in formal structures. Kornberger et al. (2017) point to the attractive opportunities for participation that emergent

groups offer spontaneous volunteers. Through their highly flexible structures, emergent groups present a favourable option for spontaneous volunteers, even when formal organisation have established presence. Thus, emergent groups have been proposed as intermediaries (Zettl et al., 2017) or links to spontaneous volunteers (Skar et al., 2016). Our work suggests that emergent groups are bolstered by spontaneous volunteers who have acted neither on offers for pre-registration, nor options of opportunistic affiliation (assuming these exist). Thus, we currently see two potential approaches for command and control to address spontaneous volunteers and emergent groups:

1) Offer forms of participation that are equally attractive as those of emergent groups. In this paper, we discussed opportunistic affiliation for that very purpose.
2) Accept emergence of self-organised groups and utilise their maturing structures as buffer between formal response and convergent, spontaneous volunteers.

CONCLUSION

Volunteers are an important part in crisis and disaster management, as they can provide surge capacity, but also flexibility and creativity. However, volunteers become more self-determined and spontaneous in their decisions to contribute, shifting away from long-term affiliation and detaching from formal response organisations. This autonomous and spontaneous behaviour poses a challenge for command and control structures: to integrate the activity of such spontaneous volunteers into traditional methods and procedures. Doing so is necessary, not only to utilise the capacity of spontaneous volunteers, but also to mitigate disruption of formal response efforts and prevent loss of health.

In this paper, we give a systematic description and analysis of the dynamics that emerged between spontaneous volunteers and formal organisations during the migration crisis affecting Europe in 2015. The increasingly short-term forms of volunteering lead formal organisations to accommodate spontaneous volunteers, especially through the adaption of registration procedures. The extrapolation of this trend leads to opportunistic affiliation, where structures of formal organisation are used for short-term volunteer participation, on the spot. This requires a high degree of flexibility that information technology can help to provide. We show how digitalisation of volunteer reception and a digital, secure, distributed information storage can be used to achieve both: better scaling of spontaneous volunteer management, and building trust. Implementing such a system facilitates opportunistic affiliation, one possible approach to spontaneous volunteer management.

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Taxonomy of Community Interaction in Crises and Disasters

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ABSTRACT

Taxonomies are integral to systems engineering, as they structure our knowledge of a field and so provide the foundation for technological development. We contribute such taxonomies for the field of Community Interaction and Engagement in Crisis and Disaster Management, which represents the interface between members of the public who commit to relief efforts and established organisations that have a pre-defined role in crisis management. These actors are unified in their purpose to help those in need, but also set apart by their organisational structures and modes of operation. We classify the actors of Community Interaction and Engagement, as well as the interactions between them. Our contribution outlines areas where the application of Information and Communication Technology can offer benefits to Community Interaction and Engagement.

Keywords

information and communication technology, sociotechnical systems, crisis and disaster management.

INTRODUCTION

Citizens' behaviour in the event of a disaster or crisis has been subject to academic interest for decades. The earliest research on this matter dates back to the Halifax harbour munition explosion disaster (Prince, 1920). Later, the research conducted at the Disaster Research Center of the Ohio State University investigated the sociological and organisational aspects of the involvement of citizens in *Crisis and Disaster Management* (CDM). Especially the works of Dynes and Quarantelli and their classification of organisation types are still often referred to. Since the turn of the century, the introduction of global and ubiquitous *Information and Communication Technology* (ICT) provides affordable means of rapid coordination, resulting in new forms of cooperation. The emergence of volunteer groups, which independently organise and operate through online social media and digital communication services (Liao et al., 2016; Starbird and Palen, 2013; Twigg and Mosel, 2017), attests to the influence of ICT on CDM. Citizens can now react to an incident with great reach and speed (Palen and Liu, 2007).

For this paper, we denote as *Community Interaction and Engagement* (CIE) the confluence of such committed members of civil society and the established entities of disaster relief: emergency organisations, public authorities and civil defence. Citizens and communities have been overlooked as important actors in CDM, as the field was long considered subject to the sole command and control of governmental bodies or military forces (Dynes, 1994). Although communities of civil society and their efforts in crisis and disaster relief have long been part of the research discussed at ISCRAM, comprehensive taxonomy of their interactions with other actors has not been attempted. Addressing this gap in the existing body of literature, we propose two taxonomies, of actors and their interactions, to outline CIE.

As primary contribution, our description of Community Interaction and Engagement provides a basis for determining which interactions can be supported through ICT, and facilitates a profound design of technological systems to achieve as much.

ORIGINS

We draw on insights from our own research efforts as well as related literature. Two research projects were especially influential on this paper:

1) 'Resilience Enhancement by Advanced Communication for Team Austria' (RE-ACTA[1]), concluded in 2015, aimed to bring the structure and best practices of a successful national volunteer programme to new media. Outcomes suggested that the lateral information exchange among volunteers and their individual initiative should be considered when designing for CIE (Auferbauer et al., 2016; Auferbauer and Tellioğlu, 2017).
2) 'New media technologies in crisis and disaster management for enhancing the resilience of communities' (MEDIATOR), initiated in 2015, investigates the interaction between self-organising volunteers and the established organisations for crisis and disaster management in the context of the European migration crisis (2015). MEDIATOR focuses on interactions between formal and informal actors, as described from their respective viewpoints.

Both research projects follow(ed) an empirical approach that derives ICT for CIE through induction, based on the analysis of qualitative data from interviews and field observation. Representatives of formal organisations were involved in both projects, while unaffiliated and pre-registered volunteers participated in one project each. From RE-ACTA, we inferred a need to differentiate in more detail the various forms of volunteer engagement; a classification into 'emergency organisations' and 'volunteers' did not appear to sufficiently cover the actors of relief efforts. Data from MEDIATOR confirmed this by revealing well-organised and structured groups of volunteers that were active on a long-term basis outside the formal response system and beyond ephemeral actions of spontaneous groups. Ultimately, both projects prompted us to attempt a comprehensive taxonomy of interactions between the emergency response system and civil society as a foundation for the application of ICT in CDM.

RELATED WORK

A typology of factors that influence multi-agency coordination has previously been proposed to the ISCRAM community by Curnin and Owen (2013). Their typology describes attributes of successful communication for coordination; whereas our present work aims to map out the purpose and participants of interactions. We consider the two synergistic, as the work of Curnin and Owen can be applied to each of the interactions we detail herein. Further, communication structure, channels and content during incident response have been described in a detailed, scenario based manner (Eide et al., 2013); primarily considering information exchange within the formal emergency response system, but lending some concrete examples for parts of the abstract taxonomy presented herein. Liu et al. (2013) provide a comprehensive review of existing ontologies and their applicability for CDM; within their conceptualisation of subject areas, our present work would likely concern 'processes', for which the authors report no ontologies similar to the one proposed herein.

TAXONOMY OF ACTORS

In this work, we distinguish between actors based on their socialisation in the field of CDM, meaning their internalisation and incorporation of norms, values and social behaviours related to CDM. In Table 1, actors of CIE are shown in two categories, each ordered by increasing level of socialisation.

Together with established organisations, volunteers play an important role in relief efforts. However, the definition of 'volunteer' varies between organisations, context of activity and cultural background (Whittaker et al., 2015). As *unaffiliated volunteer* we define a person who is participating in relief efforts, but is not part of an organisational structure that has a predefined role or obligation in CDM planning. The unaffiliated volunteer acts outside of the formal crisis management system and has thus been referred to as 'informal volunteer' (Whittaker et al., 2015). The *pre-registered volunteer*, on the other hand, has signed up with a volunteer programme or platform (possibly managed by a formal organisation, see below) and has, as such, become part of an organisational structure (Neubauer et al., 2013). However, they have not entered a long-term membership association with a formal organisation for crisis management or disaster relief. *Affiliated supporters*, on the other hand, hold membership status with a formal CDM organisation, thus being subject to different obligations (e.g. mandatory training or adhering to the chain of command). They may be volunteers, receiving little to no monetary compensation for their contribution, or employed by the organisation they are members of, contributing as part of their gainful employment. Lastly, *affiliated decision-makers* are differentiated from

[1] http://www.kiras.at/en/financed-proposals/detail/d/re-acta/

affiliated supporters by being afforded enough authority through embodied cultural capital to make tactical or strategic decisions within the organisational structure. While these roles may be filled by volunteers, the term 'volunteer' traditionally has included primarily those that we have classified here as affiliated. However, unaffiliated volunteers and their consideration in crisis and disaster relief have increasingly gained attention (Barsky et al., 2007; Harris et al., 2017; Neubauer et al., 2013; Twigg and Mosel, 2017; Whittaker et al., 2015). They may be regarded as disturbance, as valuable resources or as critical factor for recovery, depending on the observer's viewpoint (Rogstadius and Teixeira, 2013).

Individual actors	
Unaffiliated volunteers	Persons intending to participate spontaneously in relief efforts without prior affiliation to formal emergency organisations.
Pre-registered volunteers	Persons who have signed up for a programme or initiative and conduct their activity within its organisational boundaries.
Affiliated supporters	Persons who have membership status in a formal CDM organisation, who conduct their activity along its organisational structure.
Affiliated decision-makers	Persons who have membership status in a formal organisation, who are afforded decision making in its organisational structure.
Composite actors	
Emergent groups	Formed through the self-organisation efforts of persons as reaction to a crisis or disaster event.
Supporting organisations	Established organisations that participate in relief efforts, but do not engage in such activity as part of their regular operations.
Formal CDM organisations	Established organisations whose regular objectives include crisis and disaster management activities.

Table 1 Taxonomy of Actors in Community Interaction and Engagement (Summarised)

Individual actors, as they are outlined above, can form compound entities with a complex organisational structure. Most prominent among these are the established *formal CDM organisations*, whose regular functions include responsibilities in disaster relief. Emergency organisations, humanitarian aid agencies, civil defence and public authorities all have a pre-defined role in CDM; legally and socially, though their involvement and role varies based on cultural context. Their capacity and contributions are included in *a priori* planning. They rely on organisational structures, hierarchies and formalised procedures that have existed before the onset of a crisis, comprising the formalised side of CDM.

When unaffiliated volunteers coordinate to address perceived issues, emergence of organisational structure can follow, in the sense of institutions (Berger and Luckmann, 1967). *Emergent groups* form their own identity as a collective and build organisational structures to varying degrees of complexity. They are institutions *in status nascendi* and become more than a simple gathering of unaffiliated volunteers. Emergent groups may be organised with little vertical hierarchy, later developing more formal hierarchies and division of labour. We define emergent groups as a collective of individuals that has formed an organisational structure after the onset of a crisis or disaster, with the purpose of meeting challenges posed by the causal event. As with unaffiliated volunteers, emergent groups operate outside of formalised CDM system and often find no consideration in the planning of response efforts. For an in-depth discussion on the topic of emergent groups, we refer the reader to Drabek and McEntire (2003) as well as Twigg and Mosel (2017).

There are communities within the public whose structures have existed before the onset of the event, but were not established for CDM. These *supporting organisations* take on tasks that fall beyond their usual scope of activity to support relief efforts and keep their internal structures intact while doing so. Whittaker, McLennan and Handmer (2015), as an example for this type of organisation, note Four Wheel Drive clubs organising caravans, transportation and clearing debris in a bushfire event. Our classification closely follows the typology of organisations formulated by Dynes and Quarantelli (1976): formal organisations, supporting organisations and emergent groups correspond to Types I, III and IV, respectively[2]. Transcendence of this typology has been suggested (Drabek and McEntire, 2003; Schmidt et al., 2018), but lies outside the scope of this work.

[2] We have not explicitly included Type II as actor; we consider this to be constituted implicitly through formal organisations managing pre-registered volunteers and expanding in this manner to provide surge capacity.

TAXONOMY OF INTERACTIONS

In the context of CIE, we only consider such interactions as happen between an actor within the organisational system – c.f. (Luhmann, 1995) – of a CDM Organisation and one without. Further, we include those interactions that occur among individual volunteers, emerging organisations and supporting organisations. This excludes the interactions between actors within the organisational system of one or more formal CDM organisations. The taxonomy of interactions thus defined is summarised in Table 2 and described in detail below.

	Category	Functions
A.	Contribution	*Co-creating, Crowdsourcing, Crowdtasking*
B.	Dissemination	*Warning, Preparation & Education*
C.	Experience	*Telling Stories, Sharing Knowledge, Feedback*
D.	Coordination	*Awareness, Orchestration, Intermediation*
E.	Personalisation	*Reception, Personal Mobility, Acknowledgement*

Table 2 Taxonomy of Community Interactions

A. Contribution

Under 'Contribution', we classify interactions to elicit action or information from other actors.

Co-creation

In the context of commerce, (autonomous) co-creation was defined as process where 'individuals or consumer communities produce marketable value in voluntary activities conducted independently of any established organisation, although they may be using platforms provided by such organisations' (Zwass, 2010). The resulting marketable value may be placed in commons, universally shared and accessible to all. The information flow in co-creation is that of all-to-all, whereby every participant eventually has access to the information provided by any other participant. Geiger et al. (2011) classify these interactions as '[i]ntegrative sourcing without remuneration'. When we consider 'marketable value' as being information relevant to crisis management, Zwass' definition represents an approach that is popular in the CDM context. Online social networks, Micro-Blogging platforms and messengers have been successfully used to gather and share relevant situational information (Alexander, 2014; Palen et al., 2009; Vieweg et al., 2010). Support for this activity has previously been considered a worthwhile goal for community infrastructure designed specifically for CDM (Wu et al., 2008). Similarly, many platforms for Volunteer Geographic Information (VGI) are based on co-creation (Haworth, 2016; Meier, 2012). The actors involved in co-creation are primarily unaffiliated volunteers, as both producers and consumers. Formal organisations may also benefit from becoming consumers of such information, if they have the capacity to do so (Alexander, 2014; Haworth, 2016; Simon et al., 2015; Tapia et al., 2011).

Crowdsourcing

This term encompasses a wide variety of approaches, whereby one sourcing actor elicits contributions from a 'crowd' of actors (Geiger et al., 2011). In differentiation to co-creation, the sourcing and contributing actors do not necessarily share peer status in this interaction. Not every actor in the system necessarily has the authority to source for contributions. Similar to co-creation, Wu et al. have also found this type of interaction to be a goal in the design of their Community Response Grid (Wu et al., 2008), though they restrict the applicability of this interaction to incidents that are critical neither in time nor severity. Tapia *et al.* have previously discussed crowdsourcing in the context of citizen science and how this approach can benefit CDM through event detection (Tapia et al., 2014). An example of crowdsourcing in CDM is provided by GDACSmobile, where the submission of relevant information is elicited by enabling a mission space for contribution by any member of the crowd. The manner of contribution is at the discretion of the participant, i.e., which information they submit is decided by their notion of what is important. Information submitted by untrusted volunteers is vetted by a central agency before being re-released to all users (Link et al. 2013, 2015). For an in-depth discussion on sourcing in the CDM context, we refer the reader to Liu's comprehensive crowdsourcing framework (Liu, 2014).

Crowdtasking

To elicit contribution through crowdtasking (Neubauer et al., 2013), a central entity sends a request for specific

information to a selected group of participants, qualified through their skill, experience, or physical location. Crowdtasking is a one-to-many interaction that does not necessarily make contributions available to the crowd. In contrast to crowdsourcing, this interaction usually employs micro-tasking to request specific action and does not allow the submission of information on the crowd's initiative[3]. The crowdtasking concept lends itself to a form of interaction oriented towards the Command and Control paradigm, such as between formal organisations and pre-registered or affiliated volunteers (Auferbauer et al., 2016; Auferbauer and Tellioğlu, 2017). The interplay of the examples we have given for crowdsourcing and crowdtasking in the CDM context has been previously discussed (Middelhoff et al., 2016).

B. Dissemination

The dissemination of information that is relevant to health and safety of citizens in a crisis or disaster represents an exchange between formal organisations and the public as well as unaffiliated and pre-registered volunteers. Whereas in many types of crises and disasters the active involvement of helpers delivers substantial benefits while hardly imposing any limitations on their engagement, there are clearly situations in which their participation should be carefully tailored to the situation on the ground due to concerns for their safety and wellbeing in the context of a dynamically developing situational picture. Technical means of one-to-many (i.e., multicast) or one-to-all (i.e., broadcast) communications are required to inform, warn or alert the potentially affected persons about the prospective or imminent dangers. The quality of such communication is an important factor in building community resilience (Cohen et al., 2017).

Alarming

It is imperative to reach all the potentially affected persons while minimising disturbances to all unaffected persons who should not be bothered with unsolicited information (Collins et al., 2009). Traditionally, societies around the world have been relying on public radio and TV broadcasting and on siren networks in order to warn or alert their citizen about potential public safety-relevant dangers, whereas in recent years SMS, cell broadcast and mobile apps have been added to the portfolio of potential information channels (Gojmerac et al., 2016; Preinerstorfer et al., 2017). These technological advances allow crisis managers to make citizens aware of potential danger in a fine-grained, context-aware manner, alarming only those persons that would potentially be affected, while still increasing the coverage and reach of the dissemination of critical information. Citizens in large urban areas, for example, may be more reliably reached through their phones than via sirens, due to noise pollution and demographic factors (Gojmerac et al., 2016).

Preparation and Education

In the same manner as new ICT allows for a tailored dissemination of critical information in the response and recovery phase of a disaster, so does it also afford crisis managers new ways to prepare and educate citizens in between crises and disasters. The dissemination of information regarding environmental hazards to the local population has been argued to contribute to reducing the vulnerability of both individuals and society, due to an association between a person's risk perception and their disaster preparedness (Helsloot and Ruitenberg, 2004; Miceli et al., 2008). Social networks, multimedia content and web sites provide opportunities to engage citizens, e.g., in public health efforts (Merchant et al., 2011). A wide variety of smartphone applications are already targeted at providing educational material to citizens (Bachmann et al., 2015). Contemporary ICT could be used to further tailor and personalise the disseminated information to the needs and context of the recipient, as well as monitor their perceived and actual level of preparation.

C. Experience

The exchange of personal experience among actors is a category of interaction that serves multiple distinct purposes, depending on recipient and intent of communication.

Sharing Knowledge

The content transmitted during knowledge sharing includes best practices and lessons learned regarding the

[3] We consider this sufficient differentiation between crowdsourcing and crowdtasking. However, the two are undeniably related: crowdtasking has been classified based on Liu's crowdsourcing framework (Liu 2014) by Auferbauer *et al.* (Auferbauer et al. 2016) and further fits the type of crowdsourcing process that Geiger *et al.* defined as 'selective sourcing without crowd assessment' (Geiger et al. 2011).

originating actor's past activity in their respective roles and fosters the collaborative learning of practically relevant knowledge, pertaining to disaster management processes themselves. The information flow in this activity is considered many-to-many; shared knowledge is accessible to all participants of the information system. Supporting this function for emergent groups and unaffiliated volunteers may require different approaches than knowledge management in formal organisations. Due to the high volatility of emergent groups, Majchrzak et al. (2007) suggest that a Transactive Memory System for such entities likely consists of links between tasks that are required and the skills needed to perform these tasks, rather the currently supported links between person and expertise. As the formation of a knowledge base and sharing mechanisms is a normal social process during institutionalisation, it will be necessary to determine the viability of ICT support during the different phases of formation.

Telling Stories

Storytelling is an emotional way of sharing knowledge and creating interpersonal social reality. People connect to common narratives by talking about episodes through the filter of their socialisation. The psychosocial component to cope with distress is important, considering that volunteers are prone to higher mental health impact after volunteering in disasters (Thormar et al., 2010). The content of information exchange shifts, from purely practical subject matter, to experiences that have been stressful for the participant or accounts of their current situation. Participants in our interviews during MEDIATOR have stated that such exchange gives them the feeling of not being alone in their efforts, that their activity is not futile. One participant told us how regular exchange regarding their group's activity has become ‘a form of self-help’. Representatives of formal organisations in our group discussions have shown awareness of the importance of this function. They report having established dedicated (digital) points of contact where volunteers can submit accounts of their experiences, and that this feature has found heavy use. Telling stories can either be done via many-to-many interactions, e.g., via a public forum (digital or physical), or in the form of many-to-one submissions of accounts to one actor. Said actor may then selectively disseminate stories they receive to the public.

Feedback

Giving feedback is a one-to-one information exchange, where an individual volunteer submits an account of their experience to a formal organisation. This is intended to either provide emotional relief (regarding an experience that occupies the mind of the volunteer), or to improve the work of the formal organisation (as perceived by the sender). It is differentiated from knowledge sharing and telling stories by being targeted at one specific actor and the subject matter being not necessarily applicable or relevant to actors not involved in the exchange.

D. Coordination

Coordination has been defined as ‘the act of managing interdependencies between activities performed to achieve a goal’ (Malone and Crowston, 1990) and interpreted as the arrangement of tasks for cooperation through organisation of activity that prevents loss of communication and efforts (Fuks et al., 2008). Solutions for coordination aim to facilitate that actions are planned and conducted in such a way that they utilise the synergies between them and avoid redundant activities in the pursuit of a common purpose.

Awareness

It has been accepted for more than two decades that awareness of participants’ activities is critical to cooperation, as far as computational support is concerned (Dourish and Bellotti, 1992). In the context of CDM, that means awareness regarding relief activities of other helpers, capabilities of actors (such as time to deploy, number of personnel and available equipment) and their know-how as well as their organisational structure (so far as it is relevant to coordination). This function becomes especially important when considering interactions between emergent groups and formal organisations: due to the volatile nature of emerging structures, it is difficult for other actors to keep track of their formation and establish contact with the right liaison. During group discussions in project MEDIATOR, formal organisations have reported difficulties when trying to establish communication with emergent organisations, because they were not aware of qualified[4] points of contact. Further, we found that formal organisations would appreciate more awareness regarding the presence and activity of individual, unaffiliated and pre-registered volunteers, to prevent them from overworking

[4] Qualified, in this case, does not necessarily mean that the liaison is in charge or speaks for all the group, but they need to have enough internal standing to act on information. This is particularly true for groups with less vertical hierarchies.

themselves and burning out; volunteers were reported to do shifts that sometimes span multiple days. Considering this, we feel that ICT could contribute through e.g. the concept of awareness by shared feedback: the ability to passively monitor other's action, through continuous and automated status updates, allows the tailoring of one's own contribution and elicits response (Dourish and Bellotti, 1992).

Orchestration

Actors that 'understand' each other, in vocabulary and manner of organisation, can use the same communication channels to work towards a common goal and coordinate *ad hoc*. Orchestration has been investigated as happening between unaffiliated volunteers, resulting in emergent groups. Starbird and Palen (2013), for example, have reported on the work of the initiative 'Humanity Road', consisting of digital volunteers, which was orchestrated to support relief efforts by information processing. This initial orchestration has resulted in an organisational structure with formalised activity and processes. Another example of orchestration has been noted by Kaufhold and Reuter (2016) when they discussed the role of a 'moderator', filled by unaffiliated volunteers, who used social media to mediate supply and demand and to organise other volunteers. They further remark that coordination with formal organisations, in contrast, did not work through social media, which suggests a need for intermediation (see below). For a more in-depth investigation into orchestration, we refer to the publication of Liao et al. (2016).

We would remark that the endeavour of providing a specialised ICT solution for orchestration in CDM likely yields a questionable ratio of benefit to effort when unaffiliated volunteers are involved. In our current research on project MEDIATOR, we found that volunteers can well organise mature organisational structures for orchestration of work within large groups, without the help of specialised ICT solutions. Contemporary online social networks and messengers are sufficient for this purpose and indeed are preferred due to their familiarity. Such observation is in line with works that have reported on volunteer's creative appropriation of technology (Starbird and Palen, 2013; Voida et al., 2015) and social media being well suited for the purpose of volunteer collaboration in disaster response (Waldman and Kaminska, 2015).

Intermediation

Intermediation focuses on bridging the gaps between actors that do not share common communication channels, vocabulary or organisational structure - i.e., cases where interoperability is low. It is not so much the task of coordinating actors in their cooperation towards a certain goal. Rather, intermediation aims at establishing a common ground that makes coordination and cooperation viable in the first place. Such intermediation can contribute specifically to the relation and interaction between unaffiliated volunteers, emergent groups, supporting organisations and formal organisations - actors who follow different organisational structures and are likely diverse regarding their regular activity outside of crisis or disaster situations. Research on a platform to match reports of displaced and found pets in the aftermath of a disaster (Barrenechea et al., 2015) is one example of intermediation through ICT. By providing an appropriate data structure and pulling data from social media into the platform, information is made more accessible to formal organisations (shelters) and exchange is facilitated.

In intermediation, social media channels alone appear to be of limited applicability. While they work well as tools for volunteers to orchestrate efforts with their peers, formal organisations have as of yet not institutionalised them for two-way communication (Alexander, 2014; Simon et al., 2015; Tapia and Moore, 2014). An approach to intermediation that is not primarily technological in nature is postulated by Zettl et al. (2017), who discuss the role of emergent organisations as intermediaries between spontaneous volunteers and emergency organisation.

E. Personalisation

The transitory and self-motivated involvement of citizens (Hustinx and Lammertyn, 2003) requires affordance of greater mobility, regarding the manner of participation.

Reception

Receiving (convergent) helpers is an interaction between formal organisations and unaffiliated volunteers. Due to the problems posed by convergence of people and goods (auf der Heide, 2003; Whittaker et al., 2015), unaffiliated volunteers may come to be seen as a complication, rather than a potential asset (Rogstadius and Teixeira, 2013; Skar et al., 2016). To mitigate this, solutions are required that support formal organisations in the reception of unaffiliated volunteers, while at the same time providing these helpers with information and

guidance. Arriving volunteers will be looking for information on the local situation and where to best apply their efforts. Formal organisations need to register arriving unaffiliated volunteers, to file their skills, capabilities and contact data, as well as to fulfil possible legal obligations. The On-Site Operations Coordination Centre by the United Nations Office for the Coordination of Humanitarian Affairs or the Volunteer Reception Center of the US Federal Emergency Management Agency address the reception of incoming helpers (relief organisations and volunteers, respectively). There have been no investigations into the viability of a digitalisation of this interaction, though the development of such a virtual reception centre could prove helpful (Waldman and Kaminska, 2015).

Personal Mobility

Considering the transitory activity of unaffiliated and pre-registered volunteers, we see an opportunity for ICT to contribute by providing digital identification of helpers' skills, know-how and experience. This function offers a transfer of information from individual, pre-registered or affiliated volunteers towards multiple formal organisations with the goal of quickly signing up for relief activities via an established volunteer identity. Using the concept of cultural capital according to Bourdieu (1986), this means a symbolical representation of embodied cultural capital (of experience and know-how in CDM), potentially transferring it to an institutionalised state.

From an organisational perspective, this means the establishment of a meta-organisation that issues verification of volunteer data. From a technological perspective, such an infrastructure will require a data format and storage option for volunteer data and experience that offers high usability to the volunteer on one hand and meets the standards of formal CDM organisations on the other. We are currently not aware of any such format being widely accepted in CDM. A digital persona of the volunteer could be established at the initial registration (during reception, see above) and stored locally on volunteers' smart devices. From that point, it would be available to returning volunteers as rapid form of 'checking in,' acting as identification and verification. However, the establishment of a persistent digital identity immanently brings with it issues regarding privacy and social impact, potentially leading to discriminative treatment of volunteers based on their past activities.

Acknowledgement

Acknowledging volunteers for their activity stands to reason as being a motivating factor in their engagement – c.f. (Liao et al., 2016). This may be achieved through acknowledgement and showing appreciation (Kriplean et al., 2008), highlighting the importance of a task for common goals (Zhu et al., 2012) or the impact it has on relief efforts (Voida et al., 2015). Our findings from group discussions with formal organisations show that they would appreciate a way to say, 'thank you' to volunteers, while interviews with members of volunteer groups suggest they draw motivation from acknowledgement by peers and formal organisations. Technological support for this interaction has not been extensively addressed. Providing a persistent digital persona for volunteers (see above) could enable such feedback and credit for the contributions of pre-registered and affiliated volunteers.

DISCUSSION

Methodological Considerations in Taxonomy

As Nickerson et al. (2013) have pointed out, the development of taxonomies for information systems has mainly followed an *ad hoc* approach, relying on the researchers' intuition for classification. We must count our present work among them. The taxonomy proposed herein, the dimensions and characteristics it uses for differentiation, have grown over the course of several research projects, instead of being established through a formalised methodology. Further, our classification of actors and interactions could be likened to a typology, based on sociological assumptions regarding volunteers and societal factors, rather than a taxonomy (Smith, 2002). However, Nickerson and colleagues also argue that 'a taxonomy is useful if others use it' and when it allows for observations that were not possible before. Our present work is intended to serve as basis for discussion and guidance – if it serves this purpose, which we are convinced it will, then it offers utility. Nevertheless, we aim for a formal taxonomy development approach in future work on this taxonomy.

On the Classification of Actors

In our taxonomy of actors, we have used as differentiating factor their socialisation in the field of CDM, internalised in the form of long-lasting dispositions. This differentiation is not discrete. Rather, it is a continuum along the axis of the internalisation of the norms, values and social behaviours in CDM. This represents the

degree to which a person's perception, thought and deed are shaped and changed through identification with the field. Such classification draws inspiration from what Bourdieu has termed '*habitus*' – the key between individual behaviour and the social structure of a field, formed through learning processes specific to the field (Kieserling, 2008). Also from Bourdieu (1983) comes the concept of cultural capital, which, in its embodied form ('*Inkorporiertes Kulturkapital*'), becomes part of a person and thus habitus. When we say that socialisation in CDM is used as the distinguishing attribute, we refer to the actor's embodied cultural capital in this field: their attained and incorporated knowledge regarding such things as, e.g., nomenclature, organisational structure, forms of cooperation or processes being followed.

Conversely, the differentiation between affiliated supporters and affiliated decision-makers could arguable be made based on *institutionalised cultural capital* instead, such as, e.g., titles, rank or certifications, which can be used societally to determine the cultural competencies of a person. Such symbols are canonical and confer a different kind of cultural capital than the embodied form, i.e. 'the capital of the auto-didact, which may be called into question at any time' (Bourdieu, 1986). The circumstance that these symbols likely hold more value in a hierarchical context (such as most formal CDM organisations) than they would in emergent groups, where social capital potentially plays a larger role, suggests segmentation of the field (Anheier et al., 1995). A more thorough examination of actors in CIE through the lens of Bourdieu's theories appears an intriguing prospect for future work.

Lack of Multi-Dimensional Representation

Any eventual taxonomy of CIE that aims to model a substantial part of interactions will necessarily be of multi-dimensional character; for classifying both actors and interactions. We expect distinctions to be added on multiple levels to the one-dimensional classifications in this paper. Given that the present work follows from research that is empirically disposed, space and time would be obvious candidates in the light of transcendental idealism. A spatial dimension may be introduced by differentiating between 'on-site' and 'virtual' actors (also: 'online' or 'digital'); such as in the case of volunteers (Kaufhold and Reuter, 2016; Schmidt et al., 2018; Starbird and Palen, 2013). Introduction of a temporal dimension may be based on the phases of the disaster management cycle; to differentiate in more detail the interactions we have presented. Further, our classification of interactions is based on the primary intent under which actors use ICT for interaction. It does not consider latent social functions of interactions; such as building trust (Hughes and Tapia, 2015), persuading actors (Vineyard et al., 2012) or building new structures (Liao et al., 2016).

Global Applicability

From a constructivist point of view, we consider it important to note the cultural preconceptions that influence this work. Related literature we have considered is primarily published in Anglo-American and Western European venues and written in English, which is relevant both due to the cultural context from which data was drawn and when considering that the language being used itself exerts an influence. Cultural differences will, without doubt, affect the applicability of our taxonomies and any eventual technological framework based on them.

CONCLUSION

There currently exists no comprehensive, systematic description, classification or taxonomy of Community Interaction and Engagement (or any otherwise named domain with a comparable definition). Because taxonomies are integral to systems engineering and provide the foundation for technological advances by structuring our knowledge of a field, we address this gap to facilitate future development of ICT. As the primary contribution of this work, we have provided two taxonomies for the context of CIE: one that classifies its actors and a second that classifies the interactions between them. They shall provide the reader with an improved understanding and overview of the different types of interaction in CIE and offer an outline for potential contributions through ICT.

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