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Toward a Model for Building Information Awareness in Crisis Situations

Completed Research

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Abstract

In crisis situations access to information is key to reduce uncertainty and enable effective decision making. With the advent of modern information technologies there is an abundance of possibilities to obtain, process, and share information. The number of actors that can potentially provide information has grown concomitantly. The challenge therefore is no longer the availability of information but rather the ability to find and connect with actors providing information in a volatile and dynamic environment. This requires of organizations to be aware of the actors and their information potential, and actively build informational awareness. In this paper we propose a model for the development of the awareness of organizations of the information landscape during critical events. We validate this model using two case studies and extract key factors that contribute to the challenges and success of leveraging information potential of actors in a crisis.

Keywords

Personal Data Processing, Data Processing, Public Trust, Transparency, Data Responsibility.

Introduction

An increasing number of emergencies and disasters are affecting people around the world (EM-DAT 2020). This is due not only to increased exposure to risks posed by the changing climate but also to the growing vulnerability of our societies, as the interconnectedness and complexity of communities, economies, and systems rise (Helbing 2013). These interdependencies not only increase the vulnerability and susceptibility to risks, but they also raise the complexity of the emergency response to disruptive events, as the effects can be widespread and can affect many aspects of the communities involved.

To cope with these developments, a large number of actors who specialize in the various areas of emergency response have emerged, ranging from local response leaders to large international organizations (Rey 1999). The result is a growing number of people who can support the response indirectly, including logistical support, situational analysis, and other services. Individuals affected by disasters themselves have become more prominent in emergency response efforts (Baharmand et al. 2016; Comes et al. 2019), as technological developments have provided new avenues for them to generate, collect, process, and share information. As these information and communication technologies have become more common, the information environment surrounding emergency responses has become increasingly complex as well (Crowley and Chan 2011). Social media and mobile computing have been significant contributors by enabling communities to gather and share information.

In short, we identify three main developments: (1) a greater number of actors involved in emergency response, due to increasingly complex emergencies and introduction of specialized agencies; (2) new tools and modalities available to emergency responders, such as more accessible information and communication technologies; and (3) better availability of information. These developments have resulted in a more complex information landscape, in which additional actors are able to share greater amounts of information across a number of new channels. These developments present both an opportunity and a challenge for emergency responders.

Problem statement

Previous studies have indicated the importance of information to enable effective responses to uncertain and unknown situations (Comes et al. 2019). Due to technological and societal development, combined with a policy-driven focus on strengthening the role of information in crisis response, the challenges related to information shortage are becoming less acute (Walter 2005). In fact, a growing number of professionals and scholars stipulate that responders are facing an information *overload* challenge (Bharosa et al. 2011; Meesters 2021). Using crowd sourcing and digital platforms, for example, emergency responders can now bring together key information in a short period of time, even without physical presence (Crowley and Chan 2011). Furthermore, technology (i.e. social media) has created a democratization of information, enabling even more actors to participate in the information exchange during a crisis (Comes et al. 2019; Meesters and Wang 2021). Existing approaches and solutions to this information overload have a strong technological focus. (Gurstein 1999; Samarajiva 2005).

However, with the ever-expanding information environment *finding* relevant information becomes more challenging. More specifically, the challenge is to understand which actors possess information or have the potential to generate it. With the growing number of actors, the increase in available information, and the rising number of communication channels, it is both key and challenging for emergency responders to develop awareness about the potential information environment.

Research objective

Understanding how information awareness develops and how this results in an effective information-sharing network can help formal responding agencies to leverage the information potential available more effectively in their network and environment. It avoids duplication of efforts, reduces information overload, and eventually builds a more effective response. The aim of the research is to provide a common frame of reference for the development of awareness of the information environment for crisis responders. We are interested in understanding how information awareness develops in a crisis context as well as the challenges that an organization encounters in an emergency. In summary:

How does the awareness of information availability evolve in a crisis, and what drives the development of information network strategy in a sudden onset crisis?

In this paper specifically, we present the initial findings of two exploratory field studies using this common frame of reference and demonstrate how such model can help distinguish key development stages that organizations go through during a crisis response. Subsequently, we examine the key considerations, capacities, and capabilities that enable responders to overcome these challenges and to effectively manage their information awareness. In general, this model can support further researchers in examining how the nature of information management and specifically the awareness of information providers has changed in response to the growing number of responders.

Research approach

This study combines theoretical and empirical work, as highlighted in Figure 1. The starting point is the development of a framework based on the literature regarding decision-making, information, and coordination in crisis events. Specifically, we focus on the role of information-sharing between actors in an emergency. From there, we develop and define the concept of information awareness and design a first set of key activities that build to this awareness. Next, we test and revise these new activities in a research case study: a large emergency response involving a plethora of stakeholders with diverse objectives, coordination structures, and information systems. In the case, the researchers were involved in the response to support information management activities, resulting in firsthand experience with how information is found, retrieved, shared, and used during an emergency response. At the same time, our physical presence allowed for multiple methods of collecting data, including interviews with stakeholders, first-hand observations, and reviews of documentation related to information management practices. The collected recordings and notes have been transcribed and subsequently tagged using the various information activities defined in the theoretical framework.

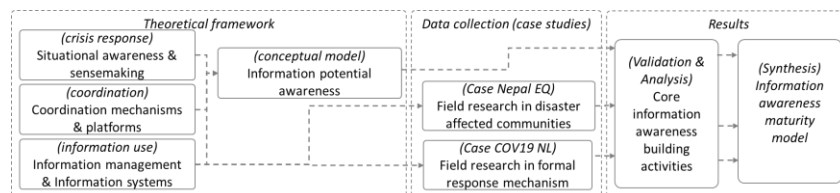


Figure 1. Research approach

Theoretical background

According to Azemi et al. (2018), information is vital for individuals and organizations to enhance decision-making. Possessing information about a subject helps reduce uncertainty and enhances awareness of a particular situation. Additionally, information helps generate adequate knowledge and allow effective work toward achieving individual and shared goals (Harrald and Jefferson 2007). Conversely, informed decision-making also requires the commitment and investment of time and resources to gather, process, and analyze information and include it in the decision-making process (Elwyn et al. 2012). Crisis situations are often characterized by high uncertainty and a reduced capacity to obtain information (Comfort 2005; van den Homberg et al. 2014). However, we have seen that the ability to generate, collect, process, and share information has increased rapidly at the same time (Meesters 2021; Turoff et al. 2004), as have the (technological) possibilities to connect and exchange information with other actors (Crowley and Chan 2011).

Coordination & Relationships

The various actors involved in disaster response, ranging from those affected directly to the wider diaspora and from local emergency responders to international donors, are all developing situational understanding (Morrow et al. 2011). However, each actor has specific information needs related to their role, objectives, and interests. At the same time, each actor also has relevant details that could address the information needs of others. Moreover, an increasing number of actors are using social networks to gather information to develop situational understanding and support their decision-making (Sadovykh et al. 2015). However, to gather valuable information, effective relationships with the appropriate actors need to be developed. For example, to gain an understanding about the needs of an affected community, it is key to work with local leaders. Critical information can reach the responding agencies only if the appropriate relationships are established (Steijn et al. 2013).

Information management and sharing

Information management during natural disasters or emergencies is a major challenge due to constraints in time, resources, as well as drastically changing information (Walter 2005). Actors requiring information can gather it from data sources such as in-field surveys, crowdsourcing, and online social networks. Such data collection approaches require the allocation of scarce resources (especially during a crisis response) to collect, process and analyze the data into actionable information. Responders also have the option to obtain and use information from other responders, avoiding duplication of efforts and information. This approach to develop information networks and shared understanding is described in the distributed cognition theory by Hollan et al. (2000) as the process during which information is shared socially to expand cognitive resources and create awareness about them.

Such approaches do still require efforts, e.g., actors need to identify the beneficiary and share the valuable details with individuals who can use them. Vice-versa those seeking information need to spend efforts finding (potential) source of information and developing effective relationships. However, as the information environment grows the information potential within the network also grows. Especially over time the formation of suitable relationships between peers and effective networks will allow actors to distribute information among larger social groups, reduce the duplication of efforts, and ensure higher-quality knowledge (Cameron and Green 2019).

Informational potential and awareness

To build these networks and relationships effectively, especially in dynamic and complex emergency situations with a large number of actors, it is key to understand which actors can provide which information. Similar to situational awareness as an indicator of the knowledge of the circumstances, *information awareness* refers to the knowledge or perception about the informational environment, in other words, to what extent an actor is aware of the various information that is available in a crisis. Akin to situational awareness, the awareness of information availability provides several benefits. Among others, it reduces the potential duplication of efforts in information management, saving valuable resources during the crisis response. It also provides decision-makers with more information to support their decision-making process. In short, increased information awareness can heighten the knowledge available to an actor, thereby improving situational awareness (Hutchins 2006).

However, information awareness is not limited only to the facts that an actor currently holds. The information itself may not exist but could be generated or obtained. For example, communities may not have details about their needs readily available, but they have the option to gather this information. It is, therefore, more accurate to talk about the “information potential” as opposed to the information readily available. Certain actors may not have information available, but they certainly possess the potential to gather more detailed, more accurate, or

higher-quality intelligence. The communities affected by a disaster are a prime example of high information potential (Comes et al. 2019; Onencan et al. 2018). Information awareness is therefore a multifaceted concept that includes aspects of coordination (establishing relationships), distributed cognition (exchanges and sharing), and information (needs & potential).

Toward a model for building information awareness

Several key steps to building this information awareness can be undertaken by an actor and are illustrated in Figure 2. These include (1) identifying one's own information needs and evaluating the currently available information, (2) identifying new actors to address remaining information gaps, (3) assessing the information or information potential of these actors, and (4) integrating these new relationships in a structural manner.

(1) Identifying information needs: These activities are often driven by an introspective analysis of one's mandate, objectives, or immediate decision-making needs (Gralla et al. 2015). These can include the needs of the affected population, the logistical possibilities, or the available resources. To fill these information gaps, an organization or actor will begin examining what information is available to address these needs such as through pre-established networks, digital coordination platforms, and relationships with other agencies. Through these modalities, an actor will create an overview of the information that is often directly available to them (Van de Walle and Comes 2015).

(2) Identifying actors: When information needs cannot be filled, an organization will undertake its own activities to generate or collect the necessary data. However, as argued, there is an increasing likelihood that the information is available from or can be obtained by other actors. Therefore, an organization can take an extrospective approach to find actors by actively searching for or connecting with them, thereby investing resources, time, and effort into the process. However, other actors may also present themselves. In this "passive" approach, an actor may reach out to the organization providing details addressing the perceived information needs (Hutchens 2006).

(3) Assessing information potential: When a new actor is identified, the next step is to assess the information this actor can provide. This includes not only whether the information addresses the need but also the quality of the data, for example, the reliability or timeliness (Bharosa et al. 2011). Other criteria that may be employed are the "fit" of the information with one's own internal systems and procedures (Turoff et al. 2004) or the coverage of the information (Azemi et al. 2018). However, it is also important to assess not only the readily available information of an actor but also the potential facts this person or organization can provide. In addition to information, actors can provide access, resources, capacities, and other capabilities to *produce* information. Furthermore, they can do so in a structural manner (Gao et al. 2011; Goodchild and Glennon 2010).

(4) Integrating relationships: To support the inclusion of the actors and their information in a structural manner, a platform, organization, or network opens up new possibilities. Specifically, it increases the awareness of the informational environment, not only through a network effect by including a new actor, who, in turn, can bring in other actors, but also because such inclusion creates a new modality and entry point for these new partners. This specifically applies to actors who are not part of pre-established structures and existing relationships such as the spontaneous volunteer initiatives that may emerge during a crisis. In other words, the development and expansion of networks provides organizations with greater awareness of the actors and their potential knowledge contributions, leading to new insights about information needs and the environment.

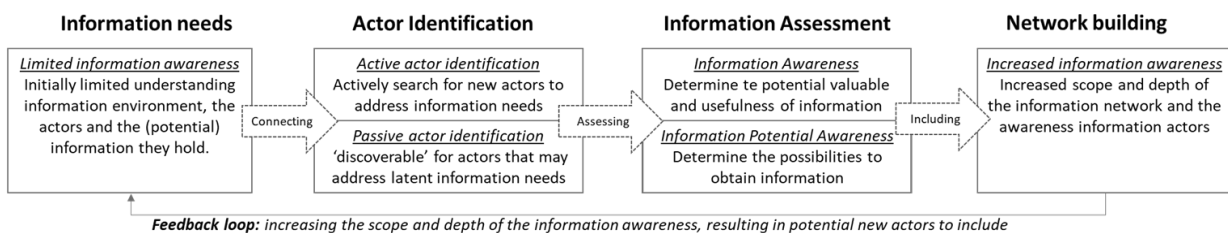


Figure 2. Proposed conceptual model for building information awareness

The process of obtaining information from other actors is not a simple request and response. Information needs may be latently present in an organization or community that does not realize what facts are needed or are valuable. At the same time, this entity may not be aware that the information already exists. In contrast, the organization may have details that could be valuable for other actors or information that may not be available but could be obtained. In short, a key aspect for organizations in a crisis is to develop the sensitivity for the informational environment in a crisis, and several activities can be undertaken to develop this.

Case studies

As the research focusses on a network-perspective of information in crisis situation, a case-study approach was followed to capture different actors building their informational awareness (Yin, 2011). The cases studied include large-scale emergency responses involving a large number of actors. The data is collected from two case studies in which the researcher was actively involved as information specialist, and which were conducted as part of joint research efforts related to the use of information, management, and systems in crisis response. The first case is the 2015 Nepal earthquake and the international response that followed involving many different organizations, including international agencies, rescue teams, national capacities, and community efforts. The second case is the initial response to the spread of COVID-19 in the Netherlands. The pandemic and its widespread impacts on social, economic, governance, and safety aspects of society forced a reconfiguration of crisis management structures and resulted in an unprecedented complex information environment.

Data collection and analysis

In both cases, the majority of the research was conducted through semi-structured interviews with a variety of actors (Yin, 2011). We specifically structured the interviews to allow participants to describe their information management approach from a practical and anecdotal narrative, using the interview protocol presented in Table 1. The interviews were recorded with the consent of the participants (verbally or in written form) and transcribed for further analysis. The interviews were further supported by direct observations and firsthand experiences from the researchers using a participatory research approach. This included attending and participating in various information activities such as meetings, assessments, and discussions with the different actors in the response.

Topic	Description
A) Introduction	Biographical information of the interviewee, the mandate, objective of the organization or team, and the specific role in the crisis response.
B) General information management approach	The information management approach and strategy employed by the team or organization, including the information needs of the organization and the existing networks and systems used.
C) Information management activities	The specific activities undertaken to identify, gather, assess, and use information in the response by the organization, including the generation of information or the use of secondary information.
D) Development of information network	The specific approach taken by organizations to identify other actors who have potential information, including the relationship formation and how these are structurally integrated or managed.
E) Reflection & closing	The factors that have contributed to successful awareness about the information availability, including how this potential was leveraged in the crisis response and lessons learned.

Table 1. Summarized interview protocol

The interviews have been transcribed and analyzed to identify key information awareness building activities that took place during the crisis response in accordance with the model presented in Figure 2. For each case study and activity, we also identified the information that actors sought after as well as information that they had available. To validate the classification applied to the interview-data, we conducted secondary data analysis using internal notes and public reports for each of the cases. Next, we classified the activities according to the conceptual model introduced and expanded the analysis with additional information obtained from the interviews according to the analysis grid in Table 2, to develop a more comprehensive understanding of which type of activities took place.

Dimension	Classifications
Information activities (a)	Based on the conceptual model, these activities include (1) identifying information needs, (2) actor identification, (3) information assessment, and (4) relationship and network building
Descriptors of activities (b)	Data to classify the activities: (1) the <i>locus</i> of these activities within the own organization, existing networks, or external environments; (2) <i>the timing</i> of these activities; and (3) <i>the scope</i> of the activities
Costs & result of activities (c)	Investments and outcomes: (1) the time and resources committed to the activity, (2) the benefits gained from the activities such as the value of the resulting information, and (3) the challenges encountered.

Table 2. Summarized data analysis grid

Case 1: Nepal earthquake 2015

On April 25, 2015, at 11:56 Nepal standard time (UTC+5.45), an earthquake with a magnitude of 7.8 Mw shook Nepal, with the epicenter located east of the Gorkha District. The impacts of this powerful earthquake included a major loss of life, with more than 8,000 people killed and 21,000 injured. In addition to the direct fatalities and wounded, many more lives were disrupted. According to reports by the United Nations Office for the Coordination of Humanitarian Affairs, hundreds of thousands of people lost their homes. The United Nations Educational, Scientific, and Cultural Organization also reported the severe destruction of several world heritage sites (Goda et al. 2015).

A large number of actors mobilized in response to the earthquake, including more than 100 international search and rescue teams, various international donors providing emergency relief items, and international agencies offering critical services to the affected population. Overall, it is estimated by the United Nations that more than 450 humanitarian agencies responded to deliver critical life-saving aid. At the same time, Nepalese emergency response capacities were also fully mobilized. Further support was provided by various government services, a large number of private companies, and other in-country organizations. Finally, the largest response came from the communities, citizens, and volunteers in Nepal, which provided direct assistance with food, shelter, and other critical humanitarian needs (Hall et al. 2017; Panday et al. 2021). The data was collected in the immediate aftermath of the earthquake as part of a research mission, in early May 2015, presented in table 3.

Focus group	Description	Data collected	Example info. needs	Example info. available
Local and regional level	Affected local communities, regional nongovernmental organizations, civic society, and emergency responders.	10 interviews 2 meetings 1 workshop Direct observation	Delivery of emergency aid, resources available to restore communities, homes, and livelihood.	Needs of the affected population, the impact on livelihood and damage to infrastructures
National level	National and governmental agencies, including armed forces & civil protection	6 interviews 2 meetings Public reports	Needs of local communities, available international resources	Mobilization of resources, baseline information, logistical capacity
International level	Foreign governments, international organizations, United Nations, iNGOs	8 interviews 6 meetings Public reports	Capacity gaps, logistical capabilities, required resources	Available international assistance. (remote) situational analysis

Table 3. Research data collection for Nepal Earthquake case

Case: Netherlands COVID-19 response 2020

In early 2020, the first COVID-19 cases emerged in the Netherlands during the time in which most of the country was enjoying the holidays. Traditionally in this holiday period, Dutch people go on ski holidays or celebrate “Carnival,” a pre-Lenten celebration in the southern part of the country. These movements and led to a major surge in COVID-19 cases, rising from the first case on February 27, 2020, to 14,000 cases one month later. On March 16, the prime minister issued the order for an “intelligent lockdown.” At the same time, the emergency services enacted their second highest response level (Kuiper et al. 2020). Since the spread of the virus grew exponentially, the national government decided that measures should be coordinated on a national level established a new coordination structure. This organization was positioned at the nexus of operational agencies, the national government, and regional safety boards. The research data was collected over a three-month period as part of an ongoing research project regarding the role of information in regional and national crisis responses.

Focus group	Description	Data collected	Example info. needs	Example info. available
Regional agencies and responders	Regional safety boards, emergency responders, regional healthcare networks, municipalities	8 interviews 4 meetings 2 workshops Public reports	(prospected) protocols to follow, additional capacity to ensure critical operations.	Available capacities, human resources, and issues for critical and governmental services.
National agencies and institutes	Specialized organizations, Ministries and executive agencies, research institutes. National COVID19 Team	6 interviews 5 meetings Direct observations Public reports	Impact of measures on critical services, resistance civil society, capacity healthcare sys.	Additional capacities to support regions, proposed legislation, (long-term) policy and support options.
Non formal responders	Individuals, groups, private organizations contributing information & analytical cap.	5 interviews 4 meetings Project documents	Long-term perspectives, possibilities for special groups/needs.	Ability to analyze impact on critical privatized sectors

Table 4. Research data collection for The Netherlands COVID19 case

Findings

While the two cases have different contexts, there are similarities in terms of the information landscape. Both cases include a diverse and dynamic emergent set of actors, each with different information needs and offers as illustrated in Table 3 and 4 above. Nevertheless, a key distinction between the two cases that is relevant to this research is that in the case of the Nepal earthquake, pre-existing structures were used, as these were designed for such an emergency, especially the initial international response (i.e., search and rescue). Standard procedures and systems provided a common ground from which to start but proved rigid at times. In contrast, the introduction of a new coordination structure in the COVID-19 case presented a challenge but allowed more flexibility to adapt to the unique needs of the crisis situation.

Evolution of information awareness

In further analysis of the interviews data, we examined the locus, the timing, and the scope of the information activities related to building information awareness in the emergency response. The objective of this analysis is to understand how information awareness develops throughout the response. Organizations go seemingly through levels of information awareness as they continue building their information awareness. With each stage the activities and focus of the organization expands outwards. In both cases, we found that when entering or joining a crisis response, most organizations follow a typical progression of activities. Even more, the activities are recurring as certain steps repeat, new actors are introduced, or the scope of the response expands. Moreover, we can see how the information awareness and network activities of an organization evolve over the course of the crisis response, which is illustrated in Figure 3 and further exemplified with quotations from the interviews below.

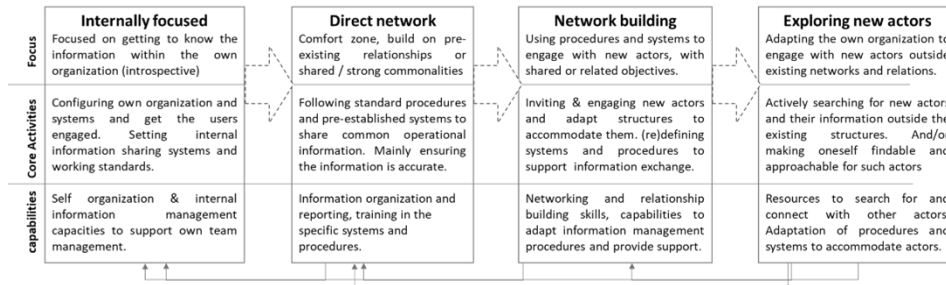


Figure 3. Maturity model for information awareness activities

Internally focused: In the early stages of an emergency organizations have an internal focus as they establish their own operations. While each organization has a basis from which to work, they will still need to adapt to the specific situation. For example, international organizations will rely on their procedures while simultaneously adjusting to the local context. Conversely, local actors may be familiar with the local context but do not necessarily have procedures in place for large-scale responses. As a result, actors will first establish their own information structures before any external information can be obtained and integrated.

“We have our systems and are trained in using them. But still, every time we arrive in a disaster situation, we need time to adjust to the local circumstances, not only regarding our facilities and base of operations but also working agreements within the team and what information we need and is available.”

—Rescue team leader in response to the Nepal earthquake

“Of course, the information is there, in our community. But we are not used to working in such as disaster context; we need to rethink how we can get the information together and create an overview.”

—Community leader of a disaster-affected area in the Nepal earthquake

To facilitate this process, organizations have certain “building blocks” or pre-established procedures or systems that can be used for recurring activities or structures. Examples of such building blocks include *standard operating procedures*. These systems and procedures provide an advantage as they reduce the time to establish the initial structures. Such systems have also been cited as hindrances, as they can be inflexible or restrictive:

“In the first days, we were put together as a team composed of people who had not worked together before, and each with a different training. It took a few days’ time before we were able to work together as we had to figure out what to use in our team. People had to learn to let go of their own systems and procedures.”

—Information officer of a section in the national operational team COVID19

In the early stages of a crisis response, the information exchange with other organizations is limited and is often centered around operational or logistical information directly related to one’s own operation. This can include the mobilization of the team, the internal reporting structures, and team management. In this stage, the main focus is on self-organization adapting systems and procedures to a given context.

Leverage existing networks and relationships (direct networks): Soon after establishing information awareness in one’s own organization, actors will begin gathering and exchanging information with other organizations. In this stage, it is useful to link an organization with other actors with whom they have pre-established relationships. Such relationships can be established through formal mechanisms such as in-country coordination systems. Relationships can also be more informal, for example, through personal relationships. Networks can also emerge during a response or be formed ad hoc, for example, in spontaneous volunteer initiatives or through community organization (Nespeca et al. 2020).

These “direct” networks are often composed of actors with a commonality such as a particular responsibility or role (e.g., rescue teams or international agencies) or a locality (e.g., local community groups), providing a “linking pin” to connect other actors. Early in the response, actors’ part of pre-existing networks and pre-formed relationships are often at an advantage.

“Within the international search and rescue teams we have agreed-upon procedures, systems, and forms to exchange information. No matter where we deploy to, we can quickly connect and work with other rescue teams that have been trained in the same way and get to work. We know where and how to find them.”

—Team leader from an international rescue team responding to the Nepal earthquake in 2015

Conversely, actors who are not part of such networks can find themselves in isolation, limiting their ability to retrieve information from others or to share any relevant information. At the same time, existing networks can also be a barrier for new actors to enter or can limit the incentive to find new actors.

“We were a group of local volunteers who had not only the technical know-how but also the local knowledge to create detailed maps of the impact of the earthquake. However, we did not know where to go with these maps or our team. Only weeks later, through social media, did we connect with the international response.”

—Local volunteer from Kathmandu Living Labs, a nonprofit civic technology company

Active network building: Next actors begin actively developing their networks, and new actors join structures with whom no prior relationships exist. There is diversity in the networks also increases as actors, their mandates, and expertise diverges. There is less use of pre-established structures and instead participants in the network jointly develop, implement, and refine their procedures. Examples of these types of networks are coordination platforms between local and international agencies. Information management becomes increasingly complex as the partners’ needs begin to diverge. For example, information can be reported from regional agencies to national authorities to create overviews, while aggregated national information is not always valuable to regional agencies. In terms of information awareness, more effort is required to understand the information needs and potential among the diverse actors. Actors who can build effective and reciprocal relationships are often at an advantage.

“Our initial thoughts were to find IM (Information Management) capacities in our team to analyze how the death rate would affect the funeral capacity in the country. We only realized later that the funeral branch was doing the same thing, but with much better information and, of course, knowledge about the sector.”

—Data analyst in the Coronavirus national operational team

Exploration of new actors: Finally, organizations and teams may also actively search out other actors who have potential information. Such actors may not even be aware that they possess potential data, but they can provide valuable details not available through the networks mentioned. They often are actors who are not directly engaged in the crisis response. Such as specialists with specific knowledge, local communities with detailed local knowledge, or the diaspora who can offer background information remotely. Compared to the previous collaborations, these are often more targeted driven by specific information needs. However, these new actors can eventually become part of a network. But this often requires strongly investing in building the collaboration.

“I actually have my students conduct a census of the village every year in my class. We have maps of the village, know the demographic breakdown, and much more. If I had known they were looking for this information I’d have happily given it to them, or even had my students conduct a new survey.”

—A schoolteacher in Nepal following the needs assessment of an international agency

Discussion

While the above application of the concept to discern different maturity stages is only applied in a case-based approach, it demonstrates the potential to analyze how information sharing between actors emerges. Nevertheless, it is important to note that when discussing information awareness it is not only referring to the awareness of information that is readily available. It also includes potential of information that *could* be generated. Vice versa, organizations and actors may also not be aware that the information they (potentially) possess could address the information needs of other actors. Such information may be latently present in an organization or community that does not realize what facts are needed or are valuable to others.

In short, a key aspect for organizations in a crisis is to develop the sensitivity for the informational environment. This sensitivity includes on the one hand the understanding of own information needs and what information is potentially available. In this case the organization would be actively searching for the information and thus requires capabilities relating to finding actors, building networks and finding information. However, it also includes the awareness of the information needs of other actors and the own information (potentially) relevant to them. Here, the organizations would rather be need capabilities to related to increase their visibility for example.

Practical implications

However, these developments also have implications for a disaster-related information management approach. Especially in crisis situations where information can be costly to obtain, and resource are scarce it is important for organizations to effectively build on the already available information and leverage the potential information from their networks. It is not only beneficial to strongly position building information awareness in the activities of responding organizations, but also a key element in democratizing the response through shared information management activities (Nespeca et al. 2020). Nevertheless, it can be difficult for organizations to expand beyond the existing structures and networks and engage new actors. These exploratory activities take time and efforts and the return on investment can be uncertain. Consequently, responders, government agencies, communities and other actors can also support their awareness development by making themselves more discoverable, their networks more accessible, and their systems more flexible. These measures are beneficial in increasing the capability of an organization to develop its information awareness and its potential for gathering vital information. Nevertheless, it will depend on the specific crisis as to what the information needs are, what other actors are present, and what their information potential is. Therefore, organizations cannot simply rely on predetermined processes or systems but need to actively determine, develop, and deploy capabilities to successfully build information awareness.

Role of communities & emerging organizations

A recurring example in our interviews of these efforts leading to the discovery of new information sources are the communities and the role of non-formal or non-traditional responders. Their critical role in disaster response is increasingly recognized (Comes et al. 2019). Even when affected themselves, communities have the potential make a valuable contribution to effective disaster response. E.g., providing access, resources, or local knowledge. Today communities have more options to actively engage with and exchange information with responders (Crowley and Chan 2011). As information technologies become increasingly more common, more people are gaining access to new opportunities to collect, analyze, and share information. This both increased the information potential for responders to build on, but at the same increases the challenges of information management. However, these communities are typically not part of existing coordination structures. Thus it takes time and resources for their information potential to be discovered by other actors.

Conclusion

The increasing number of actors involved in an emergency, ranging from formal international agencies to spontaneous volunteers, present both a challenge and an opportunity for a more effective and inclusive emergency response. On the one hand, supported by information technologies, this increased number of actors can generate and share more information than ever before. On the other hand, it becomes increasingly more challenging to be aware of the different actors and the information they can (potentially) provide. To leverage the potential of this large pool of information, avoid the duplication of efforts, and reduce the information overload, responders need be aware of this complex information environment. This does require organizations to re-evaluate their approaches and focus more strongly on building information awareness and the capabilities required to do so.

The work presented in this paper is centered on the introduction and development of the concept of information awareness, and its applicability to analyze activities undertaken in complex emergencies. It provides a common frame of reference to identify, describe, and analyze these activities. As evidenced by the maturity model based on the two case studies. Nevertheless, the research presented has its limitations such as the need for a stronger empirical foundation. Future work would focus on strengthening these results in additional studies and different contexts but also extend the scope to include other aspects that lead to the effective exchange of valuable information in a crisis response. Some of which, such as reciprocity and visibility, are already highlighted in the discussion. While this study and the preliminary results do not provide a definitive view of information awareness in crisis responses, the results do indicate important findings that warrant further examination. This is especially true in light of the ongoing democratization of information and information systems, with more actors accessing and sharing information through online networks during disaster responses.

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