

# 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.

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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].

Nonetheless, 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 unbureaucratic 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

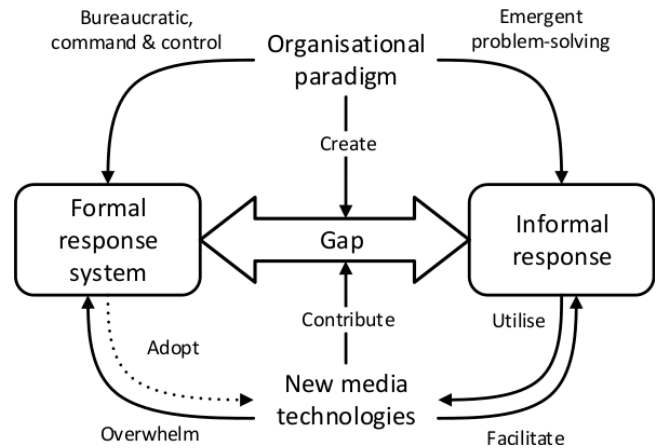


Figure 1: Gap between formal and informal response

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<sup>1</sup> 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 27<sup>th</sup>, 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 4<sup>th</sup>, 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 6<sup>th</sup>, 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, approximately 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].

<sup>1</sup>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 hindsight 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.

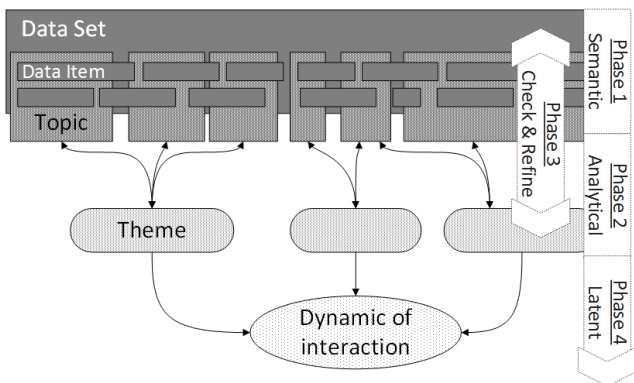
#### 4 SOCIO-TECHNICAL DYNAMICS

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 Quarantelli [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 2: Methodology used for thematic analysis**

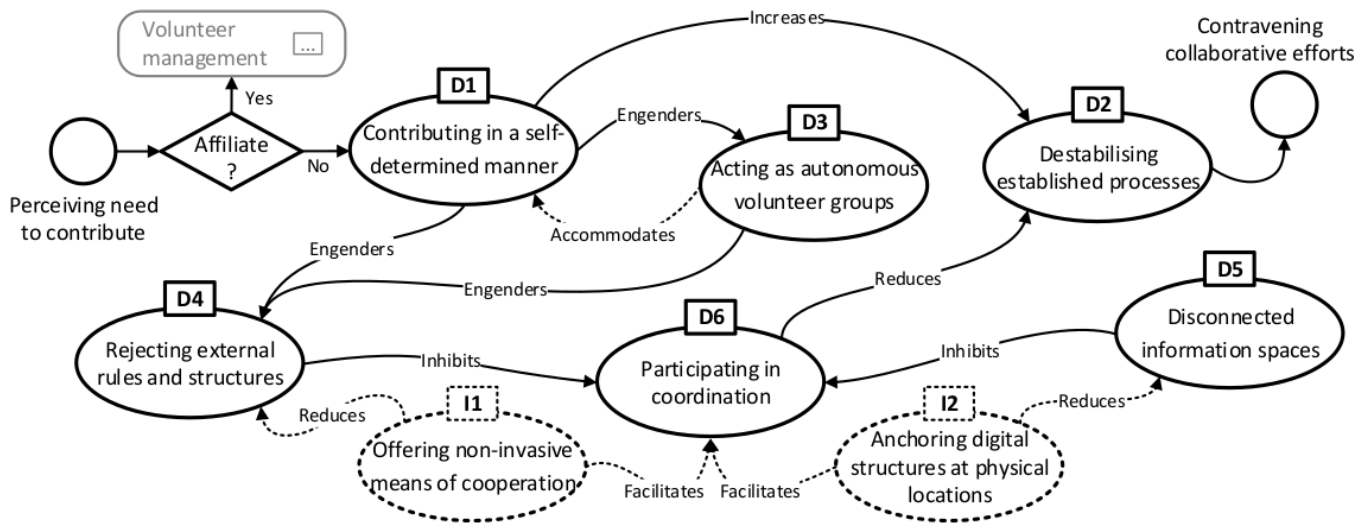


Figure 3: Socio-technical dynamics between formal and informal relief efforts, adding implications for computational systems.

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 of 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 official 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 unbu-reaucratically (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 problematic, 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 unbureaucratic 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 organisations 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



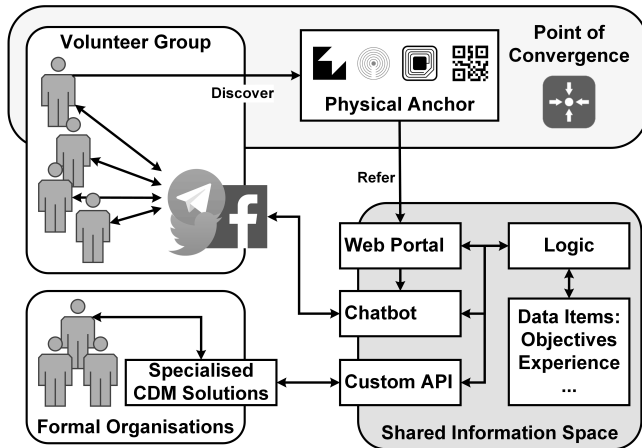


Figure 4: Example architecture combining I1 & I2

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*<sup>2</sup> 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 through 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

<sup>2</sup>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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