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RESEARCH ARTICLE

HARNESSING THE POWER OF SELF-ORGANIZATION IN AN ONLINE COMMUNITY DURING ORGANIZATIONAL CRISIS[1]

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Organizational crisis management has traditionally favored a centralized plan-and-control approach. This study explores the possibility for an orderly crisis management process to arise unintentionally from decentralized and spontaneous actions in an online community (i.e., self-organization). Based on complex adaptive systems theory, a multilevel model is developed to account for the logical relation between individual-level actions and interactions in an online community and an organizational-level orderly and rational crisis management process, as described by the organizational crisis management literature. We apply this multilevel model to an analysis of 89,596 posts from an online community that was deeply embedded in an earthquake-induced organizational crisis. Results indicate that fluctuation of message content themes in this online community served to energize continuous input from ordinary organization members. These input actualized new possibilities offered by the technology platform for crisis management actions (i.e., actualized IT affordances). Concatenation of immediate impacts of message content themes and actualized IT affordances formed feedback loops that moderated the crisis management activities toward an efficient trajectory. Our findings challenge the traditional assumption that macro-level order requires micro-level order-seeking behaviors. They suggest the viability of self-organization as a new source of organizational order that complements the traditional centralized plan-and-control approach. Theoretical and empirical implications for harnessing the power of ordinary organization members connected by today's technology platforms are discussed.

Keywords: Organizational crisis, self-organization, complex adaptive systems, online community, information technology

Introduction

Organizational crisis management, like many other management issues, is being reshaped by information technology (IT). Traditional wisdom advocates a centralized approach in organizational crisis management because restricted participation in central decision groups facilitates fast information sharing and effective resource coordination (Andriole 1985a; Billings et al. 1980; Booth 1993; Hermann 1963; Mitroff and Pearson 1993; Nunamaker et al. 1989; Smart and Vertinsky 1977). IT innovations, particularly Internet-based social interaction technologies, challenge this traditional view. Recent studies have reported the successes of ordinary citizens in

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self-organizing disaster relief efforts online during emergency situations (Majchrzak and More 2011; Palen et al. 2007; Qu et al. 2009; Salathé et al. 2013; Vieweg et al. 2010). Although these studies do not examine organizational settings, they suggest significant potential for online self-organization to serve as a viable new approach for organizational crisis management. This motivates the research questions of this study:

(1) Is self-organization in online communities a viable approach to crisis management?

(2) How does this self-organization unfold?

(3) What is the role of IT in this self-organization?

Observations of an organizational crisis triggered by a natural disaster provide an ideal opportunity to answer these questions.

On May 12, 2008, an 8.0-magnitude earthquake hit Wenchuan, China. Fifty miles away from the earthquake's epicenter, students at a university campus experienced this massive earthquake, its thousands of aftershocks, an extended campus shutdown, and a flood of information mixed with truths and untruths. While the confusion and turbulence on campus typifies an organizational crisis (Burke 2000; Gilpin and Murphy 2008), the management activities in response to the situation were unique in two respects. First, the unexpected nature of the earthquake and aftershocks impaired the ability of the university's administrators to carry out centralized crisis management. Many crisis response activities at this university were enacted by its students via computer-mediated interactions in their campus online forum. Second, the stress and time constraint caused by the unpredictable offline situation prevented students from deliberately planning and orchestrating their online interactions. Their crisis management activities were spontaneous rather than intended. We recognize in retrospect that the crisis management activities in this university's online forum, although produced by decentralized individuals, exhibited the same orderly nature as those designed by central decision groups. This manifests the hallmark of self-organization,

> [The creation and recreation of] system level order as an unintended consequence of the action and repeated interaction of lower level system components, without intervention by a central controller (Chiles et al. 2004, p. 502).

Supplied with a complete record of the written text in this university's online forum (89,596 posts), we had the opportunity to examine this episode of self-organized crisis management online, and extend both the literature on organizational crisis management and online community research. Organizational crisis management literature converges on the value of an orderly crisis management process but attributes this process to the deliberate plan-and-control of central decision groups. Online community research has begun to recognize the power of decentralized and spontaneous online interactions in disaster relief. However, this research has not formalized the organizing dynamics for a large number of *organization members* to self-organize online toward an orderly and rational crisis management process. We employ complex adaptive systems (CAS) theory as the overarching framework for integrating insights from the organizational crisis management and online community literatures. CAS theory provides a multilevel scheme for linking individual actions to system-level regularities. It illuminates organizing dynamics that are fundamental for self-organized orderly behaviors in a social system. We can therefore gain new theoretical insights regarding how decentralized and spontaneous online interactions of organization members can give rise to an orderly crisis management process. These new insights can be applied to research and practices associated with situations of organizational disequilibrium that are caused by unexpected social, economic, and organizational incidents, as well as natural disasters. They can also help to close the information systems (IS) research gap regarding the configural form of collective system use (Burton-Jones and Gallivan 2007).

In the remainder of this article, we first develop the research model of this study. We then apply this research model to extract quantitative and qualitative information from the online forum data in order to assemble a structured depiction of self-organized crisis management online following the earthquake. Finally, we present the theoretical and empirical implications and research conclusions.

Theoretical Development

Theoretical Lens: Complex Adaptive Systems Theory

Self-organization is multilevel in nature. Organizing dynamics are enacted by individual social actors while organizing patterns and outcomes are manifested on the collective level (Chiles et al. 2004). Prior research indicates that the logical relation between micro-level organizing dynamics and macro-level organizing patterns and outcomes holds the key to the viability and inner working of a self-organized process (Drazin and Sandelands 1992; Miller and Page 2007). In order to theorize this logical relation in a self-organized

online crisis management process, we need a multilevel theoretical lens that can embrace context-specific insights regarding organizational crisis management and online community activities. Moreover, this theoretical lens should explain the linkage from decentralized and spontaneous online community activities on the micro-level to the orderly and rational crisis management process on the macro-level. Complex adaptive systems theory is proposed as an ideal framework.

Complex adaptive systems (CAS) are "systems composed of interacting agents described in terms of rules. The agents adapt by changing their rules as experience accumulates" (Holland 1995, p. 10). Unlike traditional research models that reduce reality to variables and correlations among variables, a CAS model is formulated around agents (i.e., basic entities of actions), interactions among agents, and an environment (Nan 2011). This novel formulation provides an analytical advantage for examining self-organization since actions and repeated interactions of agents are the root of system-level order (Chiles et al. 2004). In CAS theory, order means putting "persons or things into their proper places in relation to each other" (McKelvey 2001, p. 137). Since any CAS is constantly in flux, order typically refers to a regular process (e.g., a chemical clock or a standing ovation) rather than a static equilibrium state (Drazin and Sandelands 1992; Miller and Page 2007). An intriguing aspect of CAS is that macroscopic regularity (i.e., order), while being a logical consequence of agents' actions and interactions within a given environment, is not caused by agents' intentions to seek order (Fontana and Ballati 1999). This has crystallized the fundamental question for CAS research as, "what causes order creation?" (McKelvey 2001, p. 150). Three interrelated order creation dynamics are identified as the key ones: adaptive landscape, recombination, and feedback loops.

Three Order Creation Dynamics

Adaptive landscape dynamics are the constantly shifting surroundings of agents in a CAS. Rather than intending to create order, individual agents interacting in a CAS intend to survive and thrive (Holland 1995). Interactions centered on a focal agent form a so-called adaptive landscape for this agent. This focal agent can then maintain or change its behaviors according to what is rewarded by its adaptive landscape. Since an agent typically interacts with a subset of other agents, an adaptive landscape provides only a partial view of an entire system (namely *bounded rationality*). However, since agents mutually define one another's adaptive landscapes, their bounded rationalities can coevolve in a common direction. Coevolution within mutually defined adaptive landscapes affords the possibility for individual efforts to be channeled into global behavioral regularities without the intervention of a central controller. For example, if surviving and thriving in an online forum refer to the ability of a forum user to obtain replies from other users, then each user would try to submit discussion topics that appeal to others. Individual efforts to improve the reply rate of their own posts can aggregate into popularity for an online forum.

Surviving and thriving in a CAS often require behavioral changes. A primary way for agents to change is to recombine successful elements of their own past behaviors or the behaviors of other agents within their adaptive landscapes (Anderson 1999). These *recombination dynamics* can either create new behavioral patterns or enable the diffusion of existing behaviors through a system. It is the root for transformation in macro-level order. Another example from online forums: when a forum user demonstrates that emoticons can effectively convey feelings, other users may follow suit and add emoticons to their posts. Over time the dominant way to express feelings can evolve from plain text to emoticons.

As agents recurrently interact with one another, the output of one application of coevolution becomes the input for the next round. This leads to *feedback loop dynamics* (Anderson 1999; Drazin and Sandelands 1992; Resnick 1994). Feedback loops can either be negative balancing loops or positive reinforcing loops. The former serve to eliminate small deviations from the norm when agents perceive deviations to be inferior. They create path dependency and stabilize an existing order. The latter amplify initial fluctuations in an adaptive landscape (Chiles et al. 2004). They allow the introduction of a novel and superior behavior to quickly develop into an evolutionary cascade. Both positive and negative feedback loops act simultaneously in a system, but have different strengths at different points of time (Sterman 2000). These feedback loop dynamics serve as the "thermostat" of a CAS in that they prevent the system from settling into a static state or engaging in excessive changes (Anderson 1999). For example, in an online forum the norm "stay on topic" would reduce the amount of digressive replies (i.e., a negative feedback loop). Meanwhile, a reply with intriguing yet off-topic content can quickly shift a discussion thread to a novel direction (i.e., a positive feedback loop). These feedback loops help the online forum to maintain the balance between consistency and diversity.

Together, the dynamics of adaptive landscape, recombination, and feedback loops can harness input from a large number of decentralized individuals and quickly channel the input to a common trajectory. They encapsulate the fundamental causal logic from individual-level bounded rationality to collective-level orderly and rational behaviors. Since these order-creation dynamics are generalized from self-organization

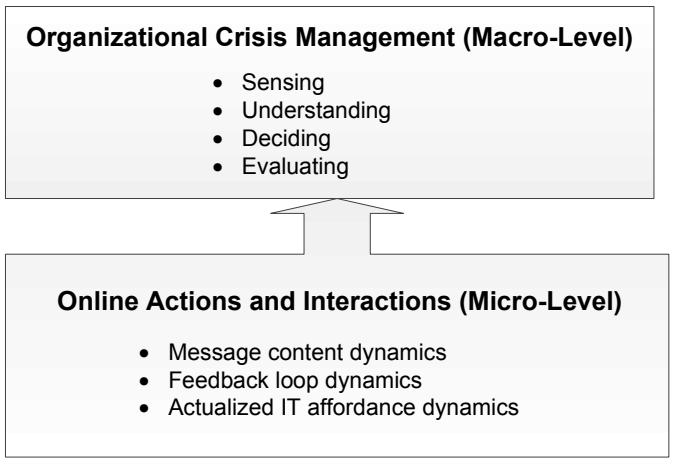

Figure 1. Research Model

incidences in a wide range of natural and social phenomena, they can serve as a meta-theoretical framework within which relevant nuggets of insights from distinct literatures are integrated into a coherent research model (Chiles et al. 2004; Smith 1986).

Research Model

With CAS as the overarching theoretical lens, we integrate insights regarding organizational crisis management and online community activities into the research model depicted in Figure 1. This research model not only captures the micro- and macro-level factors in a self-organized crisis management process, but also explains the logical relation between the two levels. Burton-Jones and Gallivan (2007) point out that a multilevel conception of IS use can reveal new ways to think about IT artifacts. Our research model explicates how macro-level system use outcomes can originate in, yet differ from, micro-level system use actions and interactions (i.e., the configural form of collective system use in Burton-Jones and Gallivan (2007)). This multilevel conception allows us to theorize the role of IT artifact via the novel concept of actualized IT affordance (Majchrzak et al. 2013; Strong et al. 2014), as explained below. In the remainder of this section, we discuss theoretical development in light of this research model.

Integrating Prior Research into the Research Model

Our theorization draws on two lines of literature that are particularly relevant to this research context: organizational crisis management and online community research. These two lines of literature provide context-specific theories that are integrated into the coherent research model through the CAS lens (Figure 1).

Prior Organizational Crisis Management Research

Organizational crisis refers to a low-probability, high-impact situation that is perceived by organization members to be threatening, ambiguous, urgent, and indecisive (Hermann 1963; Nunamaker et al. 1989; Pearson and Clair 1998). Research on organizational crisis has revolved around three main groups of factors: psychological factors such as individual cognition and emotions, social-political factors concerned with shared meaning and group dynamics, and structural factors including management procedures, policies, and technological constraints (for reviews, see Chapter 4 in Booth 1993; Pearson and Clair 1998). Organizational crisis management is essentially the systematic attempt of organization members to recover and readjust under a myriad of psychological, social-political, and structural influences in a crisis situation. An *orderly and rational process* has been prescribed by organizational researchers for accomplishing this.

By definition, an organizational crisis is a subjective experience of organization members (Pearson and Clair 1998). Therefore, the first step in organizational crisis management is sensing a crisis (Billings et al. 1980). Previous research suggests that the probability of sensing that a crisis actually exists is driven by the perceived discrepancy between a standard state and an experienced state of reality rather than the magnitude of the triggering event itself (Hermann 1963; Turner 1976; Weick et al. 2005). Since organization members

can have substantially different perceptions of reality, traditional organizational crisis management typically relies on top management's experience and judgment in defining "perceived discrepancy" (Nystrom and Starbuck 2004). In principle, crisis sensing begins with a precrisis planning process wherein top management identifies key indicators of a standard state of reality and the threshold for "sufficiently strong" discrepancy between the standard and experienced states of reality (MacCrimmon and Taylor 1976; Pounds 1965). A crisis can be discerned when the key indicators of the reality state exceed the predefined threshold (Martino 1985). Information technology can facilitate crisis sensing by continuously collecting and analyzing data about the key indicators and automatically triggering an early crisis alert (Andriole 1985a, 1985b; Nunamaker et al. 1989).

Once a crisis is sensed, an organization needs to understand its causes and impact in order to decide on coping actions. A central task for crisis management is to collect and deliver relevant, timely, and accurate information to decision makers (Billings et al. 1980; Pearson and Clair 1998). Both theoretical analyses and empirical findings indicate that small decision groups are desirable for this task in a traditional organizational setting (Blanchard 1962; Hermann 1963; Janowitz 1959; Pruitt 1964). The reduced number of communication channels in a small group enables fast information sharing and aggregation, ideal for the urgent nature of organizational crisis management. However, small groups are subject to emotional stress, cognitive overload, and information distortion (Pearson and Clair 1998; Smart and Vertinsky 1977; Weick 1993). Precrisis planning and training are commonly prescribed to help decision makers to anticipate information needs during a crisis and become familiar with information processing procedures in unusual scenarios (Pearson and Clair 1998; Smart and Vertinsky 1977). The data encryption, transmission, and manipulation capabilities of an IT system can help reduce information distortion and miscommunication in small decision groups (Hayes 1985; Nunamaker et al. 1989).

Even when information about causes and impacts of a crisis is available, the subsequent decision making faces significant uncertainties regarding effective response actions. Researchers note that a situation would not be seen as a crisis if a solution exists in the response repertoire (Milburn 1972). In addition, decision making is confined by organizational culture and goals (Hermann 1963; Pearson and Clair 1998). There is a natural tendency for organizations to centralize authority to top management and include fewer individuals in the crisis decision-making process (Hermann 1963; Nunamaker et al. 1989). Presumably, a small and centralized decision group can act quickly and decisively while conforming to shared values and beliefs of an organization. Precrisis planning can supplement this centralized decision-making approach by preparing decision criteria for anticipated contingencies and sensitizing top management to potential decision-making biases (e.g., groupthink). The relevance of IT in crisis decision making is seen in terms of providing rule or simulation-based analyses and suggestions for response actions, and facilitating the articulation and retrieval of decision criteria (Nunamaker et al. 1989).

Eventually, organizational crisis management can lead to a spectrum of psychological, social-political, and structural outcomes (for an overview, see Table 2 in Pearson and Clair 1998). Including post-crisis evaluation as the last phase can yield important learning for subsequent planning and organizational reformation (Lagadec 1993; Nunamaker et al. 1989). A crisis management team composed of senior-level experts is proposed as the ideal for consolidating learning and feedback (Bland 1998; Pearson and Clair 1998) because they can "draw lessons for the future without condemning the people involved" (Lagadec 1993, p. 309). IT can facilitate post-crisis evaluation by providing records and serving as a knowledge base (Andriole 1985b; Hayes 1985; Nunamaker et al. 1989).

In summary, the literature recognizes the multifaceted nature of organizational crisis management. It prescribes an orderly and rational management process that includes sensing, understanding, deciding, and evaluating as its primary phases. In this orderly and rational process, central decision groups and precrisis planning are recommended for effective management of psychological, social-political, and structural factors in a crisis situation (Smart 1985). IT acts primarily as an information manipulation tool and group decision support system (Nunamaker et al. 1989).

Integrating Organizational Crisis Management Research into the Research Model

Although today's IT innovations challenge the centralized crisis management approach, they do not defy the relevance of an orderly and rational process for recovering and readjusting in an organizational crisis. Through the CAS lens, the orderly crisis management process described by the organizational literature represents the system-level intelligence that is required for purposeful and efficient organizational behaviors (Drazin and Sandelands 1992). Therefore, our research model conceptualizes the orderly crisis management phases prescribed by the traditional organizational crisis management literature as the macro-level regularity (see the top box in Figure 1) that can be produced by micro-level actions and interactions. This conception follows the CAS tradition of viewing "order" as a sequence of organizational management activities rather than as a static equilibrium state.

Table 1. Summary of Self-Organized Online Crisis Management Research

Study	Context	Empirical Findings	Theoretical Insights
Li and Rao 2010	2008 Sichuan Earthquake	Twitter users provided a greater amount of information than mainstream media immediately after the earthquake.	Twitter supplemented mainstream media's information timeliness, accessibility, and collective intelligence.
Majchrzak and More 2011	2007 San Diego wildfires	Volunteers improvised a mash-up of Web 2.0 tools in providing and visualizing wildfire information for the public.	Volunteers contributed to disaster response through a broad-based serendipitous process. They were not directed by a single extraordinary effort.
Palen et al. 2007	2005 Hurricane Katrina	The public used makeshifts or created dedicated online forums for sharing Katrina-related information.	Ordinary people connected by information and communication technology have become a powerful new force in disaster response. This self-organized disaster response effort challenges traditional command-and-control crisis management.
	2003 Southern California Wildfires	A citizen remaining in the evacuated area voluntarily provided wildfire information online and became a key information source.	
	Ongoing Avian Flu Preparation	FluWiki was created by the public as a knowledge base for influenza related topics.	
Palen et al. 2009	2007 Virginia Tech Shooting	Students quickly and correctly identified all victims via peer-to-peer information communication on social media including Facebook and Wikipedia.	Large-scale emergency response can take the shape of a distributed network of individuals who possess vast information sources and skills.
Qu et al. 2009	2008 Sichuan Earthquake	Citizens used an online forum to share information and express emotions. A self-regulation code emerged to guide their behaviors.	Although the online forum was not designed for disaster response, it quickly adapted to the citizen-led disaster relief effort by affording new possibilities for self-regulated information and coordination activities.
Salathé et al. 2013	2013 Influenza A (H7N9) outbreak in China	Citizens use the Internet and mobile phones to share information about disease outbreaks, propagation, and health-related behaviors and sentiments.	Public information sharing on social media provides early and rich epidemic intelligence. It can facilitate health officials' fast response and deep understanding of emerging public health threats.
Starbird and Palen 2011	2010 Haiti Earthquake	Volunteers adopted a Tweet syntax provided by the research team. They translated unstructured disaster response Tweets into structured information accordingly to the syntax.	Technical features of Twitter and individual capabilities of appropriating these features jointly enabled volunteers to form an emergent organization for disaster relief.
Starbird et al. 2010	2009 Red River Floods	Twitter users engaged in generative, synthetic, derivative, and innovative information activities in producing emergency related information.	A suite of self-organized curation mechanisms enabled Twitter users to adapt the short-lived Twitter communications to information needs of emergency response.
Vieweg et al. 2010	2009 Oklahoma Grassfires	Twitter users shared various types of information to enhance the public's situational awareness in emergency situations such as grassfires and floods.	A coherent typology of emergency response information can be extracted from the seemingly heterogeneous and scattered Twitter communications.
	2009 Red River Floods		

Prior Online Community Research

In the growing body of online community research, a line of work particularly relevant to this study is the examination of self-organized emergency responses in online communities. Palen et al. (2007) published one of the first descriptions of citizen-led emergency responses in online forums during the 2003 southern California wildfires, Hurricane Katrina, and the Avian flu. A few years later, Majchrzak and More (2011) reported an in-depth case analysis of how distributed volunteers orchestrated a suite of Web 2.0 technologies to share, aggregate, and visualize disaster information during the 2007 San Diego wildfires. Recently, medical researchers have begun to recognize public information sharing on social media as a powerful new way for early detection and ongoing monitoring of disease outbreaks (Salathé et al. 2013).

These and similar studies (see Table 1 for a summary) provide several important implications for our theorization. First, a recurrent theme is that a large number of decentralized individuals can collaborate efficiently online without the intervention of a central control mechanism. Production, curation, and consumption of messages in online community platforms are the primary forms of interaction among these decentralized individuals. For example, Palen et al. (2009) found that after the 2007 Virginia Tech shooting, the public correctly identified all victims via self-orchestrated information sharing on Wikipedia and Facebook before the official release of victim names. Second, emergency responses in online communities are shaped by serendipity rather than deliberate planning. Collaboration among decentralized online community members evolves as some members contribute novel content to their online interactions. This notion is particularly salient in the 2007 San Diego wildfires case (Majchrzak and More 2011) where volunteers "happened" to become key players in online disaster relief through their innovative uses of Web 2.0 technologies in presenting wildfire information. Third, unlike traditional crisis management where IT is conceptualized as distinct material entities, online community research has portrayed technology and humans as coevolving forces in emergency responses. In other words, the relevance of IT is perceived through its actualized affordance that is defined as the realized potential that arises from the relation between actor intentions and technology capabilities (Majchrzak et al. 2013; Strong et al. 2014). For example, the capability of Google MyMap to combine multiple layers of geographic data into a coherent visual made it possible for volunteers from different knowledge domains to synchronize their data sharing efforts during the 2007 San Diego wildfires (Majchrzak and More 2011). Similarly, Twitter features such as reTweet and follow@ offered users new possibilities to share and synthesize information following the 2009 Red River floods (Starbird et al. 2010).

Integrating Online Community Research into the Research Model

Online community research highlights a fundamental impact of IT innovations: they enable online emergency responses to cross geographical boundaries (e.g., Palen et al. 2009). This, in turn, redefines the arena for people to influence each other from physical space to online environments (Faraj et al. 2011; Latané and Liu 1995). Specifically, prior research indicates that it is through submission, manipulation, and consumption of online messages that decentralized individuals receive feedback to their spontaneous disaster relief efforts, and this enables them to preserve or adjust their actions accordingly. As individual members iteratively contribute to and are influenced by online messages, various themes can ebb and flow in an online community environment (Qu et al. 2009; Vieweg et al. 2010). This dynamic aspect of message content in effect captures the CAS notion of adaptive landscape dynamics. Our research model therefore includes message content dynamics as one of the order creation dynamics underlying an orderly crisis management process (the bottom box in Figure 1).

Message content dynamics may expose individuals to novel and more productive ways to contribute to online crisis responses. Since humans and technology are inextricably entangled in online communities, individual recombination of novel and productive practices is likely to manifest as actualized new possibilities offered by the technology platform for crisis management actions (i.e., actualized IT affordances). Indeed, a recurrent finding in online community research is that effective online emergency responses are enacted as individual members serendipitously adopt and enhance technologies (e.g., information visualization using Google MyMap in Majchrzak and More (2011); structured information sharing by using a Tweet syntax in Starbird and Palen (2011)). Actualized IT affordances may diffuse or diminish over time as individuals recombine their online crisis management practices in different ways. They embody recombination dynamics in an online community. This conception allows our research model to acknowledge "the impact of individual practices without losing the IT artifact itself" (Strong et al. 2014, p. 57).

Message content, as the adaptive landscape of online community members, has an impact on the subsequent behaviors of members. Meanwhile, the theory of IT affordances asserts that actualized affordances produce immediate outcomes in support of organizational goals (Strong et al. 2014). Concatenation of these impacts, and the immediate outcomes of message content and IT affordances, form feedback loops. Although message content and IT affordances are in flux, organizing dynamics in online emergency responses do not

Table 2. A Summary of Prior Literature through the CAS Lens

	Traditional organizational crisis management	Crisis management in online communities
Nature of agents	Members of small decision groups	Members of large online communities
Nature of interactions	Planned and centralized	Spontaneous and decentralized
Role of IT	Distinct material entities that support human actions	Actualized IT affordances that coevolve with human actions
Salient organizing dynamics	A sequence of crisis management phases that embody macro-level orderly and rational behaviors	Message contents, feedback loops, and actualized IT affordances that represent micro-level adaptive landscape dynamics, feedback loop dynamics, and recombination dynamics respectively

unfold along random trajectories. Prior online community research has observed path-dependency and continuing diversity in citizen-led emergency responses (e.g., Qu et al. 2009; Starbird et al. 2010). This indicates the existence of both negative balancing and positive reinforcing feedback loops between and within message content and IT affordances. Explicit accounts of these feedback loops are largely lacking in the current literature. By including feedback loop dynamics in our research model, we can help close this theoretical gap and provide a more complete perspective of order creation dynamics underlying self-organized online crisis management. Message content dynamics, actualized IT affordance dynamics, and feedback loop dynamics are the three key aspects of self-organized actions and interactions on the individual agent level. According to CAS theory, as these dynamics simultaneously unfold in space and time, orderly organizing activities can surface without the intervention of a central controller (the bottom-up arrow in Figure 1).

Analytical Focuses Derived from the Theoretical Development

To this point, we have mapped concepts and ideas from the organizational crisis management literature and online community research to the order creation dynamics in CAS theory (see Table 2 for a summary). This results in the research model depicted in Figure 1. Using this research model as the formal analytical structure and guided by our research questions stated earlier, we define focuses of the subsequent data analysis as follows:

- Regarding question 1 (Is self-organization in online communities a viable approach to crisis management?), our analysis focuses on whether phases described by organizational crisis management literature surfaced from our research context.
- Regarding question 2 (How does this self-organization unfold?) and question 3 (What is the role of IT in this self-organization?), we search for salient message contents in each crisis management phase, the actualized IT affordances in each phase, the feedback loops unfolding among these message contents and IT affordances, and the way message contents, actualized IT affordances, and feedback loops jointly produced the orderly phases.

Method

Research Site

The context of our study was the 8.0-magnitude earthquake that struck Wenchuan, Sichuan Province in China on May 12, 2008. It was named "[the] most devastating earthquake since the founding of new China [in 1949]" (Zhou 2008). Over 69,000 people were confirmed dead, 17,900 missing, and 374,000 injured as a consequence of this earthquake (USGS 2011). We chose a major public university (pseudonamed FEU for the remainder of this article) located 50 miles from Wenchuan as our data collection site for two reasons. First, since FEU is not located in a region with frequent earthquakes it had no *a priori* earthquake response training or emergency plans. More importantly, due to its geographic proximity to the epicenter, FEU's normal campus life was substantially disrupted by the earthquake (e.g., classes were cancelled and all nonessential services were shut down) and the ability of FEU's central administration to command and control the situation was severely impaired. These circumstances ensured that the earthquake and its aftermath were perceived as an organizational crisis by FEU students, and thus was sufficient to trigger organizing actions required for recovery and readjustment. Second, the campus online forum was the primary channel for students divided between FEU's two

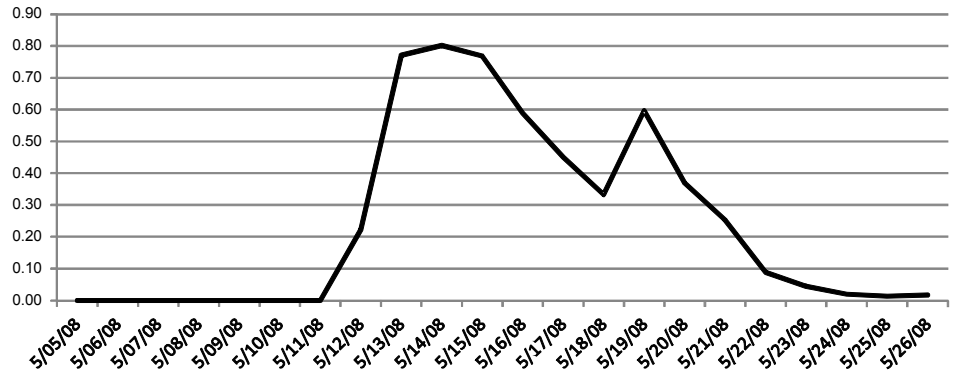

Figure 2. Percentage of Earthquake Related Posts

campuses (10 miles apart) to communicate and organize during the earthquake's aftermath (see Appendix A for technical specifications of the online forum). Normally students had access to the forum only between 8 a.m. and 11 p.m. ("lights-out" was from 11 p.m. to 8 a.m.; most universities in China cut off electricity supply to the dorms during night hours; the online forum was not accessible from smart handheld devices then). During the first two weeks following the earthquake, FEU's central administration decided to provide electricity 24 hours a day so that students could use the online forum whenever they desired. The administration also opened up the online forum to students who were not registered as users. These decisions fostered computer-mediated self-organization on the campus online forum, allowing the forum to capture a rich record of the FEU students' crisis responses immediately following the earthquake.

Data Collection

We retrieved all 89,596 posts submitted a week before and two weeks after the earthquake (May 5 to 26, 2008) directly from the online forum's server (*posts* and *messages* are interchangeable hereafter). Data collection was performed in 2009 with the support of FEU's central administration. The retroactive nature of our data collection prevented forum user behaviors from being affected by this research. Data from the week before the earthquake provides a baseline observation of the online forum. The end date (May 26, 2008) is chosen because it is the date classes and services resumed at FEU. An analysis of the percentage of earthquake-related posts among all posts confirms that this data collection window captures the majority of earthquake-induced online crisis management activities (see Figure 2). Since there are various ways to refer to an earthquake, we did not rely on particular keywords to identify earthquake-related posts. Instead, a coder read the content of each post, taking into account the topic of the discussion thread that contains the post. Based on this content analysis, a post is considered earthquake-related if it concerns the earthquake, aftershocks, or crisis management following the earthquake. For each post, we collected data regarding its topic, content, the user ID of the person submitting it, the date and time it was submitted, and the subforum where it was listed. In order to understand the social organizational context of these posts, we also collected concurrent data from official updates on the number of aftershocks and formal announcements issued by FEU's central administration.

FEU Campus Online Forum

As indicated by Figure 2, a week before the earthquake (May 5–11, 2008) the FEU campus online forum was "business as usual." There was no earthquake-related content in the online forum. Each day from 8:00 a.m. (the daily opening time of the forum), users began to submit posts either as new discussion topics or as replies to an ongoing discussion thread. The discussion threads were organized into 35 subforums. Each subforum was recognized by a distinct theme such as movies, music, schoolwork, or sports. Each contained user-developed discussion threads indicative of its theme (e.g., "Tips for Job Interviews" in the Job Hunting subforum). Discussion threads with more replies were listed higher in each subforum. The top 10 most replied-to discussion topics across all subforums were displayed on the front page of the forum system. Immediately before the earthquake the top 10 topics included "About Appearance," "New Moderator for the Cartoon Sub-Form," and "Favorite Soft Rock Songs." It is in

this routine online forum context that the self-organized online crisis management was triggered by the earthquake.

Data Analysis

Drawing on previous research defining an organizing process as its unit of analysis (Balogun and Johnson 2004; Chiles et al. 2004; Denis et al. 2001; Langley 1999), we employ a series of analytical techniques in extracting both quantitative and qualitative information from our data. The anchor point of our analysis is the list of analytical focuses presented at the end of the theoretical development section.

We employ the combination of theory-driven and data-driven approaches in identifying salient themes embedded in the online forum posts. We first consult previous examinations of emergency responses in online communities for their content categorization schemes. This exercise produced a list of content categories such as information (e.g., Majchrzak and More 2011; Starbird et al. 2010), actions (e.g., Salathé et al. 2013), emotions (Qu et al. 2009), and opinions (Qu et al. 2009). These categories are then adapted to our data analysis through an iterative comparison process prescribed by the open coding technique (Corbin and Strauss 1990; see Appendix B for more details of the coding scheme development). Six categories of message themes especially suited to our research questions surfaced through this coding scheme development approach (see Table 3 for definitions and examples). After all categories were reviewed, revised, and agreed on by the coauthors, a coder trained in content coding but unfamiliar with our research questions was hired to identify the posts falling into each category. The coding was performed over the entire data set (89,596 posts with an average of 56 characters in each post). A second coder was then hired to evaluate a randomly selected subset (10%) of the posts. Both coders were provided with the coding scheme presented in Table 3; the inter-rater agreement was 89.1 percent.

The combination of theory-driven and data-driven approaches is also employed to identify categories of actualized IT affordances. Recent IS research has conceptualized a few IT affordances in the social media context (e.g., metavoicing, triggered attending, network-informed associating, and generative role-taking in Majchrzak et al. (2013); visibility, persistence, editability, and association in Treem and Leonardi (2012)). According to the definition of actualized IT affordances (i.e., the realized potential that arises from the relation between actor intentions and technology capabilities) (Majchrzak et al. 2013; Strong et al. 2014), we take into account both actor intentions and technology capabilities in extending extant IT affordance categories in our study. Whenever a user utilized a technology capability beyond plain text, a source code was embedded in the post. For example, the inclusion of a URL in a post would be indicated by the source code "[url]" embedded within the post's content. An examination of the embedded source codes within the collected posts was performed to identify technology capabilities involved in the crisis management activities. Then, actor intentions were identified through iterations of comparing and grouping those posts that invoked different technology capabilities. This modified open coding approach yielded two affordance categories, namely assembling and verifying, that are unique to our crisis management research context. The other two affordance categories, metavoicing and associating, correspond to existing categories of IT affordances from previous research. Table 4 summarizes the IT affordance coding scheme. Since each affordance category is associated with the presence of distinct source codes, the coding was done by a computer program.

After identifying message themes and actualized IT affordances, we employed temporal bracketing and narrative techniques for developing qualitative interpretations from our data (Langley 1999). A temporal bracketing strategy is to decompose the process data into successive discrete phases that become comparative units of analysis (Barley 1986; Denis et al. 2001; Doz 1996; Lanley 1999). It enables us to identify phases in the crisis management process. We rely on message content data for temporal bracketing because salient themes embedded in the forum posts indicate the aggregated attention or actions of the online community. The narrative technique involves the construction of analytical text from the raw data (Miles and Huberman 1994). The research model presented earlier served as sensemaking devices for our construction of a thick description concerning how decentralized organization members self-organized crisis management online following the earthquake.

We also performed time series statistical analyses in order to supplement the qualitative techniques. An *hour* is defined as the unit of time lag in order to achieve a fine-grained view of organizing dynamics at our research site. In particular, the Chow test (1960) was employed to verify the different crisis management phases identified through temporal bracketing. It relies on an F-test to evaluate whether effects of the independent variables in question are significantly different between two sets of time series data associated in different phases. Furthermore, the lag effects of actualized IT affordances on message content themes were tested in order to substantiate the narrative of IT's relevance in self-organized crisis management online.

Table 3. Coding Scheme for Message Content

Coding Categories	Descriptions	Example Posts
Negative Emotions	Posts expressing fear, fright, anxiety, sadness, anger, tiredness, or frustration.	[5/13/08, 6:41 AM. Reply: It's dawn.] I am too frightened to sleep. I fear that I will never wake up. When will this end?
Information	Posts seeking, providing, or synthesizing information.	[5/15/08, 8:15 AM. Will the blood donation bus come to campus?] I heard about the bus on TV. Does anyone know whether and when will the bus come to FEU?
Action	Posts suggesting, planning, or giving support to actions.	[5/16/08, 6:41 PM. Reply: Disaster relief.] How about organizing a freshman team to tutor high school students in the worst-hit regions?
Emotional Support	Posts expressing sympathy and compassion.	[5/14/08, 9:06 AM. Reply: To those in heaven.] My deepest sympathies! Let's give a helping hand!!!
Appreciation	Posts praising others.	[5/15/08, 12:27 AM. The most awesome people.] Those at the campus radio station are still working at this hour. You are the best!
Self-Reflection	Posts evaluating or criticizing collective identities or actions.	[5/15/08, 2:37 PM. Reply: Are we inconsiderate?] I don't agree. At least my class took the trash with us after camping on the open ground.

Table 4. Coding Scheme for Actualized IT Affordances

Affordance Categories	Descriptions	Actor Intentions	Technology Capabilities
Assembling	Enable individual members to gather online and engage in ongoing conversation	Reach out to each other during the organizational crisis	Represent each member by a unique user ID
Verifying	Enable individual members to validate their message content	Ensure accuracy of information and claims	Refer to external content via URL and attachment
Metavoicing (Majchrzak et al. 2013)	Enable individual members to react online to others' message content	Converge on the most preferable crisis response actions	A "ding" reply (similar to "Like" on Facebook)
Associating (Treem and Leonardi 2012)	Enable individual members to establish one-to-one relational or content ties	Communicate and coordinate with other specific members	Quote another member's content or add an attention line directed at other specific members

Results

Orderly Crisis Management Phases

In reference to our first question (whether orderly crisis management phases surfaced), we traced the amounts of posts associated with different message content themes during the two weeks following the earthquake. Since online forum users relied on the message contents as their adaptive landscapes, the amount of posts related to distinct themes can indicate the focus of attention. The calculation of post amounts was limited to earthquake-related posts so that our analysis is focused on the crisis management activities triggered by the earthquake. Pre-earthquake message content dynamics were also traced to provide a baseline observation. In order to compare the message content dynamics before and after the earthquake, we converted the raw post counts to percentage values, with pre-earthquake percentages based on the total amount of posts submitted and post-earthquake values based on earthquake-related posts. Figures 3 and 4 depict forum message content dynamics (in percentage values) a week before and two weeks after the earthquake respectively.

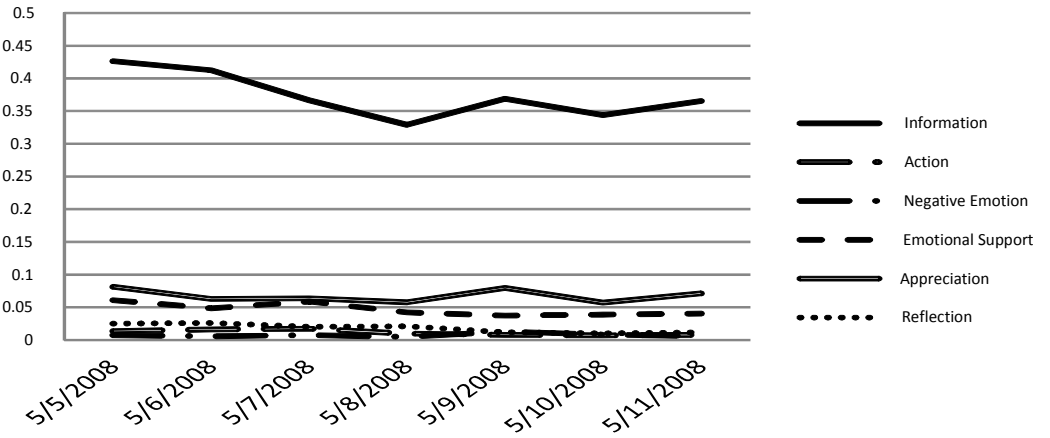

Figure 3. Pre-Earthquake Message Content Dynamics (based on all posts)

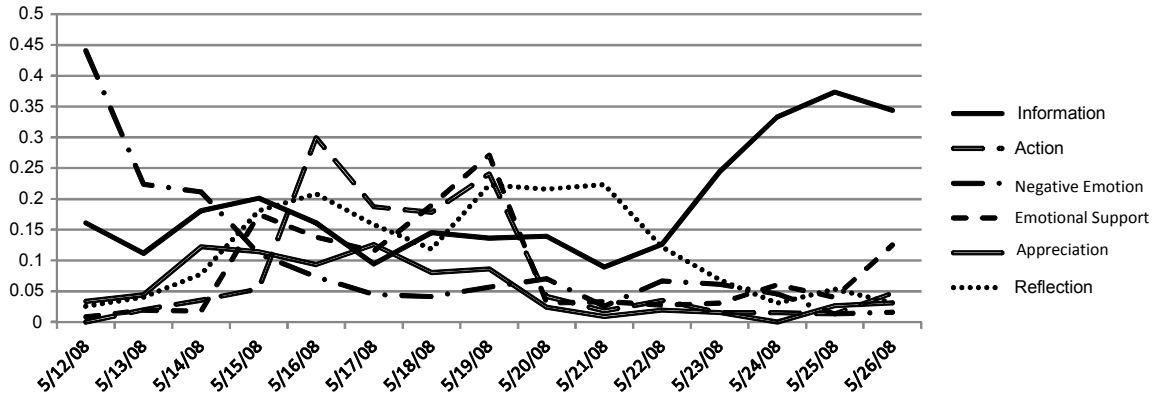

Figure 4. Post-Earthquake Message Content Dynamics (based on earthquake-related posts)

An inspection of Figures 3 and 4 reveals distinct message content dynamics. During the pre-earthquake period, message content was consistently dominated by informational activities. In contrast, there are rapid changes in the amounts of message content themes following the earthquake. In particular, negative emotion became the dominant theme during the first two days following the earthquake (May 12–13, 2008). Then informational, appreciative, and self-reflective posts became the salient message content (May 14–16, 2008). During the last two days of the first week, action related posts dominated the online forum (May 17–18, 2008). Eventually, informational posts resumed as the most salient message content theme (May 19–26, 2008). According to the temporal bracketing technique, we qualitatively decompose the data into four phases. Drawing on the traditional organizational crisis literature, these four phases are designated sensing, understanding, deciding, and evaluating.

We performed the Chow test (1960) in order to statistically verify the distinction among these phases (see Appendix C for detail). The dependent variable in this test is the percentage of earthquake-related posts among all posts since this percentage value indicates the overall activity level around earthquake-triggered organizational crisis management. The independent variables include the amounts of posts associated with different message content themes in the previous hour as well as the percentage of earthquake-related posts in the previous hour. F-tests reveal statistically significant breaks between the sensing and understanding phases ($F_{(8, 69)} = 2.11$, $p = 0.046$), between the understanding and deciding phases

($F_{(8, 87)} = 4.10$, $p = 0.0004$), and between the deciding and evaluating phases ($F_{(8, 197)} = 2.11$, $p = 0.037$). Meanwhile, a significant break is found between the time period before the earthquake and that after the earthquake ($F_{(7, 445)} = 2.77$, $p = 0.008$), confirming the noticeable change in message content dynamics following the earthquake.

These qualitative and quantitative findings together provide an answer to our first research question: there seems to be a sequence of phases following the earthquake, and this sequence of phases can be compared to the orderly crisis management phases prescribed by traditional organizational crisis management literature. Since each phase exhibits distinct message content dynamics, actualized IT affordances, and feedback loops, we will answer the remaining research questions in the context of each crisis management phase.

Phase 1: Sensing (May 12–13, 2008)

Message Content Dynamics

In the early afternoon of May 12, 2008, it was quiet on both FEU campuses since students were either in classes or in the dorm taking a break. The majority of FEU students had never experienced a massive earthquake. Naturally, students were shocked when the 8.0-magnitude earthquake rippled through both FEU campuses at 2:28 p.m. Ten minutes after the earthquake, the first earthquake-related thread was initiated on the online forum (see Table 5 for the English translation of the entire thread; see Appendix D for the original thread in Chinese). Posts included in this thread were typical of the message content submitted during the first few hours after the earthquake. They were dominated by expressions of shock and fright.

In the evening of May 12, FEU's central administration issued a brief announcement that all classes had been cancelled until May 14 for safety reasons and only essential services would be available. Not receiving further instruction regarding how to cope with the aftermath, some users expressed a feeling of being ignored and abandoned by the university. Negative emotions embedded in the posts shifted from the initial shock and fright to frustration and anxiety. Statements such as "I want to cry" and "I am paranoid" became increasingly prevalent.

Beginning on the second day (May 13), several users broke away from these negative emotions and initiated alternative discussion topics. For example, at 12:16 a.m., a user posted facts concerning the earthquake and some self-protection tips; at 5:26 a.m., a post was submitted to praise a FEU professor's bravery in protecting his students during the earthquake. These posts served as the seeds that ushered in a more diverse set of message content including informational, appreciative, and self-reflective themes.

Actualized IT Affordances

The massive earthquake and its numerous aftershocks prevented FEU students from assembling at a physical location. They also disrupted the usual campus-wide communication channels such as campus radio and campus TV broadcast. During the first few hours after the earthquake, the online forum became the primary venue for a large number of students to get in touch with each other and engage in real-time conversation. The decision of FEU central administration to open up the online forum to all FEU students further enabled students to take the action of assembling online and sharing their visions of what was going on. The number of unique user IDs submitting posts each hour grew steadily during the first two days after the earthquake (see Figure 5 for depiction).

Feedback Loop Dynamics

An examination of the message content dynamics and actualized IT affordance suggests two primary feedback loops during the sensing phase. On one hand, a post conveying negative emotions tended to stir up similar feelings in its readers and lead to additional posts with the negative emotion theme. As a user expressed, "the more I read these [earthquake] messages, the more frightened I am." This tendency could create a positive reinforcing loop of negative emotions in the online forum. On the other hand, the need to cope with fright and anxiety motivated decentralized organization members to gather online and actualize the assembling affordance of the online forum platform. As the assembling affordance enabled an increasing number of individuals to participate in the online conversation, the message content themes were diversified. These diverse themes formed a negative balancing loop to reduce negative emotions.

How the Three Dynamics Jointly Produce the Orderly Phases

Sensing a crisis that actually exists is critical for initializing an organizational crisis management process (Billings et al. 1980). The key challenge for self-organized crisis management is for decentralized organization members to converge on a perceived discrepancy between a standard state and experienced state of reality so that subsequent crisis manage-

Table 5. Discussion Thread of "Strong Earthquake Hit Campus"

Time	Post
2:37 p.m., 5/12	My heart is still pounding; during the earthquake life felt so fragile—thank Heaven I am alive!
2:39 p.m., 5/12	**Reply 1:** It is an earthquake, no kidding—humans are so trivial, oh, we are so lucky!
2: 54 p.m., 5/12	**Reply 2:** The computer in the next room was shaken to the floor.
2: 55 p.m., 5/12	**Reply 3:** Wow, you were still online during the earthquake? We ran out of the dorm; some people didn't even have clothes on
4: 41 p.m., 5/12	**Reply 4:** A number of guys ran out of the dorm in their underwear. Buildings have cracks. Things collapsed to the ground. A lot of people are standing on the open ground.
4:54 p.m., 5/12	**Reply 5:** I was reading on the fifth floor in the library. The whole building was rocking, everyone rushed down, people ran in an orderly fashion, my heart is still racing.
7:34 p.m., 5/12	**Reply 6:** The earthquake lasted a long time. It kept shaking…I was in the Sunshine Square. I heard it was really bad on the sixth floor. I wonder how those in Liulin [one of the two campuses] are doing, I can't get hold of any of them.
7:43 p.m., 5/12	**Reply 7:** I was alone in the dorm during the tremor. I've never felt that lonely, two minutes felt like several hours. I am lucky; so far 58 people have been confirmed dead in Chengdu :`(My condolences.
8:32 p.m., 5/12	**Reply 8:** It was truly frightening. I felt like the sky was falling down and I had nowhere to flee
8:38 p.m., 5/12	**Reply 9:** Just got a text message saying there may be aftershocks tonight. Be safe!!
9:08 p.m., 5/12	**Reply 10:** I am finally back to the dorm…:`( :`(:`(
9:24 p.m., 5/12	**Reply 11:** How will we survive tonight!!?
9:36 p.m., 5/12	**Reply 12:** Very shaky, earthquake for sure, I saw things collapse to the ground. The dorm is a mess. This is horrible.
10:41 p.m., 5/12	**Reply 13:** The earthquake [also] hit Liuling [a nearby county], but it wasn't very bad.
11:13 p.m., 5/12	**Reply 14:** I am reading this thread in the midst of another aftershock.
11:23 p.m., 5/12	**Reply 15:** This feels like a movie, no one will sleep tonight.
11:27 p.m., 5/12	**Reply 16:** My legs are still shaking, an earthquake ~so frightening!
12:06 a.m., 5/13	**Reply 17:** I escaped death, no fear no fear no fear.
1:05 a.m., 5/13	**Reply 18:** Several aftershocks just hit, but they were mild.
1:59 a.m., 5/13	**Reply 19:** Another aftershock.
2:00 a.m., 5/13	**Reply 20:** I want to cry.
2:03 a.m., 5/13	**Reply 21:** How will we live through tomorrow?
3:51 a.m., 5/13	**Reply 22:** Does anyone know the situation in Beichuan [a nearby county]? I hope my family there is ok.
12:02 a.m., 5/14	**Reply 23:** I also worry about Beichuan. I heard it was hit really bad there :`(devastated ~they lost all communications with the outside.

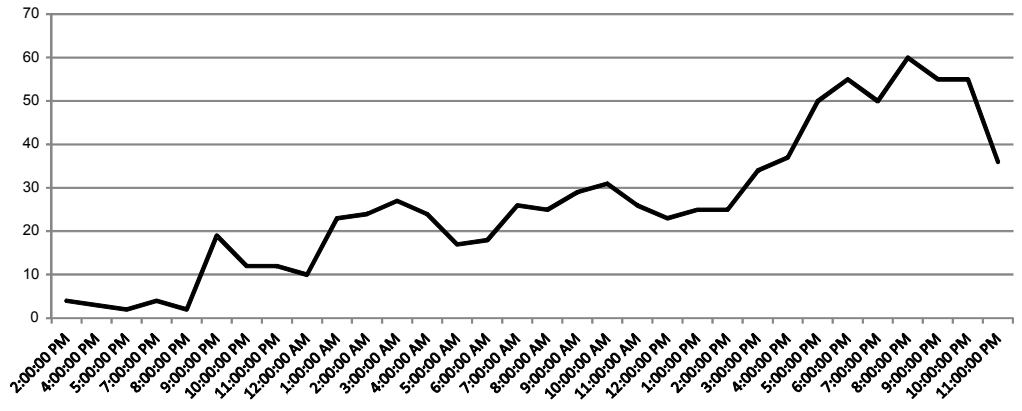

Figure 5. The Number of Unique Post Submitters per Hour During the Sensing Phase

ment phases are motivated (Hermann 1963; Turner 1976; Weick et al. 2005). The three order creation dynamics produced collective sensing of the organizational crisis by leveraging the fluid nature of online communities (Faraj et al. 2011). In particular, the message content dynamics triggered by the earthquake introduced resource fluctuations into FEU students' online adaptive landscapes. They energized the generative responses embodied by the actualized assembling affordance of the technology platform. The positive reinforcing feedback loop enabled sufficient accumulation of individual perceptions of the discrepancy between the normal and ongoing campus situations. FEU students quickly recognized the situation on campus as an organizational crisis since it was threatening, ambiguous, urgent, and indecisive (Hermann 1963; Nunamaker et al. 1989; Pearson and Clair 1998). The negative balancing loop created by the diverse views prevented the online forum from being trapped in the negative emotions. The tension of the positive and negative feedback loops helped to gradually move the self-organized online crisis management to the subsequent phase.

Phase 2: Understanding (May 14–15, 2008)

Message Content Dynamics

Following the message content dynamics of the sensing phase, posts submitted during the third and fourth days after the earthquake were characterized by increasingly diversified themes. A growing number of users posted factual information regarding the earthquake and the safety of campus buildings, or conveyed appreciation of others' actions during the earthquake and its aftermath (see Table 6 for examples). On May 14, FEU's central administration issued an announcement that earthquake structural engineers had evaluated and confirmed the safety of the campus buildings. The next day was scheduled as the class start date.[2] The announcement also provided earthquake and aftershock safety tips. This and other informational posts became the most visible message content theme during this phase (see Figure 4).

Meanwhile, the China Earthquake Administration recorded over 3,000 aftershocks in Wenchuan by the end of May 15, 2008. Some of these aftershocks were significant earthquakes themselves, ranging in the magnitude from 4.0 to 6.1. These aftershocks caused periodic bounce-back of negative emotions to the online forum. Furthermore, some users began to share doubtful truths or submit agitating complaints in the online forum (see Table 6 for examples). Although the amount of negative emotional posts in the forum leveled off during this phase, the online forum was still filled with confusion and frustration.

A message content theme that rapidly gained visibility during this phase was the self-reflection on FEU students' behaviors following the earthquake. As indicated by the examples in Table 6, these self-reflective discussions displayed a collective identity of FEU students that they should be disciplined, considerate, rational, and responsible even during a crisis. Since most of the informational posts concerned disaster relief needs and volunteer opportunities, these self-reflective discussions correspondingly shifted to the role of FEU students in disaster relief efforts. These discussions enriched the collective identity of FEU students by recognizing them as helpers rather than victims of the earthquake. A post submitted on May 15 represented these self-reflective discussions, "We are safe and sound. Stop worrying. Stop complaining. Let's think about what we can do for those in need." This collective identity was subsequently cited as the rationale for offering compassion to earthquake victims and dismissing worries over doubtful truths, complaints concerning the inconvenience during the aftermath, and fear of aftershocks. Figure 4 shows that by the end of May 15, negative emotions declined substantially while informational, self-reflective, and emotional support topics dominated online conversations.

Actualized IT Affordances

Facing the diversified message content mixed with truths and untruths, online forum members saw the need to verify the accuracy of information and claims in the posts. The URL and attachment features of the online forum platform were frequently used to provide external evidence for substantiating message content. For example, in a discussion thread concerned with drinking water contamination, a reply included a URL to the announcement about drinking water safety on the municipal government website in order to dismiss this concern as unfounded. Similarly, when reflecting on the collective identify of FEU students, a user attached a photo of FEU students' camping out during the first night after the earthquake in order to back up his/her claim. These uses of the forum features in effect actualized the verifying affordance of the technology platform.

Feedback Loop Dynamics

The variety of message content in the online forum exposed FEU students to different perspectives in making sense of the earthquake and its aftermath. The recurrent applications of these different perspectives to online interactions could pro-

[2] On May 15, the class start date was pushed back to May 26 due to frequent aftershocks.

Table 6. Example Threads during May 13–15, 2008

General Topic	Time of Initial Post	Thread Topic	Thread Content Summary
Doubtful Truth	8: 33 a.m., 5/14/08	Has anyone heard about an explosion in a nearby chemical plant? (toxic gas!)	The initial post shared unconfirmed news concerning an explosion in a nearby chemical plant. Its 19 replies brought in information from different sources and eventually clarified that there was in fact a liquid ammonia leak from a chemical plant, but it had been controlled.
Agitating Complaint	9: 40 p.m., 5/13/08	School management, who do you think we are?	The initial post complained that the services provided by the school management during the aftermath were not worth the tuition. While some concurred with the initial post, the majority of its 173 replies viewed this complaint as selfish and inconsiderate.
Information	4:55 p.m., 5/13/08	A synthesis of earthquake information	The initial post shared information and photos concerning the earthquake's cause, epicenter, damage, and casualties; its 14 replies commented on or updated this information.
Appreciation	6: 20 p.m., 5/14/08	Radio/Network/Security/Food/Hospital/ Administration	The initial post praised the faculty and staff who continued working on campus although their own families also needed them. Its 56 replies largely concurred with this sentiment.
Self-Reflection	6:18 p.m., 5/14/08	Some thought concerning FEU students	The initial post described FEU students as disciplined and orderly during the earthquake. Its 74 replies reflected on the behaviors of FEU students and faculty or staff. Several replies pointed out inappropriate behaviors such as complaining and spreading untruths.

duce a positive reinforcing feedback loop that further increased the diversity of message content themes. However, the diversification of online forum discussions opened the door to invalid content such as untruths and agitating complaints. In response to the confusion around this invalid content, forum users actualized the verifying affordance so that they could direct attention to truthful information and productive discussions. This led to a balancing feedback loop that checked the variation of message themes.

How the Three Dynamics Jointly Produce the Orderly Phases

In an organizational crisis management process, the main challenge for this second phase is to share timely and accurate information among decision makers so that they understand the nature and impact of the crisis situation. In addition, FEU students needed to achieve a consensus regarding their role (victims or helpers) in this self-organized online crisis management context. The message content dynamics, by bringing in a mix of inconsistent perspectives to the online forum, stimulated forum users' efforts in understanding the situation. Their efforts led to the actualization of the verifying affordance which in turn can reduce the sharing of doubtful truths (Oh et al. 2013). The positive feedback loop of diverse message content sustained the motivation for individual members to actively seek information and share opinions. It enabled the transition from the sensing to the understanding phase. The balancing feedback loop associated with the verifying affordance ensured the timeliness and truthfulness of the understanding gained during this phase. With the information about the crisis situation and an understanding of their role in this situation, forum users moved to the deciding phase.

Phase 3: Deciding (May 16–18, 2008)

Message Content Dynamics

As forum users came to understand the ongoing situation and identify themselves as helpers in disaster relief efforts, discussions regarding what actions they should take increased rapidly between May 16 and 17 (see Figure 4). A significant focus of these posts was proposing and selecting action proposals for FEU students' disaster relief efforts. Users submitted ideas such as donating camping tents, organizing charity sales, or biking to the worst-hit regions in order to help with rescue and rebuilding. These ideas were commented on or supported by subsequent posts. Following these proposals, forum users began to discuss implementation plans of

the selected disaster relief actions. Later some users reported their experiences in the implemented disaster relief actions. While other themes still attracted new posts, action became the dominant message content theme in this third phase (see Figure 4).

Actualized IT Affordance

With the rapid accumulation of action proposals, forum users faced the challenge of selecting the best ideas. They coped with this challenge by actualizing the metavoicing affordance of the forum platform (Majchrzak et al. 2013). Forum users submitted replies with a single word "ding" (similar to "Like" on Facebook) to proposals they would support. According to the ranking feature of the forum platform, the discussion threads that received the most replies were listed on top. The "ding" replies therefore acted as votes that enabled the most popular ideas to surface on the online forum.

In order to carry out the selected action proposals, FEU students needed to self-organize into volunteer teams and decide on the details of these actions. This required more one-to-one interconnections than many-to-many discussions. Between May 16 and 18, a number of posts included an attention line addressed to other specific users. Meanwhile, the quote feature was commonly used to link action details embedded in different posts. These behaviors embody the actualization of the associating affordance.

Feedback Loop Dynamics

The rapid increase in action-related message content indicates a positive reinforcing loop. Indeed, observations from the online forum show that action proposals invited subsequent comments and responses. They also inspired new action ideas. As the variety of proposals became overwhelming, the metavoicing affordance was actualized to help the online forum to prune the action-related message content. This metavoicing affordance could produce a negative balancing loop that prevented excessive multiplication of action discussions. Meanwhile, the associating affordance enabled online coordination and communication among disaster relief action participants. It could create another positive reinforcing loop for action-related content.

How the Three Dynamics Jointly Produce the Orderly Phases

Decision making is a difficult task in organizational crisis management because there is a lack of existing solutions to draw on (Milburn 1972) and it is confined by organizational culture and goals (Hermann 1963; Pearson and Clair 1998). At FEU, the three order creation dynamics tapped into the "wisdom of the crowd" in deciding crisis response actions. The message content dynamics around action proposals mobilized organization members to contribute to a solution repertoire. The positive reinforcing feedback loop ensured richness in this solution repertoire. The negative balancing loop of the metavoicing affordance allowed timely convergence to a few favored action proposals. Since FEU students had gained an understanding of their collective identity in the previous phase, their action proposals and votes were likely to align with organizational culture and goals.

Phase 4: Evaluating (May 19–26, 2008)

Message Content Dynamics

May 19, 20, and 21 were designated as National Mourning Days for the earthquake victims by the Chinese Central Government in Beijing. The main theme of the posts submitted on these days was emotional support to the National Mourning Days (see Figure 4). Examples of these emotional support posts include mourning articles or poems for individuals who perished in the earthquake. After the National Mourning Days, posts submitted to the online forum began to convey a sense of closure. Forum users wrote self-reflective posts that consisted of personal memories and evaluations of the past seven days. As one of the posts said,

> The earthquake has become the past. We should go back to our normal life. As students our responsibility is to study. Stop whining about the aftershocks and start preparing for finals. It's time to clean the dorms and resume schoolwork. Save your feelings and spend your time on books. That's what we should do now.

The earthquake-related posts submitted between May 22 to 26 were primarily information updates concerning aftershocks or reports of ongoing disaster relief activities.

Actualized IT Affordance

Similar to the deciding phase, metavoicing and associating were the two primary affordances actualized in this last phase. In addition to their role in ongoing disaster relief actions, these technology affordances enabled a large number of decentralized FEU students to collaboratively evaluate their self-organized crisis management process. In particular, the metavoicing affordance allowed the majority view to surface from their decentralized evaluation process. The associating

affordance helped users to comment on particular statements from others' posts and integrate statements distributed in different posts into coherent lessons about their crisis management activities.

Feedback Loop Dynamics

The metavoicing affordance helped to maintain visibility of earthquake-related discussion threads by accumulating "ding" replies. This led to a positive reinforcing loop for ongoing crisis management activities. The associating affordance adds to this reinforcing loop by enabling users to engage in reflection and evaluation of past crisis management experiences. On the other hand, since many new posts submitted during this phase attempted to bring the crisis management activities to closure, they served to shift forum users' attention away from the earthquake and its aftermath. This produced a negative balancing loop that reduced earthquake-related message content.

How the Three Dynamics Jointly Produce the Orderly Phases

The main goal of the last phase in crisis management is to extract learning from the crisis. This requires the recollection of behaviors and impact during the crisis management process. The message content dynamics, particularly personal memories and evaluations, elicited this recollection from those directly involved in the crisis situation. The metavoicing affordance and associating affordance helped to ensure effective integration of scattered personal accounts into useful lessons. With the decreasing number of aftershocks and approaching class restart date, the earthquake was no longer an immediate threat to FEU students. This, coupled with a sense of closure conveyed by the message content, produced feedback loops that crowded out earthquake-related posts and moved the online forum back to its normal state.

Summary and Further Analysis

This study set out to examine the viability, inner-working, and the role of IT in a self-organized online crisis management process. Guided by a CAS-based research model, our analysis provided a detailed account of message content dynamics, actualized IT affordances, and feedback loops that resulted from FEU students' online interactions. Although none of the online forum users showed an intention to orchestrate their online interactions toward an orderly process, the aggregate of their posts manifested the sensing–understanding–deciding–evaluating process typical of effective organizational crisis management. These findings speak to the power of individual adaptations in the fluid online community environment as a new, IT-enabled source of organizational order.

To IS researchers, a particularly interesting finding from this study is the role of actualized IT affordances in self-organized online crisis management. To gain further insight into this role, we conducted time series analyses of the immediate impact of IT affordances on subsequent message content dynamics. Data from the entire data collection window was used for this analysis. An *hour* is defined as the unit of time lag. The amount of posts related to each message content theme was regressed on the amounts of posts embodying the actualized IT affordances in the previous hour. The amount of posts related to each message content theme in the previous hour and phase dummies (the pre-earthquake phase was omitted to prevent the dummy variable trap) were included as control variables (see Appendix E for detailed results). Results substantiate our earlier qualitative findings that the assembling affordance increased the subsequent negative emotion (β = 0.056, p = 0.047) and information posts (β = 0.333, $p < 0.001$); the verifying affordance facilitated subsequent information (β = 0.287, p = 0.003) and self-reflection (β = 0.091, p = 0.007) content; the metavoicing affordance had a "pruning" effect on subsequent action-related posts (β = -0.078, p = 0.004); and the associating affordance increased subsequent action-related (β = 0.301, p = 0.003) and self-reflection (β = 0.307, p = 0.007) content.

Discussion

Implications for Traditional Organizational Crisis Management Research

A fundamental assumption of traditional organizational crisis management is that macro-level order requires micro-level order-seeking behaviors. This study suggests a new possibility: organizational order can arise unintentionally from spontaneous and seemingly disorganized actions and interactions of ordinary members. This new possibility, namely self-organization, can be particularly powerful in an online community where input from a large number of participants can be quickly harnessed and channeled toward an orderly crisis management process. The conflict between this new practice of crisis management and the traditional assumption of crisis management research opens up several opportunities to expand the organizational crisis management literature.

- Develop multilevel perspectives: in a self-organization process, micro-level behaviors often differ in kind and scale from macro-level patterns and outcomes. Our

findings show that individual members' expressions of fear and anxiety in FEU's online forum in effect stimulated the sensing phase in crisis management. Similarly, the understanding phase was energized by the individual-level uncertainties caused by doubtful truths, complaints, and aftershocks. A multilevel perspective allows researchers to reconcile the discrepancy between the micro and the macro, and obtain new insights regarding how surprises, stress, and uncertainties (something to be minimized in traditional crisis management practices) can be harnessed as resource fluctuations that serve to energize self-organized online crisis management.

- Model causal relationships as dynamic feedback loops: traditional crisis management research tends to focus on selected psychological, social-political, and structural factors while assuming away the complex web of causal links among these factors in an organizational crisis. Our examination of the feedback loop dynamics at FEU shows that the simultaneous unfolding of positive and negative feedback loops helped to balance stability and variability of system-level behaviors. These feedback loops can generate nonlinear effects of individual actions on organizational behavioral patterns. A new question for future work is how feedback loops among psychological, social-political, and structural factors serve to regulate adaptations in self-organized online crisis management.

- Make technology more central to organizational crisis management theories: this study shows that IT systems are no longer discrete material entities that support information manipulation and group decision making. The assembling, verifying, metavoicing, and associating affordances of FEU's online forum were actualized as forum users continuously recombined online actions that were conducive to solving their issues at hand. These affordances then shaped subsequent online actions. Future organizational crisis management can explicitly conceptualize technology platforms as an evolving and generative force in self-organized online crisis management and examine the bidirectional relationship between IT affordances and human actions.

Implications for Online Community Research

Online community research, being relatively new, is still searching for fruitful angles to grasp the fundamental difference between online communities and traditional forms of communication and collaboration (Majchrzak 2009). Since self-organization in online communities manifests organizing dynamics distinct from those in traditional communication and collaboration platforms, it provides a promising new angle to rethink the key constructs of existing online community research: motivation, structural mechanism, and governance (for a brief review, see Faraj et al. 2011).

- From motivation to adaptive tension: the stable motivational factors identified in prior research may not fully explain the driving force behind dynamic actions and interactions in self-organization. Our findings highlight the role of adaptive tension in mobilizing the ebb and flow of message content themes. Adaptive tension is the discrepancy between where individual agents are and where they want to be in an adaptive landscape (McKelvey 2001). It can arise in an online community when a novel and more productive message theme is introduced. For example, when FEU's online forum was dominated by negative emotions, the introduction of informational and appreciative content exposed participants to an objective and positive perspective regarding the earthquake. This in turn drove the online crisis management process from the sensing to the understanding phase. An examination of adaptive tension shifts research focus from individual characteristics to online message valences. This can reveal unique behavioral drivers in online communities.

- From structural mechanisms to order creation dynamics: structural mechanisms (e.g., subforum categorization or membership size) seek to create order from an orderly setup while order creation dynamics give rise to self-organized order through spontaneous actions and interactions. The latter is more intriguing but less understood. This study has taken the first step in defining message content dynamics, feedback loops, and actualized IT affordances as the manifestation of order creation dynamics in an online community. These order creation dynamics can direct future research toward the fundamental characteristic of online community—fluidity (Faraj et al. 2011)—and usher in new insights regarding the unique root of order in online communities.

- From governance to self-organized aggregation: current online governance research emphasizes formal leadership roles and rules (e.g., O'Mahony and Ferraro 2007). Our study suggests the possibility to reframe governance as a self-organized aggregation process. FEU's online crisis management did not surface a strong leader. Instead, ordinary members initiated, orchestrated, and eventually dissolved a crisis management process by engaging in the order creation dynamics. A self-organization lens brings ordinary online community members to the center of research, inviting new theorization of governance-related concepts such as power, authority, and decision-making.

Implications for Research Design and Methods

Future work directed at self-organization requires theories and analytical approaches suited for examining dynamics, serendipity, decentralized efforts, and causal paths from individual-level actions to collective-level outcomes. This study demonstrates the value of CAS theory in untangling the complexity of an episode of self-organized online crisis management process. Recent theoretical developments regarding tensions in online communities (Faraj et al. 2011), IT affordances in organizations (Volkoff and Strong 2013), and IT affordances in social media (Majchrzak et al. 2013) are examples of other useful lenses for understanding self-organized online crisis management. CAS and these other theoretical developments taken together illuminate new research designs directed at the role of IT artifacts in configural system uses wherein continuous adaptations of heterogeneous individuals produce orderly system use patterns and outcomes on the collective level (Burton-Jones and Gallivan 2007).

An analytical approach that is particularly suited to the dynamic and multilevel nature of online crisis management is to learn from "samples of one or fewer" (March et al. 1991). It is not surprising that most of the online crisis management studies to date have employed case analysis, as this method offers the analytical advantage of extracting rich descriptions, interpretations, and preferences from limited historical experience. Future work can explore the other form of learning from samples of one or few, namely simulating experience (March et al. 1991). This method allows one to learn from a distribution of possible events extrapolated from a series of realized events. With today's computational power, researchers can conduct computer simulations to extend learning from a few limited versions of reality.

Implications for Crisis Management Practice

This study indicates the potential of online self-organization as a new source of orderly management activities. Online self-organization can complement the traditional centralized crisis management approach. Managers seeking to leverage this organizing process are required to *harness* and *respect* rather than plan and control adaptive behaviors of employees. This study provides the following guidelines:

- Before a crisis: first of all, managers need to foster an organizational culture that values ordinary members as the locus of intelligence. Managers need to provide an online community platform that is conducive to the IT affordances: assembling, verifying, metavoicing, and associating. The actualization of these affordances can be facilitated by the new generation of online community technology such as mobile applications for enhancing the assembling affordance, a "mash-up" feature to facilitate the verifying affordance, a voting capability for the metavoicing affordance, and a tag feature for the associating affordance. In addition, managers should create a legitimating online environment for ordinary organization members to contribute diverse views. Both our and previous research indicate that diverse perspectives are critical to prevent a self-organized discourse from being trapped in the homogeneous views of a small group of decision makers (Page 2007).

- During a crisis: managers can monitor and steer the message content themes in order to mobilize the online self-organization in a productive direction. The message content themes (e.g., negative emotions, information, etc.) that surfaced from our data analysis provide managers with a scheme for tracing resource fluctuations (Faraj et al. 2011) in organization members' online adaptive landscapes. This study helps managers to understand the nonlinear feedback loops among message content themes and actualized IT affordances. Our data analysis shows that seemingly detrimental factors can have second-order beneficial effects (e.g., negative emotions eventually stimulated the inflow of diverse perspectives). Meanwhile, valued resources (e.g., information and action proposals) still need to be regulated in order to ensure an efficient management process. An understanding of the nonlinear nature of causal loops among the myriad of factors in organizational crisis management can prevent unforeseeable consequences of managerial interventions in self-organized online crisis management.

- After a crisis: the dynamic nature of self-organization merits a post-crisis evaluation that focuses on the time-dependent contour of a self-organized crisis management process. This study has demonstrated the use of qualitative (temporal bracketing) and quantitative (Chow test) methods to identify phases embedded in a self-organized crisis management process. If phases emerging from a particular incidence of self-organization match the orderly phases described by the crisis management literature, managers can gain confidence in their organizational-level efficiency. On the other hand, a different sequence of phases observed in the field can reveal novel organizing logic for an orderly crisis management process or expose inefficiencies in self-organization. In addition, managers can heed ordinary

members' memories and evaluations of their crisis management activities in the online community in order to gain learning from individual-level perspectives.

Limitations

The findings and implications of this study are limited by the fact that we did not directly experience the self-organized online crisis management process at the research site. They are based on archival data located on the campus online forum. This data presented a rich yet partial view of actions and interactions triggered by the earthquake. An important perspective missing from our data is FEU's centrally organized offline crisis management activities. This raises the concern that the orderly crisis management phases might be a simple reflection of the centralized management activities in the offline world rather than consequences of online actions and interactions. With little information from the online forum regarding the crisis management activities of FEU's administration, we searched and found an unpublished crisis management self-evaluation study sponsored by FEU's administration. This study concludes that the centrally organized crisis management activities at FEU were unsystematic and insufficient in obtaining awareness, participation, and satisfaction from FEU's students. Although offline crisis management activities might have influenced the discourse in FEU's online forum, their unsystematic and insufficient nature made it possible for online self-organization to play an important complementary role in enacting the orderly crisis management phases.

In addition, the power of online self-organization can depend on the organizing challenge at hand. A crisis situation caused by a natural disaster may be constructive to online self-organization since the orderly crisis management phases are the widely recognized, sensible responses. In contexts where an "obvious" course of actions does not exist, system-level orderly actions may not surface promptly or they may unfold in ways that do not correspond to management practices in traditional offline contexts.

While acknowledging these limitations, we believe that observations from our research site portray a modern organization whose members are increasingly connected by information and communication technologies. Ordinary members' self-organization in online communities has become a nontrivial source of organizational order. It can complement the traditional offline management activities and enhance an organization's efficacy in recovering and readjusting in a crisis situation.

Conclusion

The Chinese term for crisis, *wei ji*, is a combination of two words: *danger* and *opportunity* (Fink 1986). At our research site, the danger of a massive earthquake provided an opportunity for those young college students to grow up and act responsibly. For researchers, a study of this crisis offered a valuable opportunity to rethink possibilities offered by today's technology for organizational crisis management. In addition to designing order into a system, this study suggests that it is possible to evolve order out of a system of computer-mediated individuals. A self-organization approach centered on ordinary organization members can open up new research horizons for both organizational crisis management and online community research.

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RESEARCH ARTICLE

HARNESSING THE POWER OF SELF-ORGANIZATION IN AN ONLINE COMMUNITY DURING ORGANIZATIONAL CRISIS

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Appendix A

Technical Specifications of the Online Forum

The technology platform of FEU's online forum is an open source software product called Discuz!NT. As of May 26, 2008, the version of Discuz!NT powering FEU's online forum was Discuz!NT 2.1. This version provided basic online message board features including subforums, user profiles, photo uploading, and file attachments. Compared to today's online forums, Discuz!NT 2.1 did not have a tag feature for content association, a private message feature for one-to-one communication, an automated alert feature for triggered attending, or a follow feature for network building (according to the DisCuz!NT version history on http://zh.wikipedia.org/wiki/Discuz!NT).

Appendix B

Coding Scheme Development

In developing the coding scheme for content themes, we first identified existing content categories from the online community research (see Table 1 in the main article for the list of research articles). This step yielded the content categories listed in Table B1. Then, the first author applied the existing content categories to an initial round of coding. This exercise quickly indicated the need to revise existing content categories according to the research context and research questions of our study. For example, disease outbreak information (Palen et al. 2007; Salathé et al. 2013) does not apply to the earthquake context of our research site. Meanwhile, negative emotions should be added as a separate content theme because it captures message content dynamics and feedback loop dynamics immediately after the earthquake. Following the iterative comparison and grouping process of the open coding technique (Corbin and Strauss 1990), we eliminated content categories that do not apply to our study, aggregated content categories that reveal similar insights, and added new content categories that are salient in our data. In particular, while previous studies identified a number of information-related content categories, we aggregate these into a single category for information because information seeking, provision, synthesizing, and curation exhibit similar distribution patterns during our data collection window. They offer similar theoretical insights regarding the order creation dynamics. Meanwhile, our coding scheme includes two categories of emotion-related content: negative emotions and emotional support. These two types of emotions showed distinct changing patterns

following the earthquake and revealed different feedback loop dynamics. We also recognize two types of opinion-related content categories from our data: appreciation and self-reflection. These two content categories are differentiated by their changing patterns and theoretical insights.

Table B1. Adaptation of Existing Content Categories to Our Study

Existing Categories	Source	Related Categories in Our Study
Disease outbreak information	Palen et al. 2007; Salathé et al. 2013	Not included
Information seeking	Palen et al. 2007; Palen et al. 2009	• Information
Information provision	Palen et al. 2007; Palen et al. 2009; Starbird et al. 2010	
Information synthesizing	Starbird et al. 2010	
Information curation	Starbird et al. 2010	
Geo-location information	Majchrzak and More 2011; Vieweg et al. 2010	
Situational information	Li and Rao 2010; Majchrzak and More 2011; Vieweg et al. 2010	
Actions	Qu et al. 2009; Salathé et al. 2013	• Action
Emotions	Qu et al. 2009; Salathé et al. 2013	• Negative emotions • Emotional support
Opinions	Qu et al. 2009	• Appreciation • Reflection

Appendix C

Chow Test Results

The Chow test (1960) is commonly used to assess whether certain statistical relationships remain stable in two periods of time. It employs an F-test to decide whether subsets of coefficients in two regressions are equal. We took four steps in applying the Chow test to our data analysis. Our time series data are lagged *hourly*. First, we selected break points between different phases. The hour when the earthquake occurred (2 p.m. on May 12, 2008) was a natural break point between the precrisis and post-crisis periods. For the remaining break points, we first narrowed down the selection to a few possible hours according to the message content dynamics depicted in Figure 4 of the paper. Then following Chiles et al. (2004) we used a trial-and-error approach to identify the particular break hour between phase 1 and 2 (6 a.m. on May 14), between phase 2 and 3 (5 a.m. on May 16), and between phase 3 and 4 (3 a.m. on May 19).

Second, we created five dummy variables corresponding to the five phases in the time series data: precrisis, phase 1 (sensing), phase 2 (understanding), phase 3 (deciding), and phase 4 (concluding). We also generated the interaction terms of each phase dummy variable and the one-hour lag of the independent variables and dependent variable. As explained in the paper, the independent variables include the amounts of posts associated with different message content themes in the previous hour as well as the percentage of earthquake-related posts in the previous hour. The dependent variable is the percentage of earthquake-related posts among all posts. This regression model captures the relationship between message content dynamics and the overall activity level of self-organized online crisis management.

Third, we conducted four regressions between the dependent variable and the independent variables along with the interaction terms and the phase dummy variable. Each regression used data from two adjacent phases. The regression results are displayed in Table C1. Finally, we ran an F-test on the coefficients for the interaction terms and the phase dummy variable from each regression. The F-test results are presented in the last row of Table C1. All four tests indicate significant breaks between different online crisis management phases.

Table C1. Chow Test for Structural Breaks in Time Series Data (D.V. = Percentage of earthquake related posts among all posts; t = hour)

	Before and After Earthquake (n = 460)	Between Phase 1 & 2 (n = 85)	Between Phase 2 & 3 (n = 103)	Between Phase 3 & 4 (n = 213)
	β (p)	***β (p)***	***β (p)***	***β (p)***
Constant	-0.007 (0.615)	0.322 (0.001)	0.487 (0.002)	0.030 (0.655)
% Earthquake $_{t-1}$	0.884 (< 0.001)	0.593 (< 0.001)	0.516 (0.002)	0.757 (< 0.001)
Negative emotion $_{t-1}$	0.118 (0.001)	-0.024 (0.760)	0.081 (0.657)	0.418 (0.154)
Information $_{t-1}$	0.078 (0.003)	0.208 (0.018)	-0.586 (0.063)	-0.079 (0.759)
Appreciation $_{t-1}$	0.240 (0.008)	0.402 (0.550)	-0.588 (0.076)	-0.175 (0.374)
Emotional support $_{t-1}$	-0.030 (0.573)	0.362 (0.733)	-0.855 (0.005)	0.195 (0.345)
Self-reflection $_{t-1}$	0.061 (0.227)	-0.985 (0.080)	1.193 (0.002)	-0.040 (0.812)
Action $_{t-1}$	0.123 (0.012)	-0.089 (0.903)	-0.158 (0.438)	0.389 (0.001)
Phase dummy	0.007 (0.760)	0.165 (0.366)	-0.458 (0.010)	-0.019 (0.777)
Phase*%Earthquake $_{t-1}$	Dropped	-0.078 (0.707)	0.241 (0.193)	0.065 (0.465)
Phase*Negative emotion $_{t-1}$	-0.118 (0.905)	0.105 (0.594)	0.337 (0.387)	-0.444 (0.143)
Phase*Information $_{t-1}$	-0.078 (0.030)	-0.794 (0.016)	0.508 (0.244)	0.073 (0.778)
Phase*Appreciation $_{t-1}$	-0.240 (0.043)	-0.990 (0.187)	0.413 (0.305)	0.463 (0.065)
Phase*Emotional support $_{t-1}$	0.030 (0.834)	-1.217 (0.272)	1.050 (0.008)	-0.186 (0.392)
Phase*Self-reflection $_{t-1}$	-0.061 (0.685)	2.178 (0.002)	-1.233 (0.005)	0.158 (0.385)
Phase*Action $_{t-1}$	-0.122 (0.535)	-0.069 (0.928)	0.547 (0.026)	-0.360 (0.016)
Chow test	F (7, 445) = 2.77, ***p* = 0.008**	F (8, 69) = 2.11, ***p* = 0.046**	F (8, 87) = 4.10, ***p* = 0.0004**	F (8, 197) = 2.11, ***p* = 0.037**

Appendix D

The First Post-Earthquake Discussion Thread in Chinese

Table D1 below displays the discussion thread "Strong Earthquake Hit Campus" in the original Chinese language. Each entry corresponds to a translated message in Table 5 of the manuscript.

Table D1. The First Post-Earthquake Discussion Thread in Chinese

发帖时间; 帖子主题	帖子内容
2:37 p.m., 5/12/08; 刚才光华有强烈的地震感	现在我的心还在跳~~~在震感最强烈的那一刻~~我感受到了人生命的渺小~感谢上天~~GOD
2:39 p.m., 5/12/08; 回复：	是地震，没错~~真的是地震的感觉~~~ 生命的脆弱，人的渺小，呃~~~我们真的是很幸运~~
2: 54 p.m., 5/12/08; 回复：	隔壁的电脑都震到地上去了
2: 55 p.m., 5/12/08; 回复：	楼上两位兄弟厉害，还能坚守岗位哦~ 我们爬起来就往下面跑~~ 有的人连衣服都没穿
4: 41 p.m., 5/12/08; 回复：	数名内裤男冲出宿舍，明德楼有数出裂痕和坠落的碎物 操场上停留很多人
4:54 p.m., 5/12/08; 回复：	我在文献中心五楼看书,感觉整个楼都摇摇入坠了，然后就是大家一起往外跑，跑的还不算乱，都还有点秩序吧，出来后心都还跳的。。。。。
7:34 p.m., 5/12/08; 回复：	地震时间好长哦！一直晃了好久。。但是我当时人在阳光广场，听说6楼的很惨！不知道柳林的同学们怎么样了，我在群上呼唤了，但是显然他们被疏散离开寝室了，一个都没在.....
7:43 p.m., 5/12/08; 回复：	地震的时候一个人在宿舍~感受到了前所未有的孤独，2分钟似乎过去了N个小时~~ 命大啊~~截至目前~~大成都死亡58人~~:'(默哀~~~
8:32 p.m., 5/12/08; 回复：	实在吓人，觉得天地要塌了 有一种怎么样都逃脱不了的感觉。
8:38 p.m., 5/12/08; 回复：	收到短信说晚上可能还有余震 大家注意安全啊！！
9:08 p.m., 5/12/08; 回复：	终于回到寝室了。。。:'(:'(:'(
9:24 p.m., 5/12/08; 回复：	今晚怎么熬哦！！
9:36 p.m., 5/12/08; 回复：	很晃很地震. 刚刚一路上来.看到被晃跨的一些小地方. 看到大家凌乱的寝室. 觉得真的恍若隔世.
10:41 p.m., 5/12/08; 回复：	六零也有很强烈的感觉，毕竟温江离汶川较近啊，没事都还好
11:13 p.m., 5/12/08; 回复：	在余震中，看到了这个帖子！
11:23 p.m., 5/12/08; 回复：	像亲历电影画面，估计今夜无人入眠了
11:27 p.m., 5/12/08; 回复：	现在腿还是软的，地震～吓人啊！
12:06 a.m., 5/13/08; 回复：	今天有死里逃生的感觉，不怕不怕不怕。
1:05 a.m., 5/13/08; 回复：	刚才又小的余震了几次，不过都很小，大的已经过去了
1:59 a.m., 5/13/08; 回复：	又震了
2:00 a.m., 5/13/08; 回复：	我想哭
2:03 a.m., 5/13/08; 回复：	明天怎么过
3:51 a.m., 5/13/08; 回复：	知道不知道绵阳北川怎样啊?怎么没有人过去看看呢,我急于想要知道那里的情况,西望我的家人没有出事
12:02 a.m., 5/14/08; 回复：	我也非常想知道北川的具体情况~~~北川这次遭的很严重很严重~~~:'(心痛~~ 所有联系方式均无法联系到那边~~~

Appendix E

Time Series Analysis of IT Affordances' Immediate Impact

The time series data is lagged hourly. The phase dummy variables created for the Chow test were used in this analysis. The pre-crisis phase dummy variable is omitted from the analysis to prevent dummy variable trap.

Table E1. Effects of IT Affordances on Message Content Themes (N = 460)

D.V. / I.V.	Negative Emotion	Information	Appreciation	Self-Reflection	Emotional Support	Action
D.V. $_{(t-1)}$	0.446 ($p < 0.001$)	0.068 ($p = 0.160$)	0.024 ($p = 0.606$)	0.288 ($p < 0.001$)	0.501 ($p < 0.001$)	0.427 ($p < 0.001$)
Sensing phase dummy	0.189 ($p < 0.001$)	-0.305 ($p < 0.001$)	-0.378 ($p = 0.010$)	0.025 ($p = 0.170$)	-0.013 ($p = 0.441$)	0.009 ($p = 0.573$)
Understanding phase dummy	0.069 ($p < 0.001$)	-0.295 ($p < 0.001$)	0.025 ($p = 0.058$)	0.083 ($p < 0.001$)	0.027 ($p = 0.089$)	0.049 ($p = 0.001$)
Deciding phase dummy	0.013 ($p = 0.455$)	-0.368 ($p < 0.001$)	0.028 ($p = 0.029$)	0.098 ($p < 0.001$)	0.063 ($p < 0.001$)	0.133 ($p < 0.001$)
Concluding phase dummy	-0.0004 ($p = 0.979$)	-0.381 ($p < 0.001$)	-0.056 ($p < 0.001$)	0.083 ($p < 0.001$)	0.019 ($p = 0.193$)	0.025 ($p = 0.058$)
Assembling $_{(t-1)}$	0.056 ($p = 0.047$)	0.333 ($p < 0.001$)	-0.006 ($p = 0.754$)	-0.033 ($p = 0.191$)	0.014 ($p = 0.570$)	0.012 ($p = 0.590$)
Verifying $_{(t-1)}$	-0.005 ($p = 0.891$)	0.287 ($p = 0.003$)	-0.042 ($p = 0.128$)	0.091 ($p = 0.007$)	-0.015 ($p = 0.648$)	0.010 ($p = 0.733$)
Metavoicing $_{(t-1)}$	0.042 ($p = 0.209$)	-0.100 ($p = 0.238$)	-0.040 ($p = 0.110$)	-0.036 ($p = 0.241$)	-0.218 ($p < 0.001$)	-0.078 ($p = 0.004$)
Associating $_{(t-1)}$	0.096 ($p = 0.445$)	-0.257 ($p = 0.414$)	-0.259 ($p = 0.005$)	0.307 ($p = 0.007$)	0.228 ($p = 0.037$)	0.301 ($p = 0.003$)
Constant	-0.026 ($p = 0.095$)	0.319 ($p < 0.001$)	0.097 ($p < 0.001$)	0.020 ($p = 0.152$)	0.025 ($p = 0.064$)	-0.003 ($p = 0.808$)
F (9, 450), *p*, R^2	53.21, $p < 0.001$, $R^2 = 0.516$	18.94, $p < 0.001$, $R^2 = 0.275$	9.59, $p < 0.001$, $R^2 = 0.161$	19.82, $p < 0.001$, $R^2 = 0.284$	13.83, $p < 0.001$, $R^2 = 0.217$	46.82, $p < 0.001$, $R^2 = 0.484$

I.V.: independent variables; **D.V.**: dependent variables.

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