Foundations of responsive crisis management: institutional design and information

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Summary

The requirements for effective and responsive crisis management have developed significantly in the face of proliferating transboundary crises and rising societal demands during the information revolution. As crises disturb more and more societal strata and rapidly span across different types of networks, traditional crisis structures need to become more open and responsive. To deal with these contemporary requirements of crisis management, renewed institutional designs are needed. Institutional designs reflect the shared rules, norms, and belief systems that are established as guidelines for social behavior, which shape the nature of decision making, coordination, and information-sharing processes. In practical terms, the call for more engaged crisis management cumulates in the process of developing situational awareness (SA) through the common operational picture (COP) in traditional institutional designs like the Incident Command System (ICS). Two opposing crisis information management doctrines can be defined in this process: the information warehouse and the trading zone. The dominant warehouse doctrine presupposes that all crisis information can be gathered, synthesized, and disseminated in a uniform and unambiguous way. The trading zone doctrine contrasts this assumption by stressing the importance of negotiation through which the meaning, value, and consequences of crisis information is debated and assessed. Institutional designs based on the trading zone doctrine offer a foundation for a more responsive and societally engaged form of crisis management, as they are more sensitive to the (social) stratification and competing demands that are often found in contemporary transboundary crises.

Keywords: crisis response institutions, command and control, Incident Command Systems, situational awareness, common operational pictures, information management, crisis analysis

Institutional Design and Crisis Response: Making Sense of Organizational Structures

Dealing with crises in the 21st century is more complicated than ever before. Arguably, the characteristics of crises have changed: from local incidents to transboundary disasters, from standalone crises to interrelated situations of misfortune, and most importantly, from sudden onset and temporal to creeping and enduring crises. As a result, crises are seen as the new

normal, and therefore new crisis response designs are needed (Rodin, 2014). At the same time, a massive information revolution is transforming the world, and the amount and availability of information and data (Savolainen, 2007; Shelton et al., 2014) through social media (Qualman, 2010), participatory mapping (Meier, 2010/2013), and crisis and disaster informatics (Palen et al., 2010) are both enabling and constraining elements in crisis management.

New and unexpected crises might emerge, and their characteristics might change, yet the design of crisis management is still about enabling collaboration between the many response organizations and communities—the relevant stakeholders—that come to a disaster scene to provide help (Mendonça et al., 2007; ‘t Hart et al., 2001; Wachtendorf & Kendra, 2004), engage in transboundary work (Boin, 2009), develop a common understanding (Laakso & Palomäki, 2013), and set up communication systems (Manoj & Baker, 2007). The collaboration between a heterogeneous set of crisis response organizations and the way they coordinate their actions have been the subject of crisis and disaster studies for decades (Kapucu, 2006; Kapucu & Garayev, 2013; Mendonça & Wallace, 2004; Moynihan, 2008; Neal & Phillips, 1995; Nohrsted et al., 2018; Uddin & Hossain, 2011; Waugh & Streib, 2006; Wolbers & Boersma, 2018; Wolbers et al., 2018; Zagorecki et al., 2010).

This article contributes to this body of literature by building on the insights from the individual level of first responders or crisis managers and their processes of sensemaking (Weick, 1993) and decision making (Klein, 2008; Klein et al., 1993), in order to connect this to the dynamics at the organizational, institutional level (Boin et al., 2005; Comfort at al., 2010) of crisis response: that is, the structuring and shaping of the response (i.e., the institutional process) and its underlying logic and doctrines (Alexander, 2005; Burton at al., 2015). The process of institutionalization occurs when there is a reciprocal recognition of customs between organizations (Berger & Luckmann, 1967). This means that organizations look to their peers for appropriate behavior, and in the process, imitate each other, which creates stability (DiMaggio & Powell, 1983). Therefore, institutions can be seen as the shared rule, norm, and belief systems that are established as guidelines for social behavior. This institutionalization process can account for the existence and elaboration of organizational structure, as shared beliefs develop into frames through which meaning is made and they provide the foundation for the infrastructure on which norms and rules rest (Scott, 2008).

In crisis management, the central institution is the *Incident Command System* (ICS) embedded and used in different forms across emergency response organizations (Jensen & Thompson, 2016). Though in a technical sense ICS is not an organization, it does provide a temporary organizational, institutional structure in which actors agree on appropriate norms and behavior to operate with the ICS (Burke & Morley, 2016). Temporary organizations, such as the ICS, are in fact organized around structured role systems that are negotiated in situ (Bechky, 2006). Temporary organizations can be distinguished from permanent organizations first of all by time. Since their duration is usually limited and short, rather than long, the mode of information processing is action driven and usually more heuristic than systemic. Next, temporary organizational, institutional structures enable teamwork, allowing interdependent sets of people to work together. Finally, specific tasks, and the negotiation of tasks, define the temporary organization as they seem to be more important for the members than they would be for members of a permanent organization (Braun et al., 2013). ICS as a temporary organizational, institutional structure is a flexible form of organizing that allows

emergency response organizations to manage rapidly changing dynamic situations. According to the U.S. Department of Homeland Security (DHS, 2008, p. 45), the ICS is “a widely applicable management system designed to enable effective, efficient incident management by integrating a combination of facilities, equipment, personnel, procedures, and communications operating within a common organizational structure.” Originally designed to fight wildfires in California in the early 1970s, ICS has become a standard emergency management structure, process, and terminology, which has developed into an all-hazard approach (Bigley & Roberts, 2001; Boersma et al., 2014; Moynihan, 2009).

The ICS is not a completely separate way to structure the organizational setup of emergency response; instead, it contains various institutionalized practices. One such practice is the *common operational picture* (COP), which is a display of crisis information shared by more than one command system that facilitates collaborative planning and serves as a means to establish situational awareness (SA). It is closely related to crisis *information management*, which is a crucial means to adapting the response structure to changing contingencies (Bigley & Roberts, 2001). These and other practices are essential in a crisis situation, where vital decisions need to be made under time pressure and uncertainty (Rosenthal et al., 1989) and up-to-date information needs to feed into the incident command structure.

This article will zoom in on those situations where crisis management stakeholders come together, virtually (e.g., through online platforms) or physically (e.g., in dispatch and command centers), to share and negotiate information about the crisis situation, strategy, tactics, and policies in order to coordinate the response operation (Bharosa et al., 2010; Comfort, 2007). The guiding questions are: How do actors engaged in crisis management coordinate the actions and interactions of the relevant stakeholders in the response, and how do they invest in organizational designs that stimulate sensitivity to the “operational environment” around response organizations? The concepts of the ICS and the COP are introduced in this article to show how the design of the response shapes the nature of the coordination and information sharing.

The ICS

ICS is the leading command structure for emergency response in the United States and beyond. Over the years, ICS has become the mandated all-hazards incident management system for common emergencies, such as house fires and hazardous material accidents, and for more non-routine hazards like earthquakes, hurricanes, and terrorist attacks (Jensen & Thompson, 2016). ICS follows a modularity logic, allowing a scaling up or down of the system as required in terms of resources and management capacity. The evolution of ICS started back in the 1970s when interorganizational coordination and collaboration issues arose during numerous wildfires in California (Jensen & Waugh, 2014). In response, the fire department launched project FIRESCOPE, which resulted in the Wildfire ICS. As other fire departments in the United States, and eventually around the world, became familiar with the structured approach for managing the range of organizations active in emergency response, the use of ICS became widespread among first responders throughout the world (Harrald, 2006). In the United States, it resulted in the formal adoption of ICS in the National Incident Management System (NIMS), the leading command and control doctrine issued by the Federal Emergency Management Agency (FEMA).

ICS is based on a variety of principles, including the establishment of a hierarchical and modular organization that has a predefined span of control, allows for the transfer of roles and command, and establishes a unity of command and accountability among its users (DHS, 2008; see Figure 1). Its objective is effectively to deploy and manage a set of response units and resources. This is done by activating a command staff, including the incident commander, safety officer, liaison officer, and public information officer, and a general staff who are responsible for a number of predefined modules, including operations, planning, logistics, and finance and administration.

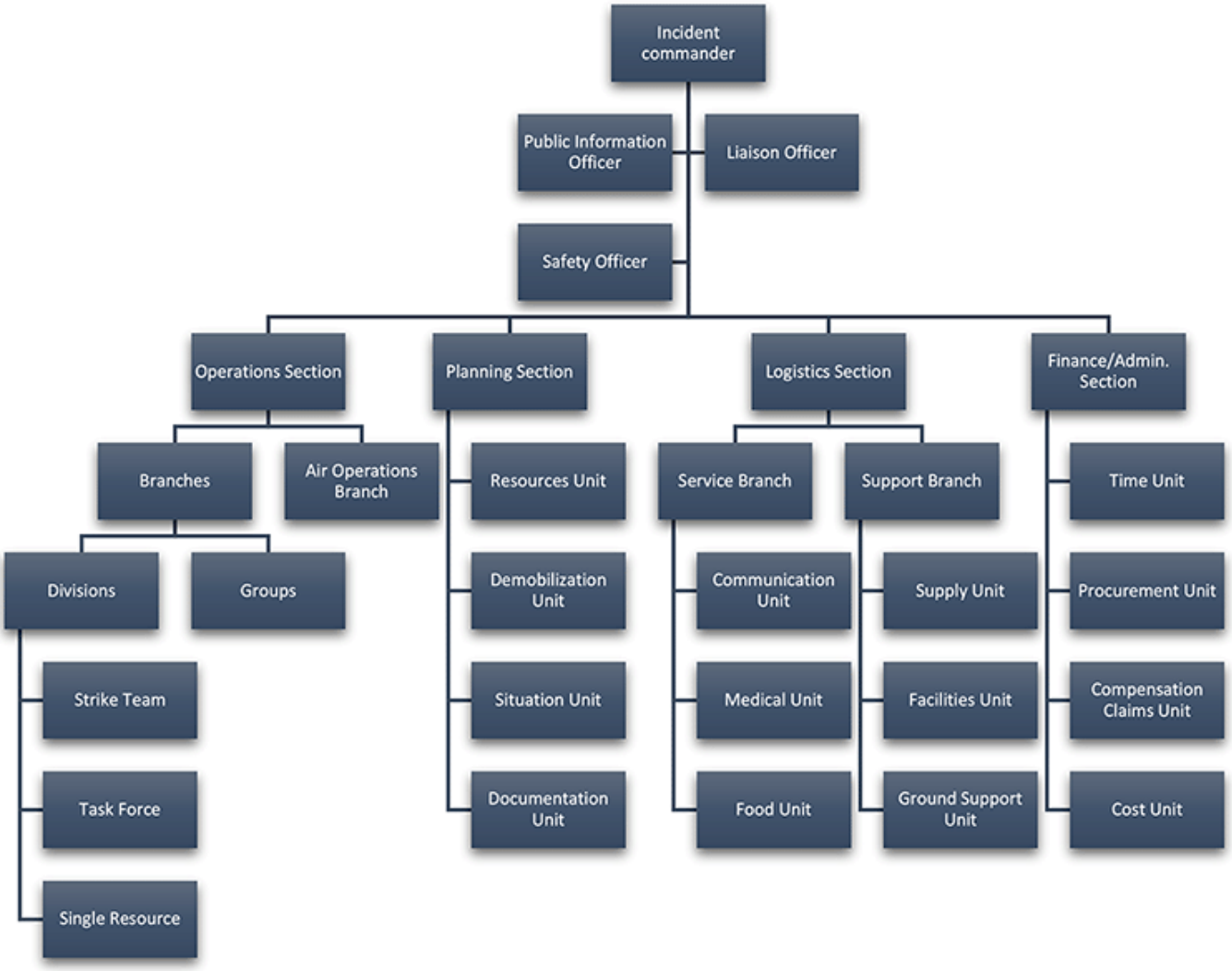

Figure 1. Incident Command System: Organizational design as part of NIMS.

Source: DHS (2008).

The system comes with designated incident facilities, branches and units, and divisions and groups, as well as a command post, a staging area, and a shared terminology that describes specific tasks, functions, and supervisory levels. Among professionals, ICS is seen as "a modular, flexible, standardized system used by emergency responders to ensure efficient resource management resulting in a safe, efficient, effective response" (Bennett, 2011, p. 31). This comes with the presumption that without ICS, responses typically lack accountability, have poor coordination, employ uncoordinated planning processes, use resources inefficiently, and fail to integrate on-scene responders (Bennett, 2011).

However, multiple studies note that ICS assumes that all actors use the system similarly and that the system can coordinate any type of event and will correct common response shortcomings with coordination and collaboration (Jensen & Waugh, 2014). This idea is rooted in the pre-structured modular design and the command and control doctrine that lies behind the system. While ICS has been associated with increasing the reliability of response organizations (Bigley & Roberts, 2001), some have argued that there are wide differences in implementation and use (Jensen & Waugh, 2014). The dominant, official narrative is that the system has standardized incident response into an all-hazards approach nationwide, while in fact the system's adoption was more concurrent, leading to many state and local differences in use (Jensen & Thompson, 2016; Jensen & Waugh, 2014). Indeed, several law enforcement agencies have expressed concerns that the top-down command structure is inconsistent with the autonomy normally granted to police officers on the street (Waugh, 2009). Opinions about ICS vary among first responders, with some regarding the system as "little more than complex organization charts, a multitude of forms and elements that do not apply specifically to a given organization" (Bennett, 2011, p. 31).

A number of empirical studies on ICS noted that the command system seems to work best when only a few organizations are actively carrying out the response and enough staff have sufficient training and extensive experience (Jensen & Thompson, 2016; Moynihan, 2008, 2009). For ICS to operate effectively, sufficient training, trust, and familiarity are deemed necessary (Moynihan, 2008). In some cases, however, evidence has shown that ICS can support more emergent collaboration during prolonged response operations by helping to instigate and structure collaboration among new actors (Beck & Plowman, 2013). Still, the reliance on structure can also have adverse effects. Problems with the use of ICS arise when responders adhere to standard procedures and routines in situations where those routines do not match the dynamic evolution of the crisis (Bigley & Roberts, 2001; Schakel & Wolbers, 2019) or where a large set of organizations that have less experience with ICS operating principles need to collaborate. In that case, ICS could guide responders toward relying on procedures and structure, while still allowing for flexibility and improvisation beyond the structure itself (Wolbers et al., 2018). Despite the contrasting scientific evidence on the functionality of ICS and its underlying command and control doctrine in emergency management, the system is in full operational use among first responders.

Situation Awareness and COPs

ICS offers the structure for organizing and managing a response operation, but maintaining *situation awareness* of the operational environment through an adequate operational picture and proper information management is equally important for adapting ICS to the changing dynamics of a crisis. Crisis information is a source for creating situation awareness among responding organizations because it provides the "knowing what is going on" (Endsley, 1995, p. 36). Situation awareness means there is an understanding of the crisis situation, and it makes effective decision making by different stakeholders possible. Stanton et al. (2010) outline three distinct perspectives about situation awareness. The individual/psychological perspective implies an internal cognitive phenomenon that can only be experienced in the mind of the individual. The computing/engineering perspective maintains that situation awareness is situated in the world, with actors working in a complex system. Finally, the systems/human factors perspective focuses on situation awareness arising from constant

interaction between people and their environment. The systems side of this perspective implies that information is held in displays and other artifacts so that situation awareness can be seen on the screen; while the human factors side asserts that situation awareness does not reside within any one agent alone.

A fourth perspective, the sociotechnical systems view, has caught the attention of crisis and disaster studies scholars who research the role of COPs as a precondition for situation awareness and coordination and eventually as the solution for failing information-sharing practices among different organizations (Boersma et al., 2012; Comfort, 2007). In this perspective, situation awareness is characterized by distributed cognition (Hutchins, 1995) that needs to be organized in order to set up a coordinated response and enable COPs (Salmon et al., 2012).

COPs can potentially provide solutions to multiorganizational coordination problems in crisis situations because they make it possible for organizations to share the same information and align their actions (Wolbers & Boersma, 2013). In creating a COP, crisis organization representatives should not just collect information but also then validate that information. They should thus involve the ideas of others or at least the appreciation of others' ideas at an early stage (Jenssen et al., 2010). COPs are not just about gathering data as pieces of information from a variety of resources, such as incoming emergency calls, weather reports, and the like. Nor are they about the verification and combination of various data sources. COPS are about the analysis of information—enriching information with new findings and developing recommendations for actions—that makes information not only available but "actionable" (Cross & Sproull, 2004; Treurniet & Wolbers, 2020). In that way, the information developed in a COP reflects the institutional norms about what is considered acceptable; validated information can then be used to confirm the chosen response strategy or as a trigger to adapt and set up new response structures (Barton & Sutcliffe, 2009). COPs, in other words, are the outcome of design practices, and, as such, are based upon particular logics or doctrines in crisis management.

Opposing Doctrines in Crisis Governance

Crisis management doctrines not only define how a crisis is perceived but also how actions and interactions are organized by stakeholders and how crisis information is exchanged (Boersma et al., 2014). Generally speaking, the doctrines of crisis management strongly influence organizational decision making (Greenwood et al., 2010). Crisis management doctrines are dualistic: they are both the dominant worldview of the involved actors and the framework for researchers and scholars, that is, they are the hermeneutic window (Bauman, 2010). Based on the groundbreaking work on disaster and crisis management by Quarantelli and Dynes (1977; see also Dynes, 1994; Quarantelli, 1978, 1998), two opposing, ideal-typical doctrines are introduced: chaos, command, and control; and community, collaboration, and coordination.

Chaos, Command, and Control: The Warehouse

The first doctrine represents the idea that crises cause chaos and that command and control are required to bring the situation back to normal. The dominant discourse within the doctrine is the military analogy: disasters are the enemy and must be approached as such. The institutional design presupposed in this doctrine is that of a paramilitary organization, as this type of organization is deemed most effective in dealing with combat situations. Command and control became the dominant doctrine in crisis management because formal response organizations often have difficulties getting their operational pictures right due to the complexity of the situation. The organizations also struggle with coordination in decision making and with the question "who is in charge," particularly in situations when various legislative, professional, and authorized organizations might have conflicting interests. As a result, exchange of information becomes problematic and can easily lead to a delay in the response. As such, crisis management is focused on collecting and storing crisis information in a way that is timely and easily accessible for authorized response organizations and professionals. To regain order after a crisis event, this doctrine considers it important to establish a chain of command through which crisis responders agree on task divisions, span of control, response operations, and formal leadership. Spontaneous volunteers and local communities are usually not part of the formal chain of command, since they are responding in unknown organizational forms without proper training and without transparent operational procedures. The dominant belief is that they are not properly trained to engage in a professional crisis response (Barsky et al., 2007). The formal crisis management actors aim at eventually regaining control over the complex situation by adopting a top-down strategy.

A striking example of the desire to regain control over a complex crisis situation comes from New Orleans shortly after Hurricane Katrina made landfall: Brigadier General Gary Jones, Commander of the Louisiana National Guard's Joint Task Force, said, "Troops begin combat operations in New Orleans to fight 'insurgents.' This place is going to look like Little Somalia." And as hundreds of armed troops under his charge prepared to launch a massive citywide security mission from a staging area outside the Louisiana Superdome, he argued, "We're going to go out and take this city back. This will be a combat operation to get this city under control" (Tierney et al., 2006, p. 72). Obviously, in this view, civil institutions are not capable of adequately dealing with disasters, because they adopt ineffective command structures, if any. Their spontaneous activities are not controllable and are potentially disruptive. Crisis information in this perspective is—or is supposed to be—unambiguous, transferrable, validated, and easy to access in real time and by all the involved, formally authorized crisis actors.

In this doctrine, the dominant metaphor for information systems in the perfect COP is the *warehouse* (Devlin & Cote, 1996). The COP as warehouse is used to force gathering, collating, synthesizing, and disseminating of information related to all aspects of any crisis. The warehouse relates to a database system with a particular classification framework that is adaptable to a wide variety of organizational structures (Khan, 2004). Proposing the COP as the solution for information exchange problems leads to a focus on the end result (i.e., creating the "perfect" COP) rather than the ongoing process of information sharing. As a result, a COP is treated as an a-political "repository" from which its users can select—and "justify"—the information that is appropriate for them to perform their tasks. In this view, a

COP functions like any other enterprise resource system (Leedom, 2003): “information useful to processes is stored . . . *in an easy and accessible form*” (Davenport, 1992, p. 89; emphasis added), whereby the nature of the warehouse supports self-synchronization.

Continuity, Collaboration, and Coordination: The Trading Zone

The second crisis management doctrine, which is gaining increasing attention from both practitioners and professionals, involves collaboration and coordination. It represents the picture of a disaster and its social impact: disasters and crises cause a certain degree of unrest, but not total chaos and panic. Thus, they do not reduce the capacity of social structures per se (Hoffman & Oliver-Smith, 2002; Solnit, 2010). In addition, civil society actors and citizens’ initiatives are a vital part of the crisis response (Ferguson et al., 2018; Helsloot & Ruitenberg, 2004; Kendra & Wachtendorf, 2016; Schmidt et al., 2018). The implication for crisis management and the response design is that using existing social structures is the most effective way to govern crises. Newly developed, top-down response structures created after a disaster will not actually work as perceived (Boin & ‘t Hart, 2003). The organizational design presupposed in this doctrine is not hierarchical or bureaucratic but networked and heterogeneous (Brooks et al., 2013; Kapucu, 2006; Kapucu & Garayev, 2013). In this view, top-down command approaches are not the most effective way of organizing; instead, they are rather compromising.

This doctrine builds upon the idea of continuity, not chaos: behavior does not change much, nor does panic emerge on a grand scale, and social structures are often not compromised (although they may be shaken). Collaboration is key in the institutional design, not control. Stakeholders need to coordinate their actions, create shared operational facilities and communication strategies, and use liaison structures in a networked fashion (McGuire & Silvia, 2010; Moynihan, 2009; Neall & Philips, 1995; Treurniet et al., 2015; Waldman et al., 2018; Waugh & Streib, 2006; Yeo et al., 2018). Because crisis information can be imperfect, incomplete, contradictory, and ambiguous, the focus is on solving the problems at hand, not on controlling chaos. Knowing *who is doing what* and *who is involved* is more important than designing the perfect COP.

Operational pictures, in this view, need to create

> a *sufficient level* of shared information among the different organizations and jurisdictions participating in disaster operations at different locations, so all actors readily understand the constraints on each and the possible combinations of collaboration and support among them under a given set of conditions.
>
> (Comfort, 2007, p. 191; emphasis added)

As Carley (2002) found when researching the COP, individuals specified it as *knowing who was doing what, who knew what*; as part of their accurate transactive memory. In this doctrine, COPs are seen as the outcome of trading zones—spaces (both real and virtual, online) where information is shared, given meaning, and talked about. By seeing the COP as part of a trading zone, researchers and practitioners can focus on the complexity and dynamics of crisis and disaster information management and practitioners can become more reflexive about their information-sharing practices (Table 1).

Table 1. Two Doctrines in Crisis Response

Doctrine	Society	Leadership	Crisis Management	Design
Chaos, command & control	The situation is chaotic, out of control, and dangerous. Governmental action is required to restore order.	Centralized decision making by a strong leader.	Top-down approach: crisis management considers disasters as the enemy, and they are approached as such to get the situation back to normal.	Paramilitary organizations as the most effective ways to deal with crises.
Continuity, coordination & cooperation	The society has been hit, but has not come to a standstill. Citizens continue to respond, and large-scale panic does not emerge.	Decentralized decision making and dispersed, temporal leadership.	Bottom-up approach: crisis management builds on social structures, which are shaken, but not compromised.	Shared operational facilities and liaison structures as ways to facilitate coordination.

Source: Dynes (1994).

COPs and Sensemaking

ICS operational procedures can be positioned in the two crisis response doctrines, but they do not say much about how COPs are actually constructed in concrete practices and how information management is actually used throughout response operations. To understand the implications and outcomes of ICS for crisis response operations, it is important to understand how various stakeholders operating within ICS—or any other command system—make sense of the crisis situation and the crisis management (Weick, 1995).

The chaos, command, and control institutional design principle, and the information warehouse solution that comes with it, has been dominant for decades, although its unintended consequences have been questioned since the late 1970s (Perry & Quarantelli, 2005; Quarantelli & Dynes, 1977, 1985), particularly in those situations where numerous, heterogeneous crisis organizations are "fighting" the same crisis. In this perspective, crisis response actors *integrate* information (often through an information and communication platform) into one coherent and COP about the crisis situation that can be used by the various actors involved in the crisis response. Thus, the actions of the various actors become aligned, and their collective efforts are more effective and efficient. This construct results in sensemaking questions like: Is my information about the crisis complete and its it accurate? Can I use it in relation to my action plans? Does the information help me create situation awareness?

In contrast, the continuity, coordination, and collaboration perspective considers COPs as the boundary objects that connect the otherwise separated response organizations (Kellogg et al., 2006). They must be malleable enough to adapt to local needs and routines while at the same time robust enough to create a common understanding across boundaries (Lee, 2007; Star, 2010). In fact, the COP in this perspective can refer to more than one "common" picture, and rather as several dynamically changing pictures that are overlapping and shared. This perspective recognizes that different actors potentially give different meanings to the pieces of information that are shared, and that differences in knowledge, beliefs, customs, and assumptions among them that can cause conflicting interpretations of information. Of course, this also means that even if all the actors have access to the same information (through a COP), there is no guarantee that problems in information management and organizational collaboration can be overcome (Treurniet & Wolbers, 2020).

Instead, crisis information is something *to talk about*: crisis management actors work out exchanges "in exquisite local detail, without global agreement" (Galison, 1997, p. 46). It is about sharing expertise and convincing the others (stakeholders) about the value of alternatives (Stirling, 2008). COPs, therefore, are the outcomes of negotiation practices in trading zones, where the various actors are literally "trading" their ideas about the relevance of crisis information. Seeing COPs as being developed in trading zones results in questions like: What does the information mean for me and for the others I am working with? (Table 2).

Table 2. Implications of the Two Doctrines in Crisis Response Design

Chaos, Command, & Control	Continuity, Collaboration, & Coordination
Paramilitaristic design	Networked design
Preplanned	Emergent
Perfect/complete COP	Good enough/partial COP
Information systems as warehouses	Information systems as trading zones

In the chaos doctrine, the idea is that a “complete” COP can mirror the actual situation. The COP can be distilled from the information warehouse, and it is seen as the most accurate presentation of the crisis. In the continuity doctrine, the COP is only a solidified impression of a constantly evolving situation. COPs are promising in the sense that they help to create a sense of urgency and “force” different stakeholders to (re)think their actions and interactions. They may potentially be of great help in creating a shared understanding of what is going on during crises and disasters (Table 3).

Table 3. Crisis Information Management within the Two Doctrines

Information Warehouse	Trading Zone
Transfer of information	Translation of information
Univocal	Multiplicity
Static (packages)	Flux (processes)
Accessible	Negotiated
Clarity	Equivocality
Self-synchronization	Collective sensemaking

Dimensions of the Trading Zone: Making Information Actionable

What makes the crisis management setting challenging is that the underlying collective sensemaking takes place in different organizations that are *temporarily* dependent on each other. Using the trading zone perspective to design a COP is therefore promising because it means the COP is part of the process of collective sensemaking and negotiation, which are difficult to achieve in a strict, top-down command and control system (Wolbers & Boersma, 2013). Collective sensemaking is subject to conflict between the participating stakeholders (due to differences in interpretations). At the individual level, sensemaking is an activity

where individuals use their mental models and structuring devices (e.g., their own COPs) to perceive situations and to interpret their perceptions. ICS, with its modular organizational design principle, can still facilitate trading zones, which are specifically designed to capture tacit knowledge and to make crisis information actionable.

Yet trading zones in ICS cannot be reduced to just a space where information is negotiated and translated in a straightforward manner. Therefore, in what remains, four key dimensions or "faces" of the trading zone are distinguished: cognitive, social, cultural, and political. Together, they set the agenda for designing and incorporating trading zones in crisis management. The trading zone resembles elements of the atrium model proposed by Demchak (2010), which provides ways to accommodate collaborative practices by recognizing the "tacit" dimension of information sharing and coordination. The atrium model, which originates from the military, is designed to facilitate networked operations enabled by information systems. It is not necessarily alien to command and control principles, but like the trading zone, it potentially enables the collective mind and heedful interrelations, as described by Weick and Roberts (1993). The cognition and knowledge in this perspective are not confined to an individual, rather they are distributed across objects, individuals, artifacts, and tools, and can be seen as a collection of individuals and artifacts and their relations to each other in a particular work practice (Hutchins, 1995; Hutchins & Klausen, 1996).

The Cognitive Dimension of the Trading Zone

The trading zone enables crisis managers to make sense of crisis information and provides space for them to think about how they share information and with whom. This is a space where people make and give meaning to information (Maitlis & Sonenshein, 2010; Weick, 1995). The design of the trading zone involves sensemaking, an ongoing process through which responders (and other stakeholders) make sense of a crisis situation. Therefore, sensemaking is crucial for understanding the trading of information.

Mullen et al. (2006) build on Weick's ideas to provide a useful analytical framework, involving identity construction, enactment, and plausibility, which are important elements in the negotiation processes. Identity construction refers to the self-conceptions that play a role in complex situations and that are based on the question "What implication does this situation have for me?" The more "selves" a crisis responder has (e.g., a commander with previous fieldwork experience, a crisis information manager with experience in data analytics), the better that person will be able to understand the actions and interactions of others involved in the crisis response. The various response roles involve different skills. One such skill is retention: the idea that individuals retrospectively think about their actions and the consequences for the crisis situation. Initial actions often set the tone in crisis situations, and reflecting upon these actions can help responders understand what they could have done differently (Demchak, 2010). Another skill is plausibility: the development of a narrative that is acceptable and credible to the operational staff and the affected community. Past experiences and expectations play a crucial role in constructing this reflective practice. Thus, in the trading zone, crisis managers do not just make sense of the situation; they also build on institutional memory partly captured in the experiences of the first responders, on their mental models and narratives, and on their ability to reflect on the here and now.

At the same time, decision making in groups can suffer from groupthink (Janis & Janis, 1982) and the (hierarchical) structure of an organization can reinforce bad decision making. For example, in analyzing the Challenger launch decision, Diane Vaughan (1999) argues that the involved actors, when repeatedly faced with evidence that something was wrong, normalized the deviance so that it became acceptable to them, with the space shuttle accident the outcome. This could lead to bias and blind spots, in what Barton and Sutcliffe (2009) call dysfunctional momentum. The cognitive dimension in the trading zone, therefore, also requires critical thinking to engage in reflective practice, which is an important extension to the set of crisis (information) management capabilities (Schön, 2017).

The Social Dimension of the Trading Zone

Meetings in the trading zone can lead to new partnerships and collaborative networks and they can enable the continuation of past alliances. Experts from different fields—for example, response services, governmental and nongovernmental organizations, private companies, and citizen networks—interact around the development of a COP. It is the COP that unites them, and links them in a network of relations. The COP serves as a mechanism to facilitate the end of achieving mutually beneficial goals that are actionable in a coordinated way. At the same time, experts see and treat the boundary object dictated by their own expertise (Gorman, 2002; O'Mahony & Bechky, 2008). If one aspect stands out from coordination at times of crisis, it is that very often crisis responders are overloaded by multiple information sources when trying to make decisions "on the spot" (Bharosa et al., 2010; Bui et al., 2000). The social aspect of the trading zone means that the crisis partners do not toss information and ideas over the border to each other; instead, they start to develop a shared (although continuously developing) representation of the COP. Rather than developing an exclusive view of the true or perfect COP, participants in the trading zone are (have to be) able to include multiple disciplinary approaches.

Furthermore, the social dimension of the trading zone relies on trust-based relationships that are developed over time (Moynihan, 2008) or that are based on *swift* trust (Meyerson et al., 1996). Swift trust is a "lighter form" of trust that exists in groups with a common objective, where involved actors do not know each other and have no time for traditional trust-building activities, but they can relate to each other's roles if not the people themselves (Ödlund, 2010). Swift trust is critical when there is little time to deepen social relationships that usually develop slowly. In the trading zone, people start to act, and they have little time to adjust to the various interactions of the heterogeneous response organizations. The social dimension of the trading zone is therefore about the sensemaking of a crisis as a collective process (Dwyer & Hardy, 2015).

The Cultural Dimension of the Trading Zone

In the trading zone, the different response organizations are confronted with different epistemic, professional backgrounds or epistemic cultures (Knorr-Cetina, 2009), such as specialized language, jargon, roles, and norms (Laakso & Palomäki, 2013). The trading zone can be considered as a space that provides bounded (for local gatherings) or distributed (for dispersed teams) habitats of knowledge practice. The epistemic culture defines what

responders know about the situation, how they know it, how they interpret data and information, and what actions they take. Formal response settings involve professionals with procedural orientations, and thus, standard operational procedures are important (Bigley & Roberts, 2001; Chen et al., 2008). Differences in epistemic cultures can be visible, but they can also include invisible elements such as standards of work practice and interpretations of particular incoming information as well as specific preferences. This does not mean, however, that epistemic cultures run solely on expert systems or expert knowledge. For example, data provided by citizens through social media platforms is increasingly important (Palen & Liu, 2007).

Narrating (i.e., storytelling) is an important element of the cultural dimension (Roe, 1994). It is based on the knowledge responders have gained through education, including training/exercises, (war)storytelling, and past experiences (Mogford, 1997). Crisis narratives are plausible—like in *folk models* (Parasuraman et al., 2008)—rather than accurate or perfect, as the crisis situation is not static but ongoing. Crisis narratives, and narratives about crisis information, are often fragmented storylines that surface fleetingly during interactive conversations rather than traditional story structures with a beginning, middle, and end (Gabriel & Connell, 2010). Through such narratives, first responders filter useful information from noise, give meaning to the situation and extract cues.

The Political Dimension of the Trading Zone

The trading zone is the space where actors influence collective decision making processes based on their resources (both cognitive and social). They also include and exclude others in professional procedures and routines and legitimize and delegitimize actions. In other words, COPs involve politics (Winner, 1980). The political dimension represents an ongoing and mutually determined interplay between various actors (Fleming & Spicer, 2008, 2014). This interplay is more of a struggle between actors than the execution of coercive power along hierarchical lines.

Eventually, COPs in the trading zone can be seen as spaces for legitimation of decision making processes and for framing, spaces where possible novel configurations of ideas and norms about crisis and disaster management can arise. During these negotiations, the emergency or disaster is (re)defined and (re)framed. Of course, framing already takes place due to governmental rhetoric and communications (Boin et al., 2009; Coombs & Holladay, 2011; ‘t Hart, 1993) to legitimize and expand authority, but it is also apparent at lower levels of the crisis organization to encourage and legitimize a course of action over another. As such, crisis decision making does not occur in isolation and is reliant on information sharing through a COP in the trading zone. Here the different goals and time horizons of operational, tactical, and strategic decisions are likely to become explicit, which offers a setting for ongoing negotiation. As strategic decision making teams often have no direct view on the incident, and adhere to broader societal processes that emerge in the wake of an incident, teams operating at these different levels can literary experience a different lifeworld.

As such, the exchange of information in the trading zone can be regarded as a discursive practice (Foucault, 1980) that addresses the processes by which cultural meanings and politicized preferences are produced and understood. In other words, the trading zones are

based on historically and culturally specific sets of rules for organizing and producing different forms of knowledge where certain knowledge, roles, and actions are privileged over others. They are the recurring episodes of face-to-face and online interactions where crisis decision making takes place. This makes the political dimension of a trading zone a crucial aspect of crisis management, since through this negotiation process decisions and frames are contested and ingrained, and the chosen course of action in an ambiguous context is legitimized (Table 4).

Table 4. Dimensions of the Trading Zone

Dimensions of the Trading Zone	Processes	Drivers	Lessons from Research
Cognitive	Sensemaking and sensegiving	Enactment and plausibility	Actors make sense of information based on training and experiences
Social	Partnering and networking	Swift trust	Actors collaborate based on trust developed in direct performance
Cultural	Narrating and storytelling	Epistemic cultures	Actors express their values and sensemaking through storytelling
Political	Legitimating and agenda setting	Power and discursive practices	Information is used for framing and negotiation of interests

Making Sense of Crisis Information through Trading and Negotiation

This article has explored the institutional, organizational design, and practice of crisis information management by focusing on the development of ICS and COP. ICS and COP are not the outcomes but the starting points of crisis management processes. Crisis managers' first intuition is to use already established procedures for making decisions in fast-paced environments, and as this article has shown, ICS is an important way to organize collective responses to crises. However, because different actors develop different understandings, equivocality arises that cannot be rationalized out; instead, the relevance of each other's perspectives must be negotiated in action. Therefore, this article explored how crisis information must first be made sense of and negotiated, for it to be useful in coordinating the multidisciplinary environment of crisis management.

The trading zone design makes room for studying how crisis information is or can be tailored for specific groups in decision making processes. It reveals that collaboration and coordination between responding organizations develop in an emergent fashion (Majchrzak et al., 2012). Actors collaborate based on who they encounter in action and develop swift trust based on others' direct performance (Beck & Plowman, 2013). This makes the tailoring of information in advance difficult. In fact, what is needed is real-time tailoring of the data based on real-time adaptation (Hutchins, 1991) in trading zones. Crisis management practices are based on in-action decision making to solve unexpected challenges at hand.

By using the trading zone design, one can study how the availability of information can be used to aid SA and decision making. Crisis managers who make decisions under pressure base their decisions on recognition-primed decision making that involves a combination of situational assessment and mental simulation (Klein, 2008; Klein et al., 1993). Decisions are based on recognizing which course of action makes sense and then using one's experience to mentally evaluate that course of action and its likely resulting actions. The trading zone highlights that actors give different meanings to (the same) information based on their various experiences, knowledge, beliefs, customs, and assumptions, which can result in conflicting interpretations of (the same) information. The advantage of negotiation as a vital part of the trading zone is that it makes positions clear without needing to develop a full consensus (Kellogg et al., 2006). Prior experience is therefore an important factor in evaluating different options and imagining their outcomes (Heath et al., 1999). In the end, it is not only about actors' own sensemaking processes but about collective sensemaking with actors from other disciplines (Wolbers & Boersma, 2013).

The lessons in this article all have one thing in common: to make adequate decisions in a crisis, when time is short, actors do not rely on sophisticated analyses of information. They develop their own hands-on products in action (Hutchins, 1991) based on their prior experience (Klein et al., 1993), situational assessment (Weick & Sutcliffe, 2011), professional training and expertise (Weick, 1993), and specific framing that suits their needs (Boin et al., 2009). The cognitive, social, cultural, and political aspects of crisis management create the crisis manager's repertoire of tools to make sense of, organize, and enact crisis information, and ICS is the institutionalized structure that facilitates this process.

References

Alexander, E. R. (2005). Institutional transformation and planning: From institutionalization theory to institutional design. *Planning Theory*, *4*(3), 209–223.

Barsky, L. E., Trainor, J. E., Torres, M. R., & Aguirre, B. E. (2007). Managing volunteers: FEMA's Urban Search and Rescue programme and interactions with unaffiliated responders in disaster response. *Disasters*, *31*(4), 495–507.

Barton, M. A., & Sutcliffe, K. M. (2009). Overcoming dysfunctional momentum: Organizational safety as a social achievement. *Human Relations*, *62*(9), 1327–1356.

Bauman, Z. (2010). *Hermeneutics and social science: Approaches to understanding*. Routledge.

Bechky, B. A. (2006). Gaffers, gofers, and grips: Role-based coordination in temporary organizations. *Organization Science*, *17*(1), 3–21.

Beck, T. E., & Plowman, D. A. (2013). Temporary, emergent interorganizational collaboration in unexpected circumstances: A study of the Columbia space shuttle response effort. *Organization Science*, *25*(4), 1234–1252.

Bennett, B. (2011). Effective emergency management: A closer look at the Incident Command System. *Professional Safety*, *56*(11), 28–37.

Berger, P. L., & Luckmann, T. (1967). *The social construction of reality: A treatise in the sociology of knowledge*. Penguin UK.

Bharosa, N., Lee, J., & Janssen, M. (2010). Challenges and obstacles in sharing and coordinating information during multi-agency disaster response: Propositions from field exercises. *Information Systems Frontiers*, *12*(1), 49–65.

Bigley, G. A., & Roberts, K. H. (2001). The Incident Command System: High-reliability organizing for complex and volatile task environments. *Academy of Management Journal*, *44*(6), 1281–1299.

Boersma, F. K., Comfort, L. K., Groenendaal, J., & Wolbers, J. J. (2014). Incident Command Systems: A dynamic tension among goals, rules and practice. *Journal of Contingencies and Crisis Management*, *22*(1), 1–4.

Boersma, F. K., Fergusson, J., Groenewegen, P., & Wolbers, J. J. (2014). Beyond the myth of control: Toward network switching in disaster management. In S. R. Hiltz, M. S. Pfaff, L. Plotnick, & A. C. Robinson (Eds.), *Proceedings of the 11th International ISCRAM Conference* (pp. 1–5). Pennsylvania State University Press.

Boersma, F. K., Wagenaar, P., & Wolbers, J. J. (2012). Negotiating the "trading zone": Creating a shared information infrastructure in the Dutch public safety sector. *Journal of Homeland Security and Emergency Management*, *9*(2), 6.

Boin, A. (2009). The new world of crises and crisis management: Implications for policymaking and research. *Review of Policy Research*, *26*(4), 367–377.

Boin, A., & 't Hart, P. (2003). Public leadership in times of crisis: Mission impossible? *Public Administration Review*, *63*(5), 544–553.

Boin, A., ‘t Hart, P., & McConnell, A. (2009). Crisis exploitation: Political and policy impacts of framing contests. *Journal of European Public Policy*, *16*(1), 81–106.

Boin, A., ‘t Hart, P., Stern, E., & Sandelius, B. (Eds.). (2005). *The politics of crisis management: Public leadership under pressure*. Cambridge University Press.

Braun, T., Ferreira, A. I., & Sydow, J. (2013). Citizenship behavior and effectiveness in temporary organizations. *International Journal of Project Management*, *31*(6), 862–876.

Brooks, J. M., Bodeau, D., & Fedorowicz, J. (2013). Network management in emergency response: Articulation practices of state-level managers—interweaving up, down, and sideways. *Administration & Society*, *45*(8), 911–948.

Bui, T., Cho, S., Sankaran, S., & Sovereign, M. (2000). A framework for designing a global information network for multinational humanitarian assistance/disaster relief. *Information Systems Frontiers*, *1*(4), 427–442.

Burke, C. M., & Morley, M. J. (2016). On temporary organizations: A review, synthesis and research agenda. *Human Relations*, *69*(6), 1235–1258.

Burton, R. M., Obel, B., & Håkonsson, D. D. (2015). *Organizational design: A step-by-step approach*. Cambridge University Press.

Carley, K. M. (2002). *Inhibiting adaptation*. DTIC Document. Report number: OMB No. 0704-0188.

Chen, R., Sharman, R., Rao, H. R., & Upadhyaya, S. J. (2008). Coordination in emergency response management. *Communications of the ACM*, *51*(5), 66–73.

Comfort, L. K. (2007). Crisis management in hindsight: Cognition, communication, coordination, and control. *Public Administration Review*, *67*(1), 189–197.

Comfort, L. K., Boin, A., & Demchak, C. C. (Eds.). (2010). *Designing resilience: Preparing for extreme events*. University of Pittsburgh Press.

Coombs, W. T., & Holladay, S. J. (Eds.). (2011). *The handbook of crisis communication*, Vol. 22. John Wiley & Sons.

Cross, R., & Sproull, L. (2004). More than an answer: Information relationships for actionable knowledge. *Organization Science*, *15*(4), 446–462.

Davenport, T. H. (1992). *Process innovation: Reengineering work through information technology*. Harvard Business Press.

Demchak, C. C. (2010). Lessons from the military: Surprise, resilience, and the atrium model. In L. K. Comfort, A. Boin, & C. C. Demchak (Eds.), *Designing resilience: Preparing for extreme events* (pp. 62–83). University of Pittsburgh Press.

Demchak, C. C. (2011). *Wars of disruption and resilience: Cybered conflict, power, and national security*. University of Georgia Press.

Department of Homeland Security. (2008). *National incident management system <https://www.fema.gov/pdf/emergency/nims/NIMS_core.pdf>*. Washington, DC, December 18.

Devlin, B., & Cote, L. D. (1996). *Data warehouse: From architecture to implementation*. Addison-Wesley Longman.

DiMaggio, P. J., & Powell, W. W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American Sociological Review*, *48*(2), 147–160.

Dwyer, G., & Hardy, C. (2015). We have not lived long enough: Sensemaking and learning from bushfire in Australia. *Management Learning*, *46*(5), 1–20.

Dynes, R. R. (1994). Community emergency planning: False assumptions and inappropriate analogies. *International Journal of Mass Emergencies and Disasters*, *12*(2), 141–158.

Endsley, M. R. (1995). Toward a theory of situation awareness in dynamic systems. *Human Factors*, *37*(1), 32–64.

Ferguson, J., Schmidt, A., & Boersma, F. K. (2018). Citizens in crisis and disaster management: Understanding barriers and opportunities for inclusion. *Journal of Contingencies and Crisis Management*, *26*(2), 326–328.

Fleming, P., & Spicer, A. (2008). Beyond power and resistance: New approaches to organizational politics. *Management Communication Quarterly*, *21*(3), 301–309.

Fleming, P., & Spicer, A. (2014). Power in management and organization science. *Academy of Management Annals*, *8*(1), 237–298.

Foucault, M. (1980). *Power/knowledge: Selected interviews and other writings, 1972–1977*. Pantheon.

Gabriel, Y., & Connell, N. C. (2010). Co-creating stories: Collaborative experiments in storytelling. *Management Learning*, *41*(5), 507–523.

Galison, P. (1997). *Image and logic: A material culture of microphysics*. University of Chicago Press.

Gorman, M. E. (2002). Levels of expertise and trading zones: A framework for multidisciplinary collaboration. *Social Studies of Science*, *32*(5–6), 933–938.

Greenwood, R., Díaz, A. M., Li, S. X., & Lorente, J. C. (2010). The multiplicity of institutional logics and the heterogeneity of organizational responses. *Organization Science*, *21*(2), 521–539.

Harrald, J. (2006), Agility and discipline: Critical success factors for disaster response. *Annals of the American Academy of Political and Social Science*, *604*(1), 256–272.

Heath, C., Larrick, R. P., & Wu, G. (1999). Goals as reference points. *Cognitive Psychology*, *38*(1), 79–109.

Helsloot, I., & Ruitenberg, A. (2004). Citizen response to disasters: A survey of literature and some practical implications. *Journal of Contingencies and Crisis Management*, *12*(3), 98–111.

Hoffman, S., & Smith, A. O. (2002). *Catastrophe and culture: The anthropology of disaster*. School of American Research Advanced Seminar Series. School of American Research Press.

Hutchins, E. (1991). Organizing work by adaptation. *Organization Science*, *2*(1), 14–39.

Hutchins, E. (1995). How a cockpit remembers its speeds. *Cognitive Science*, *19*(3), 265–288.

Hutchins, E., & Klausen, T. (1996). Distributed cognition in an airline cockpit. In Y. Engeström & D. Middleton (Eds.), *Cognition and communication at work* (pp. 15–34). Cambridge University Press.

Janis, I. L., & Janis, I. L. (1982). *Groupthink: Psychological studies of policy decisions and fiascoes*, Vol. 349. Houghton Mifflin.

Janssen, M., Lee, J., Bharosa, N., & Cresswell, A. (2010). Advances in multi-agency disaster management: Key elements in disaster research. *Information Systems Frontiers*, *12*(1), 1–7.

Jensen, J., & Thompson, S. (2016). The incident command system: A literature review. *Disasters*, *40*(1), 158–182.

Jensen, J., & Waugh, W. (2014). The United States' experience with the incident command system: What we think we know and what we need to know more about. *Journal of Contingencies and Crisis Management*, *22*(1), 5–17.

Kapucu, N. (2006). Interagency communication networks during emergencies boundary spanners in multiagency coordination. *American Review of Public Administration*, *36*(2), 207–225.

Kapucu, N., & Garayev, V. (2013). Designing, managing, and sustaining functionally collaborative emergency management networks. *American Review of Public Administration*, *43*(3), 312–330.

Kellogg, K., Orlikowski, W., & Yates, J. (2006). Life in the trading zone: Structuring coordination across boundaries in postbureaucratic organizations. *Organization Science*, *17*(1), 22–44.

Kendra, J. M., & Wachtendorf, T. (2016). *American Dunkirk: The waterborne evacuation of Manhattan on 9/11*. Temple University Press.

Khan, J. M. (2004). *U.S. Patent No. 6,735,591*. US Patent Office, Washington, DC.

Klein, G. A. (2008). Naturalistic decision making. *Human Factors*, *50*(3), 456–460.

Klein, G. A., Orasanu, J., Calderwood, R., & Zsambok, C. E. (Eds.). (1993). *Decision making in action: Models and methods*. Ablex.

Knorr-Cetina, K. (2009). *Epistemic cultures: How the sciences make knowledge*. Harvard University Press.

Laakso, K., & Palomäki, J. (2013). The importance of a common understanding in emergency management. *Technological Forecasting and Social Change*, *80*(9), 1703–1713.

Lee, C. P. (2007). Boundary negotiating artifacts: Unbinding the routine of boundary objects and embracing chaos in collaborative work. *Computer Supported Cooperative Work*, *16*(3), 307–339.

Leedom, D. K. (2003). Functional analysis of the next generation common operating picture. *Analysis*, *69*(2), 149–163.

Maitlis, S., & Sonenshein, S. (2010). Sensemaking in crisis and change: Inspiration and insights from Weick (1988). *Journal of Management Studies*, *47*(3), 551–580.

Majchrzak, A., More, P. H., & Faraj, S. (2012). Transcending knowledge differences in cross-functional teams. *Organization Science*, *23*(4), 951–970.

Manoj, B. S., & Baker, A. H. (2007). Communication challenges in emergency response. *Communications of the ACM*, *50*(3), 51–53.

McGuire, M., & Silvia, C. (2010). The effect of problem severity, managerial and organizational capacity, and agency structure on intergovernmental collaboration: Evidence from local emergency management. *Public Administration Review*, *70*(2), 279–288.

Meier, P. (2010/2013). Sentiment analysis of Haiti text messages *<https://irevolutions.org/2010/03/08/sentiment-analysis-sms/>* (updated), iRevolution Blog. Keynote address at CrisisMappers 2013.

Mendonça, D., Jefferson, T., & Harrald, J. (2007). Collaborative adhocracies and mix-and-match technologies in emergency management. *Communications of the ACM*, *50*(3), 44–49.

Mendonça, D., & Wallace, W. A. (2004). Studying organizationally-situated improvisation in response to extreme events. *International Journal of Mass Emergencies and Disasters*, *22*(2), 5–30.

Merchant, R. M., Elmer, S., & Lurie, N. (2011). Integrating social media into emergency-preparedness efforts. *New England Journal of Medicine*, *365*(4), 289–291.

Meyerson, D., Weick, K., & Kramer, R. M. (1996). Swift trust and temporary groups. In R. M. Kramer & T. R. Tyler (Eds.), *Trust in organisations: Frontiers of theory and research* (pp. 166–195). SAGE.

Mogford, R. H. (1997). Mental models and situation awareness in air traffic control. *International Journal of Aviation Psychology*, *7*(4), 331–341.

Moynihan, D. P. (2008). Learning under uncertainty: Networks in crisis management. *Public Administration Review*, *68*(2), 350–365.

Moynihan, D. P. (2009). The network governance of crisis response: Case studies of Incident Command Systems. *Journal of Public Administration Review and Theory*, *19*(4), 895–915.

Mullen, J., Vladi, N., & Mills, A. J. (2006). Making sense of the Walkerton crisis. *Culture and Organization*, *12*(3), 207–220.

Neal, D. M., & Phillips, B. D. (1995). Effective emergency management: Reconsidering the bureaucratic approach. *Disasters*, *19*(4), 327–337.

Nohrsted, D., Bynander, F., Parker, C., & ‘t Hart, P. (2018). Managing crises collaboratively: Prospects and problems—a systematic literature review. *Perspectives on Public Management and Governance*, *1*(4), 257–271.

Ödlund, A. (2010). Pulling the same way? A multi-perspectivist study of crisis cooperation in government. *Journal of Contingencies and Crisis Management*, *18*(2), 96–107.

O’Mahony, S., & Bechky, B. A. (2008). Boundary organizations: Enabling collaboration among unexpected allies. *Administrative Science Quarterly*, *53*(3), 422–459.

Palen, L., Anderson, K. M., Mark, G., Martin, J., Sicker, D., Palmer, M., & Grunwald, D. (2010). A vision for technology-mediated support for public participation and assistance in mass emergencies and disasters. *Proceedings of the 2010 ACM-BCS Visions of Computer Science Conference*, April, 1–12.

Palen, L., & Liu, S. B. (2007). Citizen communications in crisis: Anticipating a future of ICT-supported public participation. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems ACM*, April, 727–736.

Parasuraman, R., Sheridan, T. B., & Wickens, C. D. (2008). Situation awareness, mental workload, and trust in automation: Viable, empirically supported cognitive engineering constructs. *Journal of Cognitive Engineering and Decision Making*, *2*(2), 140–160.

Perry, R. W., & Quarantelli, E. L. (Eds.). (2005). *What is a disaster? New answers to old questions*. Xlibris Corporation.

Qualman, E. (2010). *Socialnomics: How social media transforms the way we live and do business*. John Wiley & Sons.

Quarantelli, E. L. (1978). *Disasters: Theory and research*. SAGE.

Quarantelli, E. L. (Ed.). (1998). *What is a disaster?: Perspectives on the question*. Routledge.

Quarantelli, E. L., & Dynes, R. R. (1977). Response to social crisis and disaster. *Annual Review of Sociology*, *3*, 23–49.

Quarantelli, E. L., & Dynes, R. R. (1985). *Community response to disasters*. University of Delaware Disaster Research Center, Article 179.

Rodin, J. (2014). *The resilience dividend: Managing disruption, avoiding disaster, and growing stronger in an unpredictable world*. Public Affairs.

Roe, E. (1994). *Narrative policy analysis*. Duke University Press.

Rosenthal, U., Charles, M. T., & ‘t Hart, P. (Eds.). (1989). *Coping with crises: The management of disasters, riots, and terrorism*. Charles C. Thomas.

Salmon, P. M., Stanton, N. A., & Young, K. L. (2012). Situation awareness on the road: Review, theoretical and methodological issues, and future directions. *Theoretical Issues in Ergonomics Science*, *13*(4), 472–492.

Savolainen, R. (2007). Information behavior and information practice: Reviewing the “umbrella concepts” of information-seeking studies. *Library Quarterly: Information, Community, Policy*, *77*(2), 109–132.

Schakel, J. K., & Wolbers, J. J. (2019). To the edge and beyond: How fast-response organizations adapt in rapidly changing crisis situations *<https://doi.org/10.1177/0018726719893450>*. *Human Relations*.

Schmidt, A., Wolbers, J. J., Ferguson, J., & Boersma, F. K. (2018). Are you Ready2Help? Conceptualizing the management of online and onsite volunteer convergence. *Journal of Contingencies and Crisis Management*, *26*(3), 338–349.

Schön, D. A. (2017). *The reflective practitioner: How professionals think in action*. Routledge.

Scott, W. R. (2008). *Institutions and organizations: Ideas and interests*. SAGE.

Shelton, T., Poorthuis, A., Graham, M., & Zook, M. (2014). Mapping the data shadows of Hurricane Sandy: Uncovering the sociospatial dimensions of “big data.” *Geoforum*, *52*, 167–179.

Solnit, R. (2010). *A paradise built in hell: The extraordinary communities that arise in disaster*. Penguin.

Stanton, N. A., Salmon, P. M., Walker, G. H., & Jenkins, D. P. (2010). Is situation awareness all in the mind? *Theoretical Issues in Ergonomics Science*, *11*(1–2), 29–40.

Star, S. L. (2010). This is not a boundary object: Reflections on the origin of a concept. *Science, Technology & Human Values*, *35*(5), 601–617.

Stirling, A. (2008). “Opening up” and “closing down”: Power, participation, and pluralism in the social appraisal of technology. *Science, Technology & Human Values*, *33*(2), 262–294.

‘t Hart, P. (1993). Symbols, rituals and power: The lost dimensions of crisis management. *Journal of Contingencies and Crisis Management*, *1*(1), 36–50.

‘t Hart, P., Heyse, L., & Boin, A. (2001). Guest editorial introduction new trends in crisis management practice and crisis management research: Setting the agenda. *Journal of Contingencies and Crisis Management*, *9*(4), 181–188.

Tierney, K., Bevc, C., & Kuligowski, E. (2006). Metaphors matter: Disaster myths, media frames, and their consequences in Hurricane Katrina. *Annals of the American Academy of Political and Social Science*, *604*(1), 57–81.

Treurniet, W., Messemaker, M., Wolbers, J. J., & Boersma, F. K. (2015). Shaping the societal impact of emergencies: Striking a balance between control and cooperation. *International Journal of Emergency Services*, *4*(1), 129–151.

Treurniet, W., & Wolbers, J. (2020). Codifying a crisis: Progressing from information sharing to distributed decision-making *<https://doi.org/10.1111/1468-5973.12323>*. *Journal of Contingencies and Crisis Management*.

Uddin, S., & Hossain, L. (2011). Disaster coordination preparedness of soft-target organisations. *Disasters*, *35*(3), 623–638.

Vaughan, D. (1999). The role of the organization in the production of techno-scientific knowledge. *Social Studies of Science*, *29*(6), 913–943.

Wachtendorf, T., & Kendra, J. M. (2004). *Considering convergence, coordination, and social capital in disasters*. DRC.

Waldman, S., Yumagulova, L., Mackwani, Z., Benson, C., & Stone, J. T. (2018). Canadian citizens volunteering in disasters: From emergence to networked governance. *Journal of Contingencies and Crisis Management*, *26*(3), 394–402.

Waugh, W. L. (2009). Mechanisms for collaboration in emergency management: ICS, NIMS, and the problem with command and control. In R. O’Leary & L. Bingham (Eds.), *The collaborative*

public manager: New ideas for the twenty-first century (pp. 157–175). Georgetown University Press.

Waugh, W. L., & Streib, G. (2006). Collaboration and leadership for effective emergency management. *Public Administration Review*, *66*, 131–140.

Weick, K. E. (1993). The collapse of sensemaking in organizations: The Mann Gulch disaster. *Administrative Science Quarterly*, *38*(4), 628–652.

Weick, K. E. (1995). *Sensemaking in organizations*. SAGE.

Weick, K. E., & Roberts, K. H. (1993). Collective mind in organizations: Heedful interrelating on flight decks. *Administrative Science Quarterly*, *38*, 357–381.

Weick, K. E., & Sutcliffe, K. M. (2011). *Managing the unexpected: Resilient performance in an age of uncertainty*. John Wiley & Sons.

Winner, L. (1980). Do artifacts have politics? *Daedalus*, *109*, 121–136.

Wolbers, J. J., & Boersma, F. K. (2013). The common operational picture as collective sensemaking. *Journal of Contingencies and Crisis Management*, *21*(4), 186–199.

Wolbers, J. J., & Boersma, F. K. (2018). Key challenges in crisis management. In R. P. Gephart, C. C. Miller, & K. S. Helgesson (Eds.), *The Routledge companion to risk and crisis management* (pp. 17–34). Routledge.

Wolbers, J. J., Boersma, F. K., & Groenewegen, P. (2018). Introducing a fragmentation perspective on coordination in crisis management. *Organization Studies*, *39*(11), 1521–1546.

Yeo, J., Comfort, L. K., & Jung, K. (2018). Timely assessment of disaster and emergency response networks in the aftermath of superstorm Sandy, 2012. *Online Information Review*, *42*(7), 1010–1023.

Zagorecki, A., Ko, K., & Comfort, L. K. (2010). Interorganizational information exchange and efficiency: Organizational performance in emergency environments. *Journal of Artificial Societies and Social Simulation*, *13*(3), 3.

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