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Handling coordination in an extreme situation: Tensions in electronic communication and organizational emptiness during the 2003 French heat wave crisis response

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ABSTRACT

This study focuses on email use in extreme situations, in particular organizational crises in disaster settings. Despite abundant empirical evidence of intensive email use in crisis response, the question of the overall support from email to coordination in critical settings has remained unanswered. Filling this gap, we draw on grounded theory principles to conduct an exploratory investigation of email use during the 2003 French heat wave crisis response. We propose a thorough analysis of the crisis responders' electronic communication practices when they attempted to address what we label organizational emptiness. Through the narration of four episodes, our findings outline electronic communication tensions during the 2003 French heat wave crisis response: email was used by the crisis responders in a helpful as well as damaging way. Our discussion outlines four contradictory behaviors among email users - immediate communication but delayed action, centrality in information processing but absence in collective action, email use and avoidance, efforts for resilience despite persistent patterns of communication - that impeded organizational emptiness resolution, thereby burdening coordination during crisis response. This study enriches literature in three manners. First, we extend the scope of investigation of extreme situations. Second we propose organizational emptiness as an original conceptual lens to comprehensively analyze IT use in crisis coordination. Third, we offer insights on technology enactment in extreme situations.

Keywords: Electronic communication, Coordination, Disaster, Crisis response, Grounded theory.

RÉSUMÉ

Cette recherche porte sur l'usage de l'email en situation extrême, et plus particulièrement dans la réponse aux crises organisationnelles provoquées par des désastres. Malgré des preuves empiriques d'une utilisation intensive de l'email durant les réponses aux crises, les pratiques de communication électronique dans ce type de contexte ont été peu étudiées et sont mal connues. En nous appuyant sur les principes de la théorie enracinée, nous avons donc étudié l'usage de l'email durant la réponse à la crise provoquée par la canicule de 2003. Nous offrons une analyse approfondie des pratiques de communication électronique développées par les acteurs lorsqu'ils répondent à la crise et font face à ce que nous appelons le vide organisationnel. Structurés autour de quatre récits, nos résultats soulignent les contradictions inhérentes aux pratiques de communication électronique durant l'épisode de canicule survenu en France en 2003. Il ressort en effet que les usages de l'email, en même temps qu'ils visaient la résolution du vide, ont souvent contribué à le maintenir, voir à l'aggraver. Pour comprendre ce phénomène, nous proposons une lecture en termes de tensions entre les dynamiques organisationnelles établies et l'expérience immédiate de la crise. Cette confrontation a induit un « enactment » ambivalent de l'email, exprimé en pratique par quatre formes de contradictions interdépendantes (réponse immédiate mais action différée ; utilisation versus évitement de l'email ; centralité dans le traitement de l'information mais absence de l'action collective ; patterns de communication persistants malgré un effort de résilience). Cette recherche enrichit la littérature de trois façons. Tout d'abord, elle étend le champ d'investigation des situations extrêmes à des situations non préparées et impliquant des difficultés de coordination inter-organisationnelle. Ensuite, à partir du concept de vide organisationnel, nous proposons une grille d'analyse de la communication électronique et de la coordination en situation de crise. Enfin, nous enrichissons la compréhension des usages des technologies en mettant en évidence les effets indirects de l'enactment de la technologie.

Mots-clés : Communication électronique, Coordination, Désastre, Réponse à la crise, Théorie enracinée.

INTRODUCTION

In disasters, crisis responders can face difficulties to meet the urgent needs of those affected when they have to handle coordination problems within and between organizations (Quarantelli, 1988). Indeed, as extreme situations, disasters are characterized by uncertainty, risk and high-velocity (Lièvre & Gautier, 2009), which significantly challenge organizational coordination. In some specific cases, disasters can also trigger organizational crises that aggravate coordination issues.

Recent research on disasters and crisis response examined how information technologies could facilitate coordination in such settings (Van de Walle & Turoff, 2007). Research in crisis management has focused on new technological systems such as Geographic Information Systems (Zerger, 2003), Command and Control Systems (Lutz & Lindell, 2008), and Decision Support Systems (Mendonça, 2007) or even social media (Palen et al., 2007). In contrast to these technologies, email has attracted scant attention from crisis management scholars.

However, email has been reported to be one of the most prominently used tools to exchange data and coordinate within and between organizations (Barley et al., 2011; Bia Figueiredo & Kalika, 2008); Ducheneaut & Watts, 2005). Likewise, literature on crisis management has provided empirical evidence that email is intensively used in crisis response (Danowski & Edison-Swift, 1985; Farnham et al., 2006; Newsom et al., 1999; Vielhaber & Waltman, 2008). Recent disasters such as the

SARS epidemic in Singapore, the Tsunami in Sri Lanka or Hurricane Katrina provide vivid illustrations of email use by crisis responders to coordinate (Majchrzak & More, 2011; Pan et al., 2012). However, given existing knowledge on electronic communication, the anticipation of whether email is likely to serve as a support or an obstacle in a specific case remains difficult.

From a theoretical perspective, such an uncertainty can be partly explained. Theories such as Media Richness Theory (Daft & Lengel, 1984; Daft & Lengel, 1986) raise important limitations of electronic communication when complexity and uncertainty are high. As a lean media, email is likely not to fit to crisis responders environment, tasks and communicational needs. More generally, inner characteristics and functions of email may facilitate as well as impede coordination during crisis response (Rice, 1990). Our literature review reveals that addressing our research question by focusing on email characteristics does not provide any satisfactory answer.

Given the lack of theoretical guidance to understand the influence of electronic communication we address the following research question: *What support from email to coordination in crisis response?*

Focused on email, this paper is included in a larger research project that considered multiple information technologies. We completed a qualitative retrospective analysis of electronic communication practices during the organizational response to the 2003 French heat wave.

The 2003 French heat wave was a natural disaster that triggered an organizational crisis in the response network. Since the beginning of the 2003 summer, the weather had gone scorching, provoking a dramatic drought, fires and electrical blackouts. At the beginning of the month of August, several cases of hyperthermia were reported. Emergency rooms rapidly went overwhelmed with dying patients while part of administrative organizations reacted to the disaster with delays. As a result, almost 15,000 people died between the 4th and the 20th of August 2003. Email was extensively used during the response to the 2003 French heat wave crisis response. However, coordination remained laborious, thereby delaying the response dramatically.

To provide a comprehensive explanation of email use on the 2003 French heat wave, this research relies on grounded theory principles – including qualitative coding – to analyze email use during the crisis response. Grounded theory is a relevant methodology to address lack of theoretical guidance and the need to take into account the actors' reality into the analysis (Sousa & Hendriks, 2006). By doing so, we made a comprehensive theoretical framework emerge from data. Our findings, through the narration of four episodes, reveal that crisis responders relied on electronic communication to address what we label *organizational emptiness* – the absence of operation of resources and means despite their being necessary to complete essential tasks. They tried to alert, find resources, define and deploy means. However, crisis responders used email

in a helpful as well as damaging way, revealing tensions in electronic communication. The crisis responders enacted email technology in an ambivalent manner, which resulted into contradictory behaviors, thereby impeding organizational emptiness resolution and crisis response. We discuss in the present paper four of these contradictory behaviors – immediate communication but delayed action, centrality in information processing but absence in collective action, email use and avoidance, efforts for resilience despite persistent patterns of communication. This study provides practical recommendation but also contributes to the literature in three manners. First, we extend the scope of investigation of extreme situations by examining inter-organizational coordination in disaster settings. Second, by proposing organizational emptiness as an original conceptual lens to coordination, we offer a holistic framework to enrich current knowledge on the role of IT on coordination. Third, we connect two topics that have been conceptually related: IT and organizational dynamics. By doing so, we offer insights on technology enactment in extreme situations.

The paper is structured as follows. We first review the literature on crisis coordination and email use. We then present the case under study, namely the 2003 French heat wave crisis response. In the following section, we detail our methodology, in particular the abductive dimension of the analysis process. The findings section is structured in two parts. First, we present the concept of organizational emptiness that emerged from our anal-

ysis. Second, we narrate four episodes that depict the influence of email use on organizational emptiness resolution. We finally discuss our findings and present our contribution. The conclusion section presents three major avenues for future research.

I. LITERATURE REVIEW

I.1. Coordination issues and information technology (IT) in disasters

Defined as *“events, observable in time and space, in which societies or their subunits incur physical damages and losses and/or disruptions of their routine functioning”* (Kreps, 1984, p.312), disasters share common features with extreme situations that challenge coordination in organizations. The first part of our literature review poses that disasters expose organizations to specific coordination issues, which have increasingly attracted scholarly attention (Chen et al., 2008; Der Heide, 1989; Leidner et al., 2009). While coordination is essential to survive to a disaster, it is also fragile. Coordination issues in disaster thus reveal the essential support that IT can provide to disaster management.

Initially investigated by psychologists (Bettelheim, 1943), extreme situations refer to situations characterized by uncertainty, risk and high-velocity (Lièvre & Gautier, 2009). First of all, disasters can suddenly trigger uncertainty within organizations by causing major and often highly improbable disruptions with respect to organizational procedures. As a result, an organization's ability to keep working according to its

pre-established patterns of coordination comes into question. In particular, sudden need for coordination and communication between unfamiliar organizations has proved to cause misunderstandings and slow down collective action (Kapucu et al., 2010). Crisis responders also face challenges when making sense of the situation, struggling to determine the actions that should be undertaken (Fink et al., 1971). Thus organizations can be compelled to redefine inputs, outputs and processes without a reliable forecast of possible outcomes of the response (Quarantelli, 1988; Waugh & Streib, 2006).

Secondly, disasters are risky situations in that they can cause or aggravate organizational crises. An organizational crisis *“threatens high-priority values of the organization, presents a restricted amount of time in which a response can be made, and is unexpected or unanticipated by the organization”* (Hermann, 1963, p.64). Organizational crises often result from the conjunction of multiple issues. Not only responding organizations have to deal with the public opinion's high-level of expectations regarding their efforts to alleviate human suffering and material damage (Turner, 1976). Also, they have to handle extra activities and grant transparency in their decision-making and logistics (Garnett & Kouzmin, 2007), which can overwhelm the crisis responders with additional tasks and endanger coordination.

Finally, disasters are characterized by high-velocity (Bourgeois & Eisenhardt, 1988). Crisis responders need to constantly adjust to an ever-changing con-

text that is characterized by informational disruptions. As a result, ongoing collective action can be burdened by the necessity to achieve new and unstructured actions (Quarantelli, 1988). In contrast with the traditionally admitted phenomenon of rigidity-threats (Staw et al., 1981), an alternate stream of research acknowledges that coordination is likely to follow unexpected deviating patterns, also called improvisation (Crossan et al., 2005; Cunha, 2005; Faraj & Xiao, 2006; Mendonça, 2007; Weick, 1993). More recently, Constantinides and Barrett highlighted that coordination is progressively shaped by crisis responders' narration of their own action (2012). It is critical to provide current and accurate information for organizations to address these coordination challenges in a disaster (Leidner et al., 2009; Pan et al., 2012). During Katrina, both the disruption of informational infrastructures and the asymmetrical access to information affected the partial collapse of coordination (Comfort & Haase, 2006). At the same time, Google Earth was extensively used by rescue services to document damages and locate the victims on web maps (Palen et al., 2007). By offering immediate access to information, firefighters in New Orleans handled coordination despite multiple obstacles.

Technological information transmission has been transforming crisis coordination in three manners. First, IT has provided new opportunities for the improvement of coordination. Increasing actors' connectivity, IT supports communication across multiple sites and actors (Constantinides & Barrett, 2012) and allows access to additional sources

of information, such as crowd sourcing (Majchrzak & More, 2011). Second, technology has imposed new requirements. If unmet, these requirements can impede coordination, for example, when users do not successfully manage to convert information formats (Dawes et al., 2004). Technology also allows information transmission at a pace that can make planning inadequate (Majchrzak et al., 2007). Finally, IT use significantly supports crisis coordination at the condition that organizations have previously developed adequate capabilities (Adrot, 2010; Rerup, 2001). As users of email since decades, organizations have adopted skills and capacities in electronic communication. From this perspective, email appears to be an essential tool for coordination in disasters. However, the influence of email on crisis coordination have not been thoroughly investigated empirically.

I.2. Email use and crisis coordination

Literature emphasizes the importance of electronic communication for collective action in crisis settings. Danowski and Edison-Swift reported that individuals intensively rely on email when a crisis strikes (1985). According to these authors, not only does the amount of exchanged messages increase. Also, the content of the messages and the structure of the communication network evolve. In particular, the amount of communicators increases, messages become shorter and more focused on organizational issues.

Recent research on disasters provides some striking examples of email

use by crisis respondents to coordinate (Majchrzak & More, 2011; Pan et al., 2012). For example, when the SARS¹ outbreak hit Singapore in 2003, 14 government agencies had to develop an *ad hoc* crisis management system to trace the epidemic's spread. Through the crisis response, they heavily relied on email to transmit their requirements and incrementally develop the system (Pan et al., 2012). Similarly, during the Tzu Chi's response to the Sri Lanka Tsunami, email was primarily used between the headquarters and the ground operation center to consult, advice and provide feedback on a daily basis. Thanks to these exchanges, Tzu Chi headquarters adjusted operational plans in accordance with changing circumstances (Pan et al., 2012). During the San Diego Fires in 2007, the local public broadcasting station received from local citizen emails signaling road closures, shelters and evacuation routes. On the radio web site, maps developed in collaboration with Google were frequently updated according to these emails (Majchrzak & More, 2011).

However, the electronic communication that took place in the case of hurricane Katrina provides cause for alarm. In the aftermath of the disaster, more than 1,000 pages of email were analyzed to determine responsibilities and failures in crisis response (Melancon, 2005). This work revealed that, in spite of the dramatic number of exchanged emails, electronic communication did not allow the recipients to grasp about the reality of the victims,

thereby aggravating inertia in decision-making within the Federal Emergency Management Agency.

These examples suggest that, with varying degrees of success, email is extensively used for vertical and horizontal, inter and intra-organizational coordination, by formal or emergent response networks. However, given existing knowledge on electronic communication, the anticipation of the influence of email use on the output of crisis response remains uncertain. In fact, inner characteristics and functions of email may impede as well as facilitate coordination during crisis response.

On the one hand, Media Richness Theory argues that email is a "lean" media, unable to process rich information (Zmud et al., 1990). The asynchronous characteristic of email places restrictions on feedback. Like other written media such as letters or memos, it transmits fewer cues than face-to-face. Email limits the user's capacity to express oneself in a diversified way or to personalize their message. These properties have the potential to hinder inter-individual communication and information sharing, in particular when the message or the task is complex and ambiguous (Daft & Lengel, 1984; Treviño et al., 2000). In a crisis context, coordination and decision-making occur under conditions of high uncertainty and high equivocality, therefore requiring a large amount of rich information. Additionally, unusual and unanalyzable tasks are more numerous (Daft & Macintosh, 1981; Perrow, 1967) and re-

¹ Severe Acute Respiratory Syndrome.

quire an information processing that is “*more personal, less linear, more ad hoc and improvisational*” (Rice, 1992, p. 478). From this perspective, one could safely assume that relying on email for coordination in crisis response can be inefficient.

On the other hand, Rice argues that electronic communication can help address constraints that are inherent to communication in crisis response (1990). In particular, he points out that email allows users to store and track specific strands of ongoing online conversations, which helps avoid ambiguity and addresses rapidly evolving situations related to past information or expectations. Furthermore, because of the ability to connect in an asynchronous manner individuals in different departments, locations and schedules, email “*could be used to establish permanent but not full-time, managed but flexible – that is « virtual », communication and decision-making structures to handle crises*” (Rice, 1990, p.100).

The Media Synchronicity Theory goes further by arguing that email can be highly relevant if combined with synchronic media (Dennis et al., 2008). Email supports rehearsability, reprocessibility and high parallelism. Email rehearsability allows “*the sender to carefully craft a message before transmission, to ensure that intended meaning is expressed precisely, thus improving recipients’ information understanding*” (Dennis et al., 2008, p.587). In crisis response, rehearsability can be important because individuals have no previous experience working with each other and transmitted information is new and complex. Reprocessibility also

supports information processing by “*enabl[ing] the sender to reexamine and consider previously sent content for the development of understanding*” (Dennis et al., 2008, p. 587). Finally, email supports high parallelism, which refers to the media capability “*to support multidirectional communication (e.g. simultaneous sending of messages to multiple recipients, simultaneously receipt of messages from multiple senders)*” (Dennis et al., p.585). These characteristics reduce risks of information losses due to the need to transmit sequentially.

Recent research, by depicting email as part of diversified IT portfolios for crisis response – including mobile applications, social media or internet platforms – illustrates the assets of email use in critical settings (Stephens et al., 2013). Future technological improvements are likely to have an impact on these assets. Given digital convergence, not only email access is increasingly embedded in Internet applications and multiple devices. In addition, email systems are acquiring new capabilities that could be highly relevant for coordination in crisis response. For example, many email systems now provide functionalities such as push-mail or voice messaging, which can significantly improve interactivity, thereby conveying more nuanced emotions.

Our literature review reveals that addressing our research question by focusing on core features of email does not provide any satisfactory answer. Email properties and functions develop a “*structural potential*” whose impact on crisis response will depend on how users perceive and collectively use email features (DeSanctis & Poole, 1994, p.127). This point is in line with

ongoing research on electronic communication that has highlighted the need to further investigate the practical use of emails by individuals. For instance, Kock (1998, 2001) has questioned previously held assumptions on media choice by demonstrating that users can deliberately choose a media they perceive as “lean” for complex tasks, such as process improvement. Crisis management research has followed a similar path by demonstrating that electronic communication practices are likely to play a prominent role during crisis response. Vielhaber and Whaltman’s analysis of electronic communication during a faculty strike highlights how the rhetoric present in emails can help crisis responders to build their cases to protect their reputation (2008).

Meanwhile, there has been little explicit analysis of the ways in which electronic communication practices impact coordination between crisis responders. For this reason, we propose to address the question of email support to crisis coordination through an in-depth, empirical investigation of the electronic communication practices of responders to the 2003 French heat wave crisis. The following section details our methodological choices and our research process.

II. THE 2003 FRENCH HEAT WAVE

This section provides an overall description of the effects of the heat wave and the organizations involved in the crisis response.

An extraordinary climatic phenomenon, the 2003 French heat wave caused a dramatic drought during the months of July and August. Lakes and rivers were dried-up enough to block the energy supply (Salagnac, 2007). The simultaneous effect of the heat and the drought raised the frequency of fires and caused energy blackouts at electrical and nuclear power plants. Additionally, mortality in the Ile-de-France region suddenly increased, especially among the elderly. Despite extensive documentation on the potential effects of the climate on the French territory and population, the health care system failed to anticipate the increase of mortality caused by the heat wave (Got, 2008). As a result, the death rate was more than 150% higher than previous years during the two first weeks on the month of August (Fouillet et al., 2006; Hémon et al., 2003). Appendix A represents both temperatures and death numbers in Paris between the 15th of June 2003 and the 15th of September 2003, which illustrates the simultaneous increase in the number of deaths and the temperature on the 12th of August 2003.

The response to the heat wave involved a set of 23 types of organizations that we label the *response network* in this study. The response network is composed of three main groups with specific missions and objectives that are detailed in the appendices (Appendix B). First of all, the group of civil protection and police organizations is in charge of assuring public security and order in routine situations. In critical situations, these organizations have the additional responsibility of providing civil

protection and emergency services, such as caring for injured people and organizing rescue operations. This group mainly includes the Paris Fire-fighter Brigade (BSPP) and Paris Police services. Both of these services are under the authority of the Paris Prefecture of Police (PPP). Similarly, the PPP is under the authority of the Minister of the Interior of France.

Secondly, the group of health care organizations is in charge of taking care of injured and sick people. This group includes three types of organizations with distinct levels of responsibilities. Local actors such as emergency medical services and hospitals handle patients' flow, diagnosis and care. Regional organizations manage and regulate medical activities in Paris and its surroundings. Some national organizations from the group of health care organizations manage the funding and organization of health care activities within France. Other organizations from this group are in charge of alerting all the health care organizations when some disaster is likely to happen such as the National Health Watch Institute (INVS).

Finally, we identified a third group of organizations that were involved in crisis response. We label this group "outsider organizations" because these organizations were not entitled to respond to the heat wave. However, outsider organizations had a significant influence on the development of crisis response.

Figure 1 represents the connections between the organizations that were involved in the response to the 2003 French heat wave crisis. Organizations

with national responsibilities are represented on the top. Progressively moving towards the bottom one can find organizations with regional and local responsibilities. As the legend explains, unidirectional arrows signify hierarchical top-down connections. Bidirectional arrows represent strong cooperational ties. Finally, links with no arrow corresponding to *ad hoc* connections that emerged between organizations during the heat wave.

In August 2003, the heat compromised the ability of the response network to perform its duties, thereby putting the organizations into crisis. Civil protection and health care organizations partially failed at protecting the lives of vulnerable citizens. Emergency rooms were overwhelmed with patients and the civil protection services did not manage to prevent outdoor and indoor fatal faints. As an increasing number of people suffered from the heat, hospital mortuary chambers became overcrowded and funeral homes were unable to manage the increasing number of corpses. The following week, the Health Minister, the National Health Watch Institute and the National Health Agency failed to provide the public with an accurate estimation of the number of deaths. It took an entire week for the Health Minister to enact the emergency plan, also known as the "White Plan" that included directions to cope with a sudden increase in the number of casualties caused by a disaster.

The 2003 French heat wave not only triggered internal organizational crises but also paralyzed transversal coordination within the response network, which resulted in a national political

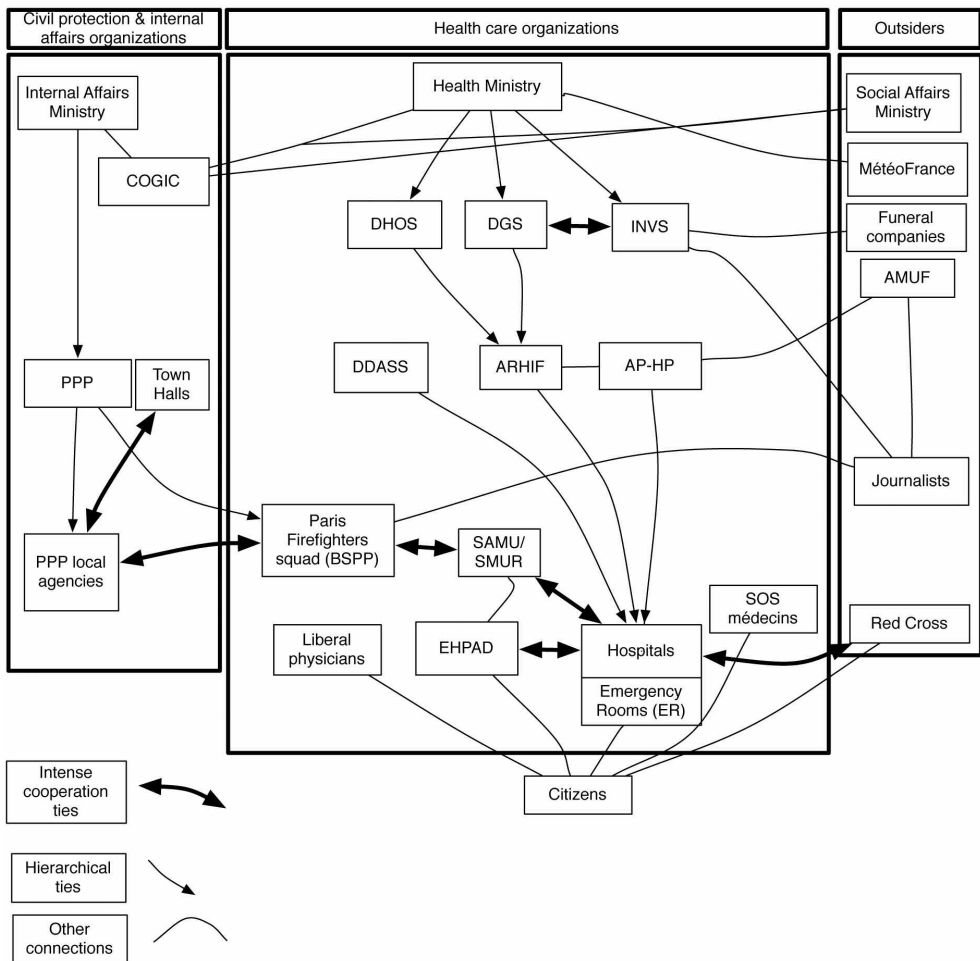


Figure 1. Organizations involved in the 2003 French heat wave crisis response.

scandal. More specifically, the extremely high temperatures led to two fundamental tensions between the health network's objectives and its actual functioning during the heat wave. First of all, hospitals were lacking information, knowledge, administrative support, energy and material resources that they usually draw from regional and national administrative organiza-

tions. Secondly, the public health system could not share information and coordinate properly to optimize resource allocation. While more than 15 employees were mobilized to write one note alerting the public to the situation, help was desperately needed to simply hydrate patients in hospitals. Each organization had internally settled crisis management teams and

meetings. However, information was not shared between the groups of civil protection organizations and medical organizations.

We provide in Appendix C a chronology of the events of the crisis that we developed from the systematic examination of the interactions between actors. We triangulated this chronology with two chronologies previously developed in the literature (Boude & Laroche, 2009; Lagadec, 2004).

III. METHODOLOGY

The research method in this study is qualitative and retrospective. We followed the grounded theory approach, as defined by Corbin and Strauss (1990). The grounded theory approach aims to build alternate explanations of social phenomena by rigorous coding processes. Thus, our analysis involved the application of abductive reasoning. To start, we triangulated three sources categories of data: i) 800 pages of public hearings, ii) 13 semi-centered retrospective interviews and iii) internal archives – emails, faxes- and external archives as secondary data – newspapers, international reports and essays.

III.1. Research settings

Our rationale for a grounded theory approach is threefold and abides by existing recommendation (Glaser & Strauss, 1973; Locke, 2001; Sousa & Hendriks, 2006; Suddaby, 2006). First of all, there is deficient theoretical guidance on email use in crisis response: existing theoretical frame-

works are undeveloped or do not provide satisfying answers to our research question, which signifies the need for theoretical enrichment. Secondly, core concepts of electronic communication and crisis response remain loosely coupled. As a result, an inductive approach is adequate to clarify the connections between the concepts being studied. Thirdly, the observation of participants is necessary to respond to our research question given the lack of knowledge on email users' behaviors.

The research process was completed in 28 months from May 2008. As this research is in line with grounded theory canons, data collection was conducted iteratively. Our criteria for data collection were repeatedly adjusted on the basis of intermediate outcomes of document analysis, coding, presentations and discussion with other researchers. Our theorizing was similarly iteratively refined on the basis of feedback from other researchers.

III.2. Data collection and coding analysis

Data was collected between 2008 and 2010; three sources of data were explored.

First of all, secondary data was collected via systematic reviews of regional and national newspaper archives, essays and testimonies of the 2003 French heat wave. Documents retained for analysis were rigorously selected on the basis of their scientific reliability and their proximity with the topic. Appendix D provides a list of the documents considered relevant for analysis

at the beginning of the research project.

Secondly, we collected transcripts of public hearings. 65 individuals involved in the crisis response that took place during the aftermath of the heat wave in the months of September and October. The public hearings focused on the interactions that occurred between various actors – including electronic, phone or even face-to-face interactions – which made them particularly interesting for our research. In particular, interviewees were systematically asked who they had interacted or coordinated with, the reasons for their interacting (or not) with other actors, what information they had access to. The public hearings are free for download from the parliamentary chambers web sites². Interviewees provided their own mails and faxes to support their testimonies during the public hearings. These documents were attached in the appendices of the national reports produced by the parliamentary chambers.

13 retrospective interviews were conducted since the beginning of the project with diverse actors within the group of health organizations. Our rationale for focusing on this part of the response network for interviews is that health care professionals were on the front scene of the crisis response and therefore very likely would have played a major role in the coordination effort. Each interview lasted for at least

one and a half hours. The theme dictionary used for interviews was refined progressively. We stopped after 13 interviews, when the whole analytical process attained theoretical and semantic saturation. We met 4 individuals from the operational personnel (ERT, nurses from geriatric services), 5 individuals from hospitals' direction (CIO, directors, Human Resources directors) and 4 top-directors of the health network. To complete these interviews, we relied on the phone to preliminarily identify actors who had been directly involved in crisis response. After each interview, we relied on snowball sampling techniques by asking to interviewees who they had coordinated with during the crisis response. Retrospective interviews supported data triangulation and provided data on dimensions that were less prominently mentioned in public hearings. Semi-centered retrospective interviews started at the beginning of the project and were completed simultaneously to an extensive search for archives on the Internet and the analysis of the public hearings.

Following a grounded theory methodology, we coded all data with the exception of secondary data. We coded data through the four steps that Corbin and Strauss recommend to follow (1990): microanalysis, open coding, select coding, axial coding. We then identified categories from this data. We transformed these categories into concepts, which corresponds to

² Url : <http://www.assemblee-nationale.fr/12/rap-enq/r1455-t2.asp>

the abstraction process as defined by Strauss and Corbin (2008).

III.3. An abductive theory building approach

Our analysis was iterative. By going back and forth between data and findings, we formulated hypotheses from the data and we confronted these hypotheses with more data.

For example, the concept of organizational emptiness presented in the Findings section, emerged from iterative cycles of data coding and literature review for conceptual refinement. At the beginning of our analysis, we completed a microscopic analysis of the segments of the public hearing transcripts that we had selected for analysis. During selective and axial coding, we identified categories such as “death”, “lack of resources”, “difficulty to be understood” that we merged into the concept of organizational holes.

To refine our analysis, we performed semantic and theoretical research on the distinction between organizational holes, vacuum, void or slack. Void or vacuum refer to a “space filled with nothing”, therefore conveying the idea of non-existence that did not fit to the crisis responders’ search for innovative solutions. Organizational holes (Burt, 1992) correspond to disparate events or lacks but our analysis rather suggested that the crisis responders a concomitant and diffuse feeling of lack. Finally, organizational slack, defined as an objective evaluation of existing but unused resources (Bourgeois, 1981),

contrasted with the experiential dimension of our data.

We eventually opted for the notion of emptiness that conveyed the idea that some resources or means were interdependently missing and prevented actors to complete processes on the usual track. Emptiness defines a space “vacant or unoccupied”, free for reinvention. In old English, emptiness referred to the lack of occupation. According to the Thesaurus dictionary, young people would refer to their emptiness to signal they were single. For further details on the definition of organizational emptiness, please refer to the findings section.

We kept on relying on an abductive reasoning to then test the following hypotheses: i) Email use primarily aggravated organizational emptiness, ii) organizational emptiness was inherent to email use. Discussion between the authors helped reject i) because empirical data provided evidence that some electronic communication helped the crisis responders to address a lack for outputs and processes, as demonstrated in the findings section. In addition, ii) was rejected as empirical data proved that organizational emptiness was experienced even when email was not used.

IV. FINDINGS

The findings are presented in two steps. First, we introduce and detail the concept of organizational emptiness that emerged from our following of the grounded theory principles in our analysis. Second, we detail the influence of electronic communication on

the 2003 French heat wave crisis responders' addressing organizational emptiness.

IV.1. Organizational emptiness

We detail this concept as a theoretical code (Strauss & Corbin, 2008) that we used as an analysis grid to coordination issues during the 2003 French heat wave crisis response. Emptiness has already been documented in management sciences, but our definition of organizational emptiness has emerged through an iterative comparison between theories and empirical data.

In this study, organizational emptiness refers to *the absence of operation of resources or means in spite of their being necessary to perform a specific process*. The notion of organizational input involved in this definition is two-fold, referring to organizational resources and means. Barney (1991) provides a fair definition and a typology of various resources that an organization can miss. By following Barney's approach, we identify two main types of organizational resources: 1) tangible such as objects and people or 2) intangible such as competencies, cognitive frameworks and information. Additionally, we draw from Mintzberg's definition of organizational means (1979). There are six types of means that refer to the mechanisms of coordination: processes, outputs, instructions, informal connection between individuals and groups, norms and skills. Derived from this conceptualization, organizational emptiness can be understood as a paralysis of coordination and therefore, a paralysis of crisis response.

Following a realist approach, we propose that the concept of organizational emptiness is both intransitive and transitive. Organizational emptiness is an intransitive matter to the extent that a mismatch between resource allocation and the individuals' needs is an objective fact. During the 2003 French heat wave, the number of deaths objectively exceeded the capacity of mortuary chambers. Similarly, no information system devoted to inter organizational coordination existed at that time. However, individuals also made their own experience of emptiness. Even though emptiness has an independent existence from human subjectivity, individuals perceived emptiness through the experience of crucial lacks during the heat wave.

Being both intransitive and transitive, organizational emptiness has an independent existence that one can hardly understand in its entirety. An individuals' perception of a lack of resources or means does not necessarily imply that these resources and means do not actually exist. In the aftermath of the heat wave, crisis responders eventually understood that some resources and means that they missed at the time of the crisis response actually existed. For example, hospitals experienced shortages of medicines despite considerable stocks. In this case, emptiness stemmed from the rigidity threat in relation to resource supply processes.

Addressing the confusion caused by the absence of operation of necessary resources and means, individuals and groups experience cognitive dissonance, as defined by Festinger (1957).

This situation can provide an opportunity for actors to develop behaviors that deviate from established paths collectively. Burt, who founded the theory of structural holes, explained how ambiguities in human agency could raise unexpected behaviors such as opportunistic strategies (Burt, 1992; Burt, 2004). This connection is consistent with French sociology that accounts for emptiness as an opportunity for actors to develop their reflexivity (Alter, 2000) and power (Crozier & Friedberg, 1977). Finally, the garbage can theory depicts the frequency of ambiguity in processes and how it causes unexpected interactions among decision makers (Cohen et al., 1972).

IV.2. Electronic communication and organizational emptiness in the 2003 French heat wave

Facing organizational emptiness, the crisis responders were compelled to reinvent their coordination practices by finding new resources and developing *ad hoc* means. Crisis responders relied on email to accomplish this. However their electronic communication practices only partially helped address organizational emptiness, which burdened crisis coordination. Table 1 presents a summary of the findings section. It represents the various dimensions of organizational emptiness and details the communication practices that supported organizational emptiness (OE) resolution, the partici-

pation of email users in solving OE, the email features involved as well as the organizational dynamics involved into electronic communication.

IV.2.1. Raising an alarm: the case of tangible resources

Crisis responders relied on email to send out an alert about shortages of material resources. The administrative personnel who received these messages from operationals responded quickly and forwarded them to multiple recipients, thereby supporting the alerting process. However, despite vivid descriptions of these shortages, the operationals did not succeed at sharing a common representation of the problems caused by organizational emptiness. The operational personnel eventually abandoned email for other media to coordinate improvised solutions.

Many material resources were missing from hospitals. Medical personnel were in need of beds, ice and air conditioners. Personnel improvised by using non-traditional materials to cool down rooms because the building structures were not adapted to high temperatures. In other cases the resources were available but not usable. In many hospitals the water was too hot to be consumed or to refresh patients.

Electronic communication was used by ERTs to alert on this type of lack and send requests regarding material resources. As one of them stated:

³ Actors and institutions were anonymized when possible.

Episode name	Organizational emptiness	Communicative practices that support Organizational Emptiness (OE) solving	Communicative practices that prevented OE solving	Email users participation in OE solving	Email features involved	Organizational dynamics involved
Raising an alarm	Tangible resources	Quick reply Rich interaction Multiple forwarding	Low intellectual and emotional engagement	No, improvisers abandoned email	Familiarity Multi-addressability Forwarding	Transparency Protection strategies
Filling with content	Intangible resources	Intellectual engagement Decreased oscillation	Focus on data and evaluation rather action	Partly, in the thinking process	Asynchronicity Focus on a title Reprocessability	Difficulties to make sense
An avoided truth	Norms, skills, informal connections	N/A	Focus on predefined rather than alternate topics Avoidance of controversies	No, improvisers abandoned email	Traceability Multi-addressability	Self-protection Fear of criticism Importance of law Risk aversion
Building from scratch	Outputs, processes, instructions	Intellectual engagement Frequent use	Strictness of instructions lightened	Partly, action was delayed.	Familiarity Asynchronicity Traceability Rehearsability	Communication strategies and patterns

Table 1. Findings summary

"Many elderly die in emergency rooms indirectly or directly from hyperthermia. Three people have died in Gamma³ [hospital] so far. The Emergency Room [ER] personnel, at least ours, has been totally overwhelmed with patients. Some patients wait for 4 or 5 hours on a stretcher. We have to search for more beds and have deleted all our scheduled medical interventions. I have never experienced such a situation in 25 years. The situation is really serious".

While this ERT's message was forwarded to persons who had the prerogative to provide such resources, the needs mentioned by the ERT in this email were not satisfied. The forward button was extensively utilized. By doing so, the recipients of this message protected themselves by showing off their reactivity and transparency as professionals. In addition, they transmitted information as it was rather than reformulating initial content into new requests. Unsurprisingly, they showed limited commitment to responding to the requests. As a result, both direct and indirect recipients of this message did not interpret the situation to be as critical as it in fact was. Their attention did not result in the initiative to respond to the ERTs' demands.

"Thank you for the information you transmitted earlier about heat strokes in the Alpha and Beta³ hospitals. I relayed it internally. The INVS has just settled an emergency data collection process. You will find attached the necessary forms. All these documents have been sent

to hospitals. The person to contact is....".

Responding again, the ERT's response unveiled statistical issues related to data collection and further expressed the need for help:

"Thanks for your message. We have sent messages everywhere. The problem with data is that they will not reflect indirect effects of hyperthermia (...). The situation is desperate here. The government [...] should trigger the White Plan or an emergency plan very quickly. As I made my promise to your colleague, could you please transfer information?"

Unsurprisingly, the administrative interlocutor effectively transmitted the email but no discussion was developed on data collection. It is interesting to note the email response to the ERT who had alerted administrative actors focused on a long-term investigation project rather than immediate action:

"Thank you for the information. Beyond the current investigation we intend to lead a long-term investigation on the total mortality that will take into account some specific pathologies such as cardiac, vascular, and respiratory diseases. Our project has to be validated but we hope that an international comparison will be feasible".

Consequently, these difficulties burdened the development of a shared understanding of the situation and crisis responders primarily relied on informal communication through phone and face-to-face meetings to

respond to these needs. As an ERT described, medical students went into restaurants and bars that were located nearby the hospitals to ask for ice:

"I asked for bottles of water. My superior did not understand why I was urging her so much to get it. Yes, we had some water. But it was too hot to drink. So students who had come back from their vacation asked in bars for some ice. One of the girls behind the bar told me: "It is the only thing I can do"."

IV.2.2. Filling with content: the case of intangible resources

In the summer of 2003, no system was capable of tracking patients to detect any work overload in hospitals. Consequently, the response network could barely manage to evaluate the number of fatalities and the extent to which the White Plan should be enacted. Organizations were missing not only informational but also cognitive resources to determine whether the situation was critical. As explained during the public hearings, the BSPP defined an *ad hoc* code to deal with the absence of informational codes report fatalities caused by the heat.

"We had to invent a new code, this code was called "syndromes due to heat". We had not thought about this code previously".

Organizational emptiness also stemmed from the crisis responders' difficulties to interpret data. The administrative personnel hardly managed drawing an overall evaluation of fatalities from the disparate and unstructured signals they received by phone,

fax and email, as suggested by an administrative director:

"I completed this unique, simple task: sending a fax and an email to inform the ER that they had to contact the INVS if required. (...) Here is the situation at that moment: I would like to get more quantitative data to identify any increase in ERs' activity. I would like to get qualitative data as well, to evaluate the gravity of the situation of patients. My main problem is the heterogeneity of information systems. If everyone sends one's own detailed and specific message, then managing information becomes almost impossible. I delegate the daily reading of information bulletins to a collaborator. However, this bulletin comprises a lot of very detailed but useless information. It is therefore necessary to question the way we can transform information into a fact that can be analyzed from a scientific perspective. It is therefore necessary to design information systems that make sense".

The absence of an information system devoted to the identification of deaths was frequently mentioned in electronic communication. To address this issue, the crisis responders relied on email to address organizational emptiness collectively:

"The heat has been causing a growing number of problems. We have received disparate but alarming pieces of information from the DDASS (...). Could you possibly think about a process to monitor fatalities or a system to collect and analyze data? Thank you (...)".

Email asynchronicity and multi-addressability supported collective reasoning, thereby helping the administrative personnel discuss strategies to collect data. However, the recipients remained focused on long-term solutions for reporting and monitoring of fatalities and barely mentioned immediate actions that needed to be undertaken, which prevented the deployment of intangible resources in time.

IV.2.3. The avoided truth: the case of norms, skills and informal connections

On the morning of 8 August, the response network became overwhelmed with patients. Multiple crisis responders were confused about what needed to be done and how to address the situation. At that moment, the crisis responders experienced organizational emptiness with respect to norms, skills and informal connections. The firefighters addressed the absence of a predefined norm regarding information transmission about death rates by informally seeking advice from physicians. With respect to skills, the physicians lacked expertise in hyperthermia. Being convinced that the patients' symptoms were due to some infectious disease, they used antibiotics, which proved to be ineffective, as patients would die in their hands. The crisis responders did not have informal connections pre-established between each other, as an operational actor explained during the public hearings:

"I would have been able to transmit data and alerts. But to who? I have

no supervisor to contact in case of problems".

Addressing organizational emptiness with respect to norms, skills and informal connections primarily excluded electronic communication for three main reasons. First, the email users restricted their exchanges to the topics targeted by the recipients and the message title whereas addressing emptiness required extended discussion about alternative topics. As a result, the crisis responders could develop skills only since some physicians spent an entire Friday night on the Internet searching for information about hyperthermia and its effects:

"[A physician] collected data on hyperthermia on the Internet. He already knew that heat can kill but did not understand how. On Friday, he used free access to research documents and read over everything. Then he discovered the same thing had happened in Chicago in 1995" (Jacquat, 2003).

Secondly, discussion on norms and skills was correlated with conflicts and controversies that were conducted primarily orally. The crisis responders perceived email as a traceable media and remained careful about any content shared via electronic communication. Email users were reluctant to share bad news and debates, which promoted politically correct information at the expense of exchanges on norms, skills and informal ties between individuals. On 11 August, when more than 5000 persons had already died, email mes-

sages still conveyed the impression that the situation was normal:

“For the first time since the beginning of the heat wave calls, the DDASS called the DGS on the last Friday, to inform them of deaths due to the heat among hospitalized patients. We attempted to draw an overall evaluation of the situation with the SAMU and the BSPP... which confirmed that the last 48 hours had been critical but that the situation was under control”.

Collective discussion and reflection remained weak through email. As one of the interviewing members of parliament suggested during the public hearings:

“Another source confirmed that nothing happened on the 9th and the 10th. No alert, nothing. I think that curiosity is necessary among the administrative personnel”.

Finally, email users faced difficulties developing sustainable connections with other crisis responders. The diversity of organizations and functions within the network partly accounts for this issue. Operational actors were struck by the heat, the feeling of being powerless against death and the lack of water. In the administrative sphere, the feeling of crisis was less strong. While email use helped by sharing a common sense, the administrative personnel generally did not figure out that the situation was critical. As one of the crisis responders explained:

“Before I arrived on the 11th of August I had received no phone call during my break. I had 300 emails

to read and no one clearly mentioned the heat wave”.

To the contrary, the operational personnel had the feeling of not being “heard” and “seen” through fax and phone interactions, which countered the experience of organizational emptiness.

IV.2.4. Building from scratch: the case of instructions, processes and outputs

The response network had not faced high temperatures since 1976, which made it necessary to define new instructions, processes and objectives to face the situation. For example, *ad hoc* instructions regarding the management of mortuary chambers were transmitted from institutional actors. Other instructions recommended the postponement of scheduled medical interventions to focus efforts on hydrating patients who were suffering from hyperthermia. As an administrative director explained:

“There were sudden shortages of resources in many facilities. [...] We gave directions so that hospitals would help assisted living facilities manage shortages. The situation was unusual. We instructed drug-stores to get more medicines to organizations that were in critical situations”.

Some directions transited via email communication. Being familiar with daily use of email, administrative actors responded quickly to new directions. For example, on 6 August 2003, one of the Health Minister advisers explained to his counterparts his concern

about the effect of the heat on citizens' health. He suggested to administrative managers – his subordinates - the need to produce a formal recommendation memo about hyperthermia in direction to health care organizations and professionals:

"It would be useful to send a memo to recall basic precautions to care for the youngest and oldest patients. There are plenty of studies about the health related impacts of heat waves (...). I think the CDC [Center for Disease Control in Atlanta] reviewed them. They could result into an emergency message".

Administrative actors responded the same day to this request, demonstrating their immediate understanding of their superior's needs and their intellectual involvement to provide immediate feedback:

"I called [colleagues] to discuss what could be done [to investigate the health related impacts of the heat wave]. First of all, we should take into account whether it is feasible or not. We therefore should collaborate with organizations that already have an information system and data from previous years. Here is our idea: we can try to bring information up to the INVS rather than settling for a specific data collection system".

However, the sender's strategy to keep a courteous tone prevented his interlocutors from perceiving the need to act immediately. In addition, a significant amount of energy was devoted to process narration. Within the same process, electronic communication was extensively used to trace emerging processes and outputs. Between 4 Au-

gust and 6 August, more than 60 emails were sent to update the status of the production of an alert message. Taking advantage of multi-addressability, interlocutors suggested to multiple users their being professional and showed off their transparency:

"As we agreed, here is an update, which informs about 4 or 5 new pathological cases in our department. I discussed with Dr. C who is in copy in this email to which I joined a press release".

In this specific case, the investigation was not perceived as immediately necessary and remained incomplete by the end of the heat wave.

In the midst of the confusion, crisis responders relied on email to send alerts about organizational emptiness, find new resources and develop new means. However, they struggled to remedy organizational emptiness through electronic communication.

V. DISCUSSION

During a disaster, coordination within and between responding organizations is challenged by uncertainty, risk and high-velocity. The present paper addresses the role of email in supporting coordination in such settings. In this section, we first provide answers to our research question. We then propose an explanation, thereby emphasizing the role played by tensions in electronic communication in coordination issues.

V.1. Handling coordination in extreme situations: what support from email?

Our findings identify email as a crucial tool for coordination in crisis response (Danowski & Edison-Swift, 1985; Farnham et al., 2006; Vielhaber & Waltman, 2008). During the 2003 French heat wave, the crisis responders heavily relied on email to cope with uncertainty, risk and high-velocity, which are all inherent features of extreme situations, with varying degrees of success. In this section, we detail this specific point and compare our findings and those of similar situations faced by organizations responding to other disasters.

First of all, the 2003 French heat wave crisis responders spontaneously turned to electronic communication to handle the uncertainty they were facing. However, they hardly established new patterns of communication that were necessary to address this uncertainty. The Melançon report highlighted similar difficulties during the Katrina disaster, where email users did not engage any action regarding crucial issues despite the desperate need for quick decision making (2005). The management of the SARS epidemic in 2003 offers a contrasting view on email use and uncertainty. In less than 13 days, Singapore officials managed to develop and constantly improve an *ad hoc* emergency system mainly through electronic communication. By doing so, they adapted to an unexpected situation in a timely manner through electronic communication.

Secondly, email users' enactment of traceability resulted into contradictory

responses to risk. When improvisation was necessary, email users' apprehended potential criticism of their own actions. In this specific case, their risk aversion with respect to communication was strong. To the contrary, email users showed a tendency to show off their reactivity and transparency when they perceived that the action they had engaged was likely to be applauded by their hierarchy. To the best of our knowledge, recent research has not provided empirical evidence of a similar situation faced in another disaster.

Thirdly, the email users did not adequately address high-velocity during the heat wave episode. They experienced difficulties in making sense of the ever-growing volume of unstructured and heterogeneous set of data provided by emails. The 2007 San Diego Fires offers a contrasting view on high-velocity. In this case, diverse actors extensively used email to exchange, aggregate and update distinct formats of data. As a result, the crisis responders produced an *ad hoc* system that represented a map of fire perimeters (Majchrzak & More, 2011).

Table 2 details the extent to which email use helped responders to coordinate and address issues caused by uncertainty, risk and instability.

V.2. Difficulties to address organizational emptiness through electronic communication

The second part of the discussion provides an explanation to the comparative analysis developed here in. Despite the 2003 French heat wave crisis responders' difficulties, electronic

Extreme situation characteristics	Coordination issues	Email support to coordination	Illustration from our Findings	Comparison with other disasters
Uncertainty	Need to break with established patterns of action Results of action unknown	Improvisation was completed but delayed	<i>Building from scratch: Ad hoc</i> production of an alert memo	SARS (Leidner et al., 2009)
		Improvisers abandoned email	<i>Raising an alarm:</i> Tangible resources were found with face-to-face and phone interactions	
Risk	Need for risk taking Risk aversion Need for transparency	Users enhanced their reactivity and transparency	<i>Raising an alarm:</i> Email users quickly responded and forwarded	
		Crisis responders avoided leaving traces of deviating action	<i>An avoided truth:</i> Improvisation was hardly mentioned in emails	
High-velocity	Information changes and unexpected events can change the course of action	Unstructured information was abundant from diverse sources	<i>Filling with content:</i> Users hardly made sense of the situation from the provided information	Mutual adjustments between diverse actors with distinct sources of information in the San Diego fires in 2007 (Majchrzak & More, 2011)

Table 2. Email characteristics and findings

communication is an essential tool to deal with coordination issues caused by extreme situations. In line with this point, our work emphasizes that crisis responders relied on email to handle organizational emptiness, e.g. the lack of operation of resources and means despite their being necessary for the

completion of a process. Such evidence echoes Markus's assessment of email as a primary media for coordination even when context or tasks are less analyzable (1994). However, despite the crisis responders' efforts, email use hardly filled organizational emptiness.

Through a thorough analysis of electronic and in-person communication practices, our work reveals that email was used both in a damaging as well as helpful way in the 2003 French heat wave crisis response. Are these coordination issues strictly a matter of media choice? By applying the Media Richness Theory, one could assume this failure was predictable. From this perspective, privileging email, as a “lean media”, for crisis coordination boils down to an inappropriate media choice. Our work objects to this simplistic approach to electronic communication in crisis response. Not only our literature review highlights the functional specificities of email that support crisis coordination but our findings also identify email as an enabler of reactivity, transparency and transversality between geographically and temporally distant users. In sum, we second Markus’s idea that email richness does not solely account for its use. We additionally argue that electronic communication is characterized by tensions. A tension has been documented as a situation characterized by opposing dynamics (Dougherty, 1996). Tensions can result in ambivalent attitudes and contradictory behaviors (Smith & Tushman, 2005).

The 2003 French heat wave enacted email characteristics in an ambivalent manner. Stakeholders reacted to the crisis they were presented with and took advantage of email characteristics to support information transmission and coordination. Nonetheless, email users also utilized this media as a means to protect themselves from accountability within their organization’s political arena. Power dynamics that

were established before the crisis did not fade away, no matter how extreme the situation became. Furthermore, these dynamics contributed to the crisis responders’ tendency to perform behaviors and actions that burdened coordination. This interplay between critical settings and the persistence of organizational characteristics resulted into the expression of four main contradictions that defined electronic communication in crisis response, thereby leaving coordination issues unsolved. In the following paragraphs, we detail and discuss these contradictions.

Immediate reaction with delayed action

The crisis responders benefited from email asynchronicity and multi-addressability to conduct collective *ad hoc* discussion on the lack of operation of material resources and instructions. In these specific cases, electronic communication promoted fast response but did not result into immediate action, thereby leaving organizational emptiness acknowledged but unaddressed. This contradiction finds an illustration in the finding section’s episode entitled ‘*Raising an alarm*’, where the lack of beds remained unaddressed despite its vivid description by the ERT and the administrative interlocutors’ reactivity. In our view, the lack of emotional involvement from the administrative personnel echoes previous research on the brain-finger disconnect syndrome (Weber, 2004) and excessive attention towards email treatments (Sumecki et al., 2011). From this perspective, the administrative recipients achieved the tasks they were

in charge of by *processing* the received emails but did not focus on the burning issues that were signaled and required immediate action. Paradoxically, actions such as sending or replying to email were immediately achieved at the expense of the actions requested by electronic message senders.

Centrality in information processing but absence in collective action

Because of multi-addressability and traceability, electronic communication conducted some interlocutors to interact with numerous colleagues and counterparts. By doing so, these email users developed what was previously reported as *centrality* in information processing, which stems from email users' ability to connect users, scan information sources, disseminate and transmit information to influential users (Cucchi & Fuhrer, 2007). Our findings, in particular the episodes entitled '*Filling with content*' and '*Building from scratch*' depict some actors from the response network developing these abilities and becoming centralized contributors to electronic communication. However, these actors remained focused on their electronic interactions. As a result, they remained marginalized from collective improvisation, extemporaneously coordinating within the response network to address organizational emptiness. As illustrated in the episode entitled '*Raising an alarm*', some operational personnel emphasized through email their need for beds and other resources but eventually favored informal interactions when they improvised collectively. These elec-

tronic interactions aggravated the exclusion of the email users from collective action. We observe a strong involvement from the email users in electronic communication at the expense of action.

Email as an opportunity to support coordination and a professional threat

Depending on the dimensions of organizational emptiness, crisis responders developed divergent intentions of use. With respect to resources, crisis responders used email to alert others about organizational emptiness. They also used email to collectively produce *ad hoc* means for coordination, outputs such as bulletin boards or instructions and *ad hoc* processes such as the collaborative production of a press release. To the contrary, email was avoided when discussing norms, diffusing skills and settling on informal connections. In our view, email users were reluctant to write on the tacit dimensions of these means that are primarily communicated orally. As a result, the 2003 French heat wave crisis responders utilized some specific features of email as both an opportunity and a threat. For example, the forward function of email supported a quick diffusion of information when some operational personnel tried to raise an alarm. However, this function inhibited discussion on deviation from established procedures in the episode entitled '*An avoided truth*'. As another example, traceability significantly helped to narrate processes and develop new outputs in the episode entitled '*Building from scratch*'. However, this fea-

ture was also perceived as a potential threat against the expression of alternate solutions. This duality refers to active and passive traceability strategies analyzed by De Vaujany (De Vaujany, 2001) and previous work on email as a factor of control and empowerment (Boukef Charki, 2008). This finding also echoes previous work on the linkage between adaptive use and perception of technology as an opportunity and a threat (Beaudry, Pinsonnault, 2005). Alternate theoretical grounds, such as the Critical Social Theory (Ngwenyama & Lee, 1997) would enrich our understanding of such tensions. For instance, in the episode entitled *'An avoided truth'*, instrumental and strategic action went into opposing. By using email, the 2003 French heat wave crisis responders relied on available technologies to accelerate speed of communication, thereby optimizing crisis response. However, this instrumental action contrasted with the actors' strategic action, e.g. avoiding some topics in emails, that stemmed from their awareness of the "rules of the game" regarding electronic communication.

Efforts towards agility and persistent communication patterns

Email users strove to use email to collectively address an unexpected situation but hardly managed to adapt their communication patterns. As illustrated by the episode entitled *'Building from Scratch'*, the email users kept in mind power dynamics and strictly abode by established rules of politeness. By focusing on

these rules, they lightened the strictness of their tone, which prevented the recipients from perceiving the situation as an emergency that required immediate action. The episode entitled *'Filling with content'* provides another illustration of disconnect between efforts for agility but persistent communication patterns. The administrative personnel addressed the lack of information through intensive data collection and figures by email. However, the data collectors failed at making sense of the amount of information collected in a timely manner. As a result, official statistics regarding fatalities did not rise until the funeral homes released their own figures. The crisis responders' inability to adapt their practices for a richer communication prevented them from addressing organizational emptiness. The Channel Expansion Theory (Carlson & Zmud, 1999), which relates communication richness to users' experience, provides some explanation to this tension. Despite email's rehearsability (Dennis et al., 2008), the 2003 French heat wave crisis responders lacked familiarity with the context of organizational crisis, alert related messages and topics. In addition, they had limited experience with communicating with unknown counterparts. According to Carlson and Zmud, these three experiential threads have a significant impact on communication richness. Thus further investigation could focus on the existence of a learning curve between email users' experience of extreme situations and their ability to coordinate to address organizational emptiness.

VI. CONTRIBUTION

VI.1. Managerial recommendations

Our study emphasizes the importance of tensions related to electronic communication in extreme situations. These tensions appear as highly influential factors affecting the persistence and aggravation of organizational emptiness during crisis response. On this premise, we infer two managerial recommendations to manage these dualities that can undermine an organization's ability to cope with disasters.

First, we question organizations' tendency to focus on investments in IT tools that are specifically designed to optimize access to information. Despite communication failures, the 2003 French heat wave crisis responders spontaneously turned to email to address organizational emptiness. From this perspective, our findings advocate email as a potentially reliable and profitable tool to support coordination in crisis response.

Second, as a practical guideline, we propose that organizations promote "good practices" related to the use of email (Bia Figueiredo & Kalika, 2008). Such an initiative could optimize their efforts to successfully address organizational emptiness during responses to disasters. We suggest that an organization can meet this goal by drawing users' attention to the problematic behaviors that we examined during the 2003 French heat wave such as signaling behaviors, brain-finger disconnections (Weber, 2004) and other misuses (Sumecki et al., 2011). In ad-

dition, organizations could gain inspiration from the High Reliability Organizations (HRO) practices (Weick & Sutcliffe, 2001) to improve their use of email. Using codes to specify the type of action related to the message or forwarding emails to experts rather than hierarchical superiors are examples of recommendations that could be made to users. Finally, we suggest that organizations promote the development of adaptive strategical capabilities (Kock, 1998; Kock, 2001) to help crisis responders break patterns of communication that exhibit persistent issues. We believe that crisis simulation exercises could be excellent opportunities to apply these guidelines.

VI.2. Theoretical contribution

Our discussion provides an interpretation of the influence of email use on coordination issues in extreme situations. Our approach to electronic communication contrasts with prominent studies on this media (Dennis & Kinney, 1998). We not only consider email use in an extreme situation. In addition, we rely on a grounded theory approach, which has been scarcely used so far in research on electronic communication. Thanks to its originality, this work enriches the literature in three primary ways.

First of all, our work extends the variety of cases examined within literature about extreme situations. The literature on extreme situations has mainly focused on intra-organizational coordination (Bouty, 2011) in organizations that develop specific skills for organizational resilience (Weick & Sut-

cliffe, 2001), such as military combat or polar expeditions (Lièvre & Rix-Lièvre, 2011; Nizet & Pichault, 2011). In contrast with this stream of research, we explore coordination between organizations with weak relational ties and diverse degrees of familiarity with regards to time constraints and emotional pressure. Even though the 2003 French heat wave represents a worst-scenario case as a combination of disaster and organizational crisis settings, our paper provides an alternate perspective on extreme situations that highlights its inherent tensions. In particular, electronic communication practices renew when a crisis strikes but are also shaped by deeply rooted organizational dynamics. By proposing an alternate approach to extreme situations, our work highlights the difficulties for common organizations to survive this kind of events.

Secondly, our work enriches current knowledge on the role of IT on coordination during crisis response by offering a holistic framework that includes the concept of organizational emptiness. Prominent studies on IT support to crisis response have focused on technological requirements and features (Van de Walle & Turoff, 2007) or on organizational dynamics (Milburn et al., 1983; Pauchant & Douville, 1993). Our work bridges two strands of research that have had little rapprochement. By doing so, our investigation goes further than merely putting into perspective the pros and the cons regarding email use in crisis response. Rather, we provide a comprehensive framework that involves technological features, crisis settings

and organizational dynamics. Specifically, the concept of organizational emptiness, that emerged from field data, enables an alternate understanding of coordination issues during disasters. Indeed the concept was particularly helpful to put into perspective individuals' efforts for coordination and their communication practices. This stance promoted a rather counter-intuitive report of email in this paper. Frequently tagged as a trivial topic for research, this paper highlights the complexity of electronic communication practices. Our approach to email thus recalls the relevance of a practice view on technology use rather than the pursuit of technological features optimization.

Thirdly, by examining technology enactment in crisis settings, this work bridges two topics that, despite significant efforts from some authors (Mendonça et al., 2007; Mendonça & Wallace, 2007; Roux-Dufort & Vidaillet, 2003), have been rarely conceptually related so far: IT use and organizational dynamics in extreme situations. Not only does our work echo previous work that highlighted paradoxical patterns in technology use. Furthermore, it reveals that the enactment of certain technological characteristics (Orlikowski, 2000; Weick, 2011) can cause tensions in electronic communication that have the potential to endanger organizational survival in extreme situations. For the first time, we add technology use into the panel of variables traditionally considered by scholars as crucial factors of an organization's survival in crises, such as organizational resilience (Rerup, 2001) or improvisational capabilities

(Mendonça et al., 2010). We suggest that technology enactment can impede organizational coordination in extreme situations. By doing so, we complement previous research that has rather focused on sources of resilience in extreme situations (Lièvre & Gautier, 2009).

CONCLUSION

Recent research has stressed that IT, in particular email, is massively used in critical settings (Leidner et al., 2009; Pan et al., 2012). While we have known for a long time that email is an essential tool for coordination (Markus, 1994), crisis management research has focused its attention on new generational tools, at the expense of a thorough analysis of electronic communication in critical contexts. As a result, the question of the overall support from email to coordination during critical situations has remained unanswered, despite coordination being a topic of continued importance for organizations involved in disasters (Quarantelli, 1988).

This study draws on grounded theory principles to conduct an exploratory investigation of email use during the 2003 French heat wave crisis response. Specifically, we examine the influence of email use on organizational emptiness during the 2003 French heat wave. By doing so, we bring into focus the importance of tensions related to electronic communication on the handling of organizational emptiness in crisis response. These tensions culminate into i) an ambivalent enactment of email characteristics

and ii) contradictions in electronic communication and crisis response. In other words, while the crisis responders spontaneously turned to email to resolve organizational emptiness, their contradictions made email use counterproductive.

Our work, however, does not denounce email as an irrelevant technology for disaster management and crisis response. To the contrary, our findings provide a nuanced view on the tool, with undeniable sources of support to crisis coordination. We emphasize the importance of electronic communication practices into the equation of email use in disasters. In addition, we propose some practical guidelines to promote a better use of email in crisis response.

Despite all our efforts, this research calls for further investigation and challenging viewpoints on our results. In particular, we propose three avenues for research that we view as a necessary extension of this study.

First of all, additional investigation is needed to determine the importance of the role of organizational emptiness in extreme situations. Our work focuses on a specific case of extreme situations that involves administrative and operational personnel. Heterogeneity of organizations and actors is commonplace in disaster settings. In addition, crisis response often involves numerous organizations and stakeholders with weak, if not inexistent, relational ties. One could thus safely assume that organizational emptiness is inherent to large scale disasters that involve numerous actors. We believe this view can conduct managers to misleading

conclusions. For this reason, future research is necessary to test and enrich the concept of organizational emptiness with empirical data from various cases of extreme situations.

Secondly, confronting our findings to an actor-network analysis would help refine our understanding of email use in crisis settings. Networks, whether they are informational (Pan et al., 2012), organizational (Kapucu et al., 2010), or social (Lang & Benbunan-Fich, 2010), have been increasingly attracting scholarly attention in the crisis management field. The actor-network sociology (Latour, 2005) provides an integrative analysis of heterogeneous sets of actors – labeled as association of actants - who experience disruptions. Disasters, as defined in our literature review, correspond to this type of reality. Not only do crisis responders have to coordinate with unfamiliar groups of individuals but they also physically, emotionally and organizationally experience disruptive contexts. This work suggests that non-politically correct topics can be avoided in electronic communication. Thus, adopting the actor-network posture on controversies (Hussenot & Missonier, 2010) appears as a promising way to provide alternate insights on crisis response. More specifically, we believe that this perspective can extend and nuance our description of how electronic communication tensions influence organizational emptiness. However, the actor-network approach represents a methodological challenge that is difficult, if not impossible to pair with data from the field of the 2003 French heat wave. Even though retrospective data was abundant, we could not exhaus-

tively trace and describe interactions between actants within the response network. Future empirical research could be designed to systematically trace interactions during a disaster.

Thirdly, the comparison of our findings to 2012 empirical cases of disasters corresponds to another possible extension of the present research. By focusing on email rather than a specifically designed technology, we somewhat optimize chances to generalize our findings across disaster cases. Email, is by far the most probably used technology in disasters and its basic functionalities have essentially remained unchanged since 2003. Documented as the most prominently used technology in organizations (Barley et al., 2011), email remains one of the most accessible technologies for organizations that face disasters. Despite reports of email as a core support to crisis response through the years (Lalande et al., 2003; Majchrzak & More, 2011; Melancon, 2005; Nelson et al., 2011), recent evolutions in email use and design suggest the need to confront our findings with ongoing changes with respect to email use. First of all, email users' learn from their practices over decades of use (Van Den Hooff, 2005), which implies that nowadays crisis responders may have developed knowledge on how to handle the tensions resulting from electronic communication that we identify in this work. A longitudinal design would help to determine whether crisis responders actually learn to effectively use electronic communication to address organizational emptiness occurring during crises. Secondly, one could argue that nowadays email ap-

plications encompass a broader variety of formats than they used to. Traditional email interfaces have been substituted by electronic communication applications embedded in social media interfaces such as Facebook and Twitter. In addition, smartphones have been increasingly used in disasters (Palmer et al., 2012), making electronic communication more interactive. As a result, the type of data transmitted through electronic communication is broader and can include tweets, videos, pictures and maps. The ergonomics of email, e.g. smaller screens and embedded interfaces can also have an impact on how email users deal with organizational emptiness. Future investigation could explore the influence of these ongoing evolutions on tensions inherent to electronic communication.

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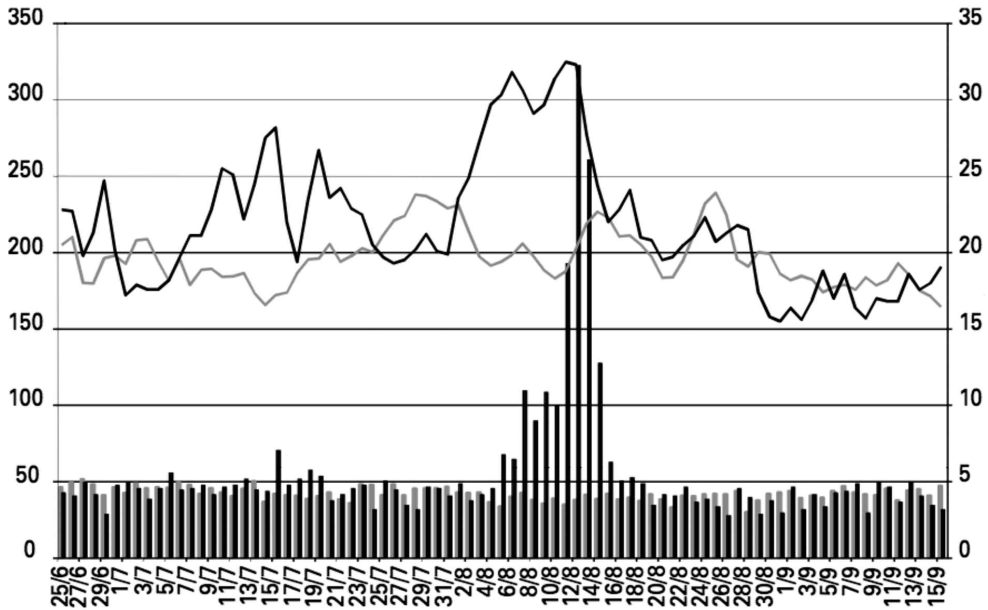
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APPENDICES

Appendix A. Temperature and death numbers in Paris between the 25th of June to the 15th of September



Appendix B. Organizations involved in the response network

Appendix B.1. Sanitary organizations in the Parisian health network

1. National organizations

The Health Ministry also called Le ministère de la Santé: The Health Ministry activities are related to health services, health insurance and social welfare in France. However, this ministry delegates many of its responsibilities to national organizations such as the DGS (more detail in the following paragraphs). The Health Minister collaborates with his or her cabinet advisers who play a significant role in decision making in the ministry.

The National Health Watch Institute or Institut National de Veille Sanitaire (INVS): The

INVS's role is to warn and alert when some phenomenon is likely to affect French people's health. The INVS' mission is to watch potential sources of epidemic and injuries at national and international levels. When the INVS identifies a potential health threat, it then provides its recommendations to the DGS that implements them. The INVS was created in 1998 but in 2003 most field actors, such as physicians, did not know of its existence and name.

National Health Agency or Direction Générale de la Santé: The National Agency for Health is in charge of developing and implementing programs for health at the national scale. Coordinating with the INVS to implement the monitoring/alerting system is part of its responsibilities as well.

Hospitalization and Health Care Organizations Agency or Direction de l'hospitalisation et de l'organisation des soins (DHOS): This agency's task is to organize health care activities in France, relying on coordination with the DDASS and DGS. In particular, this organization is devoted to the allocation of financial resources. Recently, its mission has expanded to the management of the coordination between the diverse actors involved in health issues.

2. Regional organizations

Local Agency for Social and Health or Départementale de l'aide sociale et sanitaire (DDASS): The DDASS is in charge of social and health matters in French regions and counties. The DDASS delegates to sub agencies that are located in Paris (DASS 75) and the Ile-de-France counties (for instance DDASS93, DDASS94).

Ile de France Hospitalization Agency or Agence Régionale Hospitalière d'Ile de France (ARHIF): The ARHIF manages and coordinates hospitals, in particular when national programs and projects are implemented. For instance, there has been a specific program to promote hand washing by professionals. This project provided washing solutions, communication displays, etc.

Parisian Agency for Hospitals Management or Assistance Publique des Hopitaux de Paris (APHP): The APHP is in charge of managing 39 hospitals in the Parisian region, which includes all hospitals in Paris intra muros and some hospitals in the neighborhoods of Paris. The APHP regulates funding, resource allocation, patient flows and alerting. The APHP hospitals have a strong identity, calling the head of the APHP the "core". As a result, conflicts between the APHP and the DDASS commonly occur because of these two organizations have equal responsibilities in some hospitals.

3. Local organizations

Hospital personnel: Each hospital is in charge of the quality and the coordination of its health care activities. Hospital personnel include managers, administrative personnel and medical personnel. While the managers are responsible for the back office management such as human resources, information systems, quality and performance measurement, another set of administrative personnel handle coordination between services and surrounding hospitals and assisted living facilities. From a medical standpoint, each hospital gathers diverse specialists from psychiatric to emergency practitioners. Professional values are strong among medical staff such as physicians, Emergency Room Technicians (ERTs) and nurses. Public and private hospitals hardly coordinated with each other during the heat wave (Evin, 2004). However, hospitals personnel were retrospectively appraised by national organizations for their courage. Most of the hospitals personnel faced their overwhelming workload and relentlessly worked at treating patients despite their suffering from the heat and exhaustion (Evin, 2004; Lalande et al., 2003).

Emergency Room (ER) personnel: This is a special group within medical staff. While people who suffer from long-term diseases get planned treatments, patients who spontaneously suffer from injuries are treated in emergency services. Emergency rooms were overwhelmed during the heat wave. Officials did not recognize Emergency Rooms Technicians (ERT) as medical specialists in 2003. For this reason they were extensively represented by trade unions such as the AMUF.

Private physicians: Private medical activity is now very segmented and highly specialized (Poutout, 2005). Some private physicians practice in double locations: they see patients in a private medical practice as well as in hospitals and clinics. Co-

ordination between physicians and other health care organizations is controversial. Some private physicians were criticized for not being available during crisis response (Lalande et al., 2003). As a result, hospitals were missing staff but could not contact physicians. During public hearings, the specialization of physicians was claimed to be a social issue. For older people who have multiple sources of suffering, it is complicated to find a physician who is experienced and knowledgeable about their specific needs.

Assisted living facilities also called Établissement d'hébergement pour Personnes Âgées Dépendantes (EHPAD): Establishments that offer apartments and health support for the elderly. During the heat wave, administrative actors struggled to grant sufficient access to hydrating resources to both EHPADs and hospitals. However, EHPAD are eligible for access to resources in surrounding hospitals in case of important shortages: when the EHPAD staff is overloaded with patients, their counterparts in hospitals are called upon to take care of them, therefore alleviating the workload of the EHPAD staff. During the heat wave, mortuary chambers in many EHPADs were overloaded. In most cases, even the surrounding hospitals could not manage all the corpses, which provoked more confusion within EHPAD.

Physician network for emergency service, called SOS Médecins: This non-profit organization involves physicians who offer mobile medical intervention for emergencies at home. As other emergency services, they experienced an overwhelming increase in requests between the 4th of August and the 14th of August. Public hearings revealed that they had interacted with journalists since the beginning of the crisis.

Emergency ambulance service, called Service d'Assistance Médicale d'Urgence (SAMU) and Emergency and Ressuscitation Mobile Service, called Service mobile

d'Urgence et de Réanimation (SMUR): SAMU and SMUR's memberships are composed of emergency medical practitioners who provide mobile and immediate help to people who are injured. It provides phone assistance as well, with the objective of providing medical advice for emergency situations. Emergency ambulance services coordinate with hospitals when they cannot treat their patients with mobile devices. They also coordinate with firefighter squads but provide a different service in that the SAMU first tries to advise by phone before intervening. Moreover physicians are less numerous among firefighters than within SAMU. The emergency ambulance services extensively coordinate with firefighter squads (BSPP). During the crisis, firefighter squads and the SAMU developed *ad hoc* information systems together.

Appendix B.2. Civil protection & internal affairs organizations

The objectives of the civil protection organizations are twofold. First of all, they have to maintain public order and protect the civilian population from terrorism and large-scale accidents. Secondly, they have to provide support to civil protection in critical situations. The civil protection organizations' mission is oriented towards security. For this reason, these organizations abide by strict rules of operation. For instance, the BSPP refused to transmit data about deaths to the INVS without an official authorization from the Paris Police Prefecture on the 11th of August.

1. National organizations

Internal Affairs Ministry, called Ministère de l'Intérieur: This ministry is at the head of the civil protection organizations. Its involvement in the crisis response efforts was initiated on the 12th of August. On the 13th, this ministry intervened by provid-

ing military beds for the purpose of stocking corpses.

The Inter-Ministry Coordination Agency, also called Le centre opérationnel de gestion interministériel des crises (COGIC): The COGIC organized inter-ministry meetings between the Internal Affairs Ministry, the Health Ministry and the Social Affairs Ministry on the 12th of August to collectively find solutions to specific issues such as corpses storage and electrical blackouts.

2. Local organizations

Paris police authorities also known as Préfecture de Police de Paris (PPP): This organization is responsible for the protection of citizens. PPP is additionally in charge of police services and the administrative processes related to identification documents.

Paris Police Prefecture local agencies: PPP local agencies exist in every administrative region, or arrondissement, in the Ile de France region. PPP services directly intervene when called. This organization is an equivalent to 911 services in the United States. During the heat wave, the PPP local agencies collaborated with BSPP and SAMU/SMUR to assist people who fainted, in particular homeless people.

Paris Firefighters Squads also called Brigade des Sapeurs Pompiers de Paris (BSPP): One of their missions is to alleviate citizens' immediate suffering and to provide assistance in emergency situations. Their area of expertise is not restricted solely to damage from fires due to the fact that firefighter squads include medical personnel. The BSPP is officially a military organization, a characteristic that distinguishes it from squads of firefighters from other regions. Its hierarchy and values are similar to those of the army. On the field, the BSPP extensively coordinates with the SAMU/SMUR teams in managing patient transfers into hospitals.

Paris Town Hall: The Paris Town Hall provided material support to health care organizations. In addition, they transmitted alerting information to the public in relation to hyperthermia. Finally, they collected data about victims when these data could not be obtained from private physicians.

Appendix B.3. "Outsider" organizations

These organizations do not extensively coordinate with the other organizations from the network in routine situations. However, they developed *ad hoc* connections with other organizations during the heat wave.

1. National organizations

Weather forecast agency called in French Météo France: Météo France is in charge of providing national weather forecasts. Prior to the crisis there was already coordination between Météo France and the InVS. Météo France was in charge of providing updated information on the weather on a regular basis.

The Social Affairs Ministry also called Ministère des Affaires Sociales et de l'Emploi: This ministry is in charge of social issues such as social exclusion and unemployment. In 2002 as well as on the 26th of May 2003, the Ministry anticipated that the elderly could suffer from the heat during the summer and sent a fax to local governmental agencies to recommend extra attention on this specific point. During the heat wave, this ministry was involved in the response by participating in inter-ministry meetings beginning the 11th of August. However, the Social Affairs Ministry members remained isolated and stated that they received scarce information from health care organizations.

Funeral homes also called Pompes Funèbres: Funeral home companies usually do not coordinate with hospitals but with town halls and prefectures. However during the heat wave, the lack of coffins to stock corpses was problematic. For this reason, hospitals developed extensive coordination with funeral companies. Furthermore, funeral homes participated in some inter-organizational meetings. The leading company on the market was the only organization that was able to provide statistics related to mortality at a quick rate. Given data about coffin orders and the fact that they corner approximately 25% of the market, it was easy for them to determine an estimated number of fatalities. Thus they transmitted their data about death rates to ministries since the 12th of August.

Journalists: Television journalists from local and national channels as well as local and national newspapers journalists, such as Le Parisien had frequent interactions with crisis responders. From the beginning of the crisis, firefighter squads were followed by journalists. News programs broadcasted interviews with surgeons and provided advice to avoid hyperthermia. In addition, some medics participated in television and radio programs to alert the public to the situation. Journalists heavily criti-

cized the lack of reactivity from national health care organizations such as the DGS, INVS and the Health Ministry. As the number of fatalities came as a surprise, journalists investigated how data was managed, which resulted in a political and social controversy. During the last phase of the crisis response, press conferences were frequent and some administrative actors permitted inter-organizational meetings to be recorded as evidence of their willingness to remain transparent. Internet users, including journalists, covered the evolution of the heat wave and interacted with the population through articles and comments about web pages.

French Emergency Room Technician Trade Union, or Association des Médecins Urgentistes de France (AMUF): This trade union was particularly active in July 2003 and alerted the public about bed shortages. The union leader intervened on television by sending out an alert about the massive amount of deaths on August 10th, asserting that such deaths could have been avoided and were not natural. On that point he experienced an open conflict with the DGS director who claimed at that time that he was a liar. The trade union leader intervened in *ad hoc* transversal meetings that took place on the 11th and the 13th of August.

Appendix C. Chronology of the 2003 French heat wave crisis response

Crisis response steps	Events
Disparate signals	Loose signal detection starts on the 4th. There are disparate signals from emergency professionals, such as SAMU and BSPP. For example, the DDASS from Britain signaled the suspicious deaths of three persons under the age of 60. These signals were reported to the heads of the INVS and the DGS, who expressed their concern regarding the health effects caused by the heat. One of the Health ministry's advisers then asks his delegates to write an alert message to health professionals on the 6th. The writing of the alert message follows a full validation process that takes more than 36 hours. Similarly some of the AP-HP directors informally meet emergency squad members on the 5th to voice their concerns about the heat.
From the 4th to the 7 th	
The beginning of the coping	The situation rapidly worsens. Health care operational actors become overwhelmed and begin to improvise. The AP-HP sends an alert that basically asks the hospital staff to mobilize itself, help each other with patients and prepare to face difficulties because the weather should be hot during the weekend. They ask them to act as if the White plan was on the scene. On Friday morning the situation remains under control. Still, during the afternoon, all the emergency squads are overwhelmed with patients and requests. During the weekend, the situation worsens even more for all emergency squads: emergency units in hospitals, SAMU and SMUR, firefighters, SOS médecins. During the weekend many field actors develop improvisation practices, ranging from the <i>ad hoc</i> information system between firefighters and SAMU to innovative uses of ice in hospitals. At the end of the weekend, the AMUF leader alerts the public opinion on television and asserts that deaths are numerous and the situation is more than critical. Some administrative actors then participate in the ongoing collective improvisation, such as AP-HP and DHOS, who provided extra resources.
Between the 8th and the 10 th	
What do we do now?	From the 11th, the administrative sphere recognizes that the situation is out of control and attempts to resolve several issues. The catastrophe is taking place and panic emerges because no organization has a precise idea of the number of deaths. The hospital's staff is exhausted, as the AMUF leader claims on television. Transversal meetings between DHOS, DGS, AP-HP, InVS and Health Ministry advisers take place on the 11th and the 12th.
Between the 11th and the 13th	
The beginning of the controversy	Since the afternoon of the 13th, the situation gets better; the temperatures and the attendance of emergency services simultaneously decrease. However, the administrative sphere has settled into heavy data collection processes on the hospitals' activities, which requires hour-hour reports from services in critical situations about patients, deaths and temperatures in rooms. In the afternoon the Internal Affairs Ministry officially triggers the national emergency plan, also called "White Plan". From this time on, the effort to compile statistics of death rates start and the political controversy surrounding the government's ability to handle the situation develops. It is the end of the organizational crisis but the beginning of the political crisis.
Between the 13th and the 20th	

Appendix D. References on the heat wave

Table 1. Classification of essays

Title, authors & source	Proximity	Reliability
<i>Les systèmes de santé en questions: Allemagne, France, Royaume-Uni, États-Unis et Canada</i> , A-L. Le Faou., 2003, Paris, Éditions Ellipses	Medium	Medium
<i>Canicules, La santé publique en question</i> , L. Abenheim, 2003 Editions Fayard	High	Medium
<i>Urgentiste</i> , P. Pelloux, 2004, Editions Fayard.	Medium	Low
<i>Les chiffres de la canicule</i> . Lettre d'information de Pénombre, 2003, December	High	Low
<i>Heat Wave: A social autopsy of disaster in Chicago</i> , E. Klinenberg. <i>The university of Chicago Press</i>	Medium	High

Table 2. Classification of academic studies

Title, authors & source	Proximity	Reliability
<i>Impact sanitaire de la vague de chaleur d'Août 2003 : Premier résultats et travaux à mener</i> . Bulletin épidémiologique Hebdomadaire – Novembre 2003	High	Medium
<i>The heat wave in France in August 2003</i> , D. Hémon, E. Jouglà. <i>Revue épidémiologique de santé publique</i> , Février 2004	Medium	High
<i>Média et Santé publique : l'exemple de la canicule pendant l'été 2003 en France</i> , Boyer, L., Robitail, S., Debensasion, D., Pasquier, P. <i>Revue d'épidémiologie et de santé publique</i> , 2005	Medium	Medium
<i>Understanding the French 2003 Heat Wave Experience: Beyond the heat, a multi-layered challenge</i> , P. Lagadec. <i>Journal of contingencies and crisis management</i> , 2004	High	High
<i>August 2003: Reflections in a French summer Disaster</i> , Thirion, Debeusasorn. <i>Journal of crisis and contingencies management</i> , 2004	High	High
<i>Taking off the beat: Narrative sensemaking in post-crisis inquiry reports</i> . Boudes T., and Laroche H. <i>Organization Studies</i> 377-396, 2009	High	High

Table 3. Classification of reports

Title, authors & source	Proximity	Reliability
<i>Rapport de la mission d'expertise et d'évaluation du système de santé pendant la canicule 2003</i> , Lalande, Legrain, Valleron, Meyniel, Fourcade. Ministère de la santé, de la famille et des personnes handicapées, 2003, 61 p.	High	Medium
<i>Surmortalité liée à la canicule d'Août 2003. Rapport d'étape</i> – Hermon, Jouglà. INSERM, septembre 2003. 59 p.	High	Medium
<i>Apport Information Canicule : La crise sanitaire et sociale déclenchée par la canicule</i> , D. Jacquat, 580 p.	High	Medium
<i>Impact sanitaire de la vague de chaleur d'Août 2003 en France</i> , M. Ledrans, H. Isnard. Institut de veille sanitaire (INVS), Octobre 2003, 120 p.	Medium	Medium
<i>Continuité et permanence des soins libéraux Durant l'été 2003</i> , J-C Cuenat, C. Daniel, R. Olivier, T. Roquel. Inspection générale des affaires sociales, 63 p.	High	Medium
<i>Rapport sur les rapports d'enquête sur la canicule</i> , Lagadec, Schepens, Laroche. Revue pluridisciplinaire en sciences humaines, 275 p, 2004	High	High
<i>La France et les Français face à la canicule : les leçons d'une crise</i> , Létard, Flandre, Lepeltier, 2004, 405 p.	High	Medium
<i>Rapport n° 1455 au nom de la commission d'enquête sur les conséquences sanitaires et sociales de la canicule</i> , F. Aubert, 573 p.	High	Medium
<i>WHO Regional Committee for Europe (2003) Heatwaves: impacts and responses</i> , WHO, 11p.	Medium	Medium

Table 4. Classification of newspapers articles

Source, title & date	Proximity	Reliability
<i>Le Monde, La sécheresse persistante fait craindre un été catastrophique, 20th of July 2003.</i>	High	Low
<i>Le Monde, Canicule et sécheresse, un double choc exceptionnel, 6th of August 2003.</i>	High	Low
<i>Le Monde, La canicule s'installe pour une semaine, 6th of August 2003</i>	High	Low
<i>Le Monde, La canicule a provoqué lundi la mort d'un homme de 32 ans dans le Sud-Ouest, 8th of August 2003</i>	High	Low
<i>Le Monde, Jean-Pierre Raffarin et Roselyne Bachelot n'ont pas créé de cellule spéciale pour gérer la crise, 10th of August 2003</i>	High	Low
<i>Le Monde, La vague de chaleur devrait durer encore huit jours, 7th of August 2003</i>	High	Low
<i>Le Monde, La canicule serait responsable de la mort d'une cinquantaine de personnes en Ile-de-France, 12th of August 2003</i>	High	Low
<i>Le Monde, les urgentistes s'alarment du nombre de décès, 12th of August 2003</i>	High	Low
<i>Le Monde, La prévention, remède essentiel contre l'hyperthermie, 13th of August 2003</i>	High	Low
<i>Le Monde, Nonchalance, 13th of August 2003</i>	High	Low
<i>Le Monde, hospitaliers s'estiment à présent confrontés à une « épidémie de coups de chaleur », 13th of August 2003</i>	High	Low
<i>Le Monde, Canicule : premières réactions du gouvernement, 13th of August 2003</i>	High	Low
<i>Le Monde, Douze jours pour prendre conscience d'un « drame humain », 15th of August 2003</i>	High	Low
<i>Le Monde, Le Plan blanc est activé, 15th of August 2003</i>	High	Low
<i>Le Monde, Les autorités sanitaires envisagent 3 000 morts liées à la chaleur, 15th of August 2003</i>	High	Low
<i>Le Monde, LUCIEN ABENHAÏM, directeur général de la santé « Cela correspond à ce que l'on observe dans les épidémies de grippe », 15th of August 2003</i>	High	Low
<i>Le Monde, Mourir, en France, sous la canicule, 15th of August 2003</i>	High	Low
<i>Bulletin of the World Health Organization 81(10), France caught cold by Heatwave, 2003</i>	High	Low
<i>Libération, Canicule : comment les chiffres ont flambé, 18th of December 2003</i>	High	Low

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