Percolation, temporal coherence of information, and crisis prevention

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ABSTRACT

In this paper, we study the potential benefits of using percolation theory and temporal coherence in the domain of emergency management.

We argue that the theory of percolation associated with the time coherence of information could be useful in defining efficient organizational patterns for crisis prevention, and we propose a set of six hypotheses to assess the efficiency of an emergency management organization.

In order to validate our hypotheses, we explore the organizational patterns that were set up by a company located in Port au Prince, the capital of Haiti, during the 2010 earthquake. This research was done on the basis of interviews of the key people involved in this event.

Among the many tasks achieved by the company’s managers and staff to control the situation, we identified the root of that successful management. We argue that this organizational pattern can be analyzed as a percolation process that validates our hypotheses for an efficient management of this critical situation.

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1. Percolation and temporal coherence of information

1.1. The theory of percolation and its developments

The concept of percolation (Broadbent and Hammersley, 1957) was primarily developed in Physics for the modeling of liquid/gas circulation through porous materials. It was then extended to Geography to study the emergence/disappearance of islands.

In a porous material, percolation corresponds to the combination of two processes: the liquid enters in a cell of the material and this cell is linked to other neighbor cells. If there is a continuous path between one side of the material and the other through a network of cells, then the liquid passes through the material. The more cells the liquid enters in and the more cells each cell is in close contact with, the faster and the greater will be the flow of liquid passing through.

Percolation theory introduces also a notion of threshold below which the flow is stopped; this was primarily used to design filters to eliminate toxic gases.

When this theory is applied to the propagation of information across a network of people, a “cell” is associated to each person and we can study how the information passes through the network. If one member of the network receives the information and if he/she is in relation with other people, then the information will start flowing inside the network. If a group of people has no relations with the people that have the information, they will not be informed and will form an “island”.

Percolation theory has been applied to a number of domains. Most of these studies deal with understanding how information may “cross” a network by finding a path from input to output or in the business area, how information may reach the greatest possible number of customers. We quote here some examples of applications.


1.2. Time coherence of information

In most of those applications of percolation theory, authors focus on the propagation of information through the network but don’t pay too much attention to the time dimension. If we want to generalize this percolation model to emergency management, which is a time-constrained process, we need to focus on a specific property of information: its lifetime.
In the domain of emergencies and crises, time is critical and information is generally valid only for a certain amount of time, which depends on the dynamics of the system generating the information. In physics of phenomena, this corresponds to the “equivalent periodicity”. In emergency situations, this lifetime is the delay during which a given datum, information or situation can be seen as stable. This lifetime represents a few minutes for the development of a building fire, a few hours for the development of flash flood, or a few days for the search and rescue activities after an earthquake.

Many social scientists have studied the temporal dimension of communication and information, especially during teamwork processes. We quote here some applications. Marks et al. (2001) propose a theoretical approach of the meaning of team processes forming their time-based conceptual framework. This reference work provides a number of key concepts. First, they insist on the need to account for the temporal dimension in studying teamwork:

Our framework is based on the idea that teams perform in temporal cycles of goal-directed activity, called “episodes”. (…) Episodes are most easily identified by goals and goal accomplishment periods. (Marks et al. 2001, p. 359)

Marks et al. (2001) also insist on the role of monitoring and communication in situation awareness, which is a key matter in emergency and crisis situations:

The process of monitoring critical internal and external systems, along with the effective communication of this information among team members, leads to situational awareness. (…) Teams experiencing “communication breakdowns” and those that get “out of sync” are likely to be experiencing problems with their coordination process. (Marks et al., 2001, p. 367–368)

Swigger et al. (2012) study the global software development process to identify patterns of communication behaviors among team members, by examining the temporal nature of interactions. Waller et al. (2002) study group-pacing behavior under dynamic deadlines and the relationship with attention to time.

Botti et al. (1998) address the notion of temporal coherence management in real-time knowledge-based systems. They define a number of time features of information and in particular the temporal validity of data.

Ballard et al. (2008) have done an important theoretical work in considering the time dimension of group activities. Quoting (Bluedorn, 2002), they identify epoachal times that are event-based and intrinsic to the group and fungible times that are measured by a clock (p. 329). They insist on taking in account epochal times in data collection and using in the analysis phase “methods that are designed to capture nonlinear, even interrupted, patterns to reveal otherwise hidden group processes that reflect unique, epoachal time temporalities” (p. 330). They declare that:

The internal rhythms of individuals and group members can become collectively entrained, or synchronized, to powerful external pacers, called zeitbergs, altering the phase, periodicity or magnitude of their endogenous rhythms. This rhythm creates a dominant temporal ordering that exists as a compelling coordination mechanism in teams and organizations. (Ballard et al., 2008, p. 332)

In line with this work, Ballard (2009) studies activity cycles and addresses the mutually constitutive relationship between time and communication.

Social constructions of time exist through persons’ coordination and interaction with others and, via social entrainment processes, persons’ interaction and coordinative efforts shape their experience of time. (Ballard 2009, p. 206)

In her conclusion, Ballard (2009) gives an interesting point of view on the time dimension:

Time is neither an abstract entity nor is it a neutral medium, but a result of human engagement with the world. We cannot understand time by looking at it alone but rather by analyzing the ways people are involved in everyday life. (Ballard 2005, p. 216)

1.3. Time coherence in emergencies and crises

For setting up a good level of awareness and keeping up-to-date shared information in a crisis team, information is most often updated periodically (for instance every hour at the beginning and every day at the end of the crisis). Associating this notion of temporal coherence to percolation theory, we propose a first hypothesis: in an emergency situation, the flow of information must be fast enough so that all members of the network get the information before its lifetime expires.

In line with (Ballard et al., 2008), we argue that information updating should be based more on processes (epochal) than on clock (fungible).

As we have seen above, percolation in the network depends on three factors: how many people get the information, how many relations do they have and what is their willingness to exchange data with their relations. If every member of the network can be reached, then percolation occurs.

But if we add the constraint of temporal coherence, represented by the information’s lifetime, every member should receive the information before it is out of date, which represents a more restrictive threshold. That means that having several relations is not enough; everyone needs to activate his/her relations quite soon so the sum of all the transmission times from the incoming information in the first node to the most remote node of the network must be lower than the information’s lifetime.

Our second hypothesis is: by assessing who gets what information at what time, when and to whom he/she transfers the information, a “percolation map” can be drawn to check the existence of “islands” that never get the information or get it too late.

Fig. 1 presents a simple example with three kinds of difficulties (from left to right): information received by an unusual channel, information never received, information received too late (in this example, we assume a fixed transmission time T = 0, 1).

For instance, if a company has a number of facilities disseminated over the world with a safety officer in each department of every site and all these safety officers are exchanging information every Friday evening about what happened in their department during the week, information about an accident in a site percolates through the network of safety officers with a delay lower than or equal to a week. If every of them makes a short speech in a meeting with all the department staff every Monday morning, then all employees are aware of any accident occurring anywhere in the whole company in less than ten days. By doing that, the risk of having a similar accident in another site is much reduced.

If we take the same example but with each safety officer meeting once a week only with the department manager, who meets his staff once a month and may forget to speak about that accident, percolation is delayed or even stopped in some areas. The accident may occur in another site before people have made the changes resulting from lessons learnt from the initial accident.

Based on these two hypotheses, we argue that using percolation theory and temporal coherence allows emergency managers to identify and anticipate potential difficulties and to assess which levers they can use to adjust the communication processes ensuring reliable percolation, thus they ensure the temporal coherence of
information among the stakeholders at any time, place and hierarchi-
cal level.

Brizon and Wybo (2009) propose a model of weak signal man-
agement. In this model, they introduce the model of “energy bar-
rrier” between two people: one having the information and the
willingness to transmit it to another person, and the other having
the willingness and capacity to receive the information. In this
model, energy level represents on the “emitter side” the sum of
the signal energy (is this information relevant enough?) plus the
emitter’s energy (do I trust what I see, am I confident enough to tell
that?). On the “receiver side”, it represents the energy threshold
to reach the attention of the receiver (generally somebody at a higher
hierarchical level or in a different organization). The sum of signal
and emitter energies must be equal or greater that the energy
threshold of the receiver.

Our third hypothesis is that in a network of stakeholders, this
energy threshold corresponds to the capacity of each network
member to receive information from another stakeholder and par-
ticipate in the percolation process. If there are difficult or sparse
relations between some of them, they may be reluctant to transmit
(low signal energy and low emitter energy) or to receive informa-
tion (high threshold) and so the percolation process will decrease
or even stop. In contrast, when relations are good and frequent be-
tween people, the percolation process runs well and facilitates
emergency management.

1.4. Percolation and sensemaking

As we have seen above, the percolation process contributes to
homogenize information in the network of emergency and crisis
players. Each member of the network receives information from
different members, and this information participates to his/her
sensemaking of the situation but also participates in the collective
sensemaking of the network. We can relate that to the notion of
“group mind” proposed by Weick (1993), quoting the work of
(Wegner et al., 1991):

They argued that group mind may take the form of cognitive inter-
dependence focused around memory process. They argued that
people in close relationships enact a single transactive memory sys-
tem, complete with differentiated responsibility for remembering
different portions of common experience. (Weick, 1993, p. 358)

In line with that, we argue that one of the main sources of trust
(or stress at the opposite) is the perception of players about their
control of the current situation or at least of the part of the global
situation they are in charge of. Weick (1988) addresses this aspect
with a positive mindset:

As perceptions of control increase, stress decreases, and as stress
decreases, perceptual narrowing also decreases which means peo-
ples see more when they inspect any display (George, 1986). As
people see more, they are more likely to notice things they can
do something about, which confirms the perception of control
and also reduces crisis intensity to lower levels by virtue of early
intervention in its development. (Weick, 1988, p. 315)

On the opposite side, Maitlis and Sonenshein (2010) insist on
some negative trends:

In the absence of a plausible understanding of the situation, and as
individuals try to diagnose a problem and decide what they should
do about it, their anxiety, fear, and frustration may increase – fur-
ther affecting their ability to understand what is happening, and to
take action which could help them to do so. Threat engenders rigid
rationalities, such that individuals enact well-learned, habituated
responses that are often inappropriate to the changing situation.
(Maitlis and Sonenshein 2010, p. 567)

Quoting Maitlis and Sonenshein (2010), we argue that percola-
tion participates to collective mindfulness:

Collective sensemaking in crisis is near impossible in the absence
of social processes that lead to collective mindfulness, the enriched
collective awareness that facilitates the construction, discovery,
and correction of unexpected events capable of escalation. (Maitlis
and Sonenshein 2010, p. 556)

Our fourth hypothesis is that an efficient percolation process is
essential to set up fast and reliable control loops between the field
of operation and the different stakeholders and among emergency
managers, to ensure a collective sensemaking needed to control
emergency situations.

In many public and private organizations, the dominant organi-
izational model is more hierarchical than network. Wise (2006)
addresses the question of the adequacy of a hierarchical organization
to manage emergencies, because such a model implies require-
ments that are often difficult to meet:

The idea of top-down (i.e., hierarchical) coordination to achieve
cooperative effort that provides stability in a multi-organizational
environment rests on the notions that the organizations to be coor-
dinated have been identified or can readily be identified by the
headquarters coordinators; that the relationships of these organi-
izations to each other are well understood; that agreement has been
reached about what objectives will be accomplished by altering
certain of these inter-organizational relationships; and that the
authority and means to effectuate desired goals exist to alter the
relationships in the desired direction. It assumes hierarchy will
facilitate the implementation. (Wise, 2006, p. 310)

Wise (2006, p. 314) proposes a model to manage major crises
like Katrina, which is represented by a cycle:

- The different players discuss together about available data and
the problem.
- “Adaptive managers” design plans to reach objectives and
reduce uncertainties.
• Apply plans associated to reporting tasks to analyze data and update managers’ understanding on efficiency of measures.
• Elaborate strategies for the next step.

In his model, Wise (2006) doesn’t address the question of time in the coordination and control activities. We argue that this notion of time is essential to keep control of situations that may escalate.

Wybo and Kowalski (1998) identified four processes that participate in the efficient work of a crisis team:
• Sharing competences and abilities for cooperation;
• Capacity of adaptation on arrival and departure of team members;
• Classification of members’ roles: perception, communication, information and analysis;
• Prioritization and distribution of tasks.

These observations about the need to organize the response to emergencies and crises with a networking strategy and a balance between centralization and autonomy are quoted by Boin and Hart (2003):

So even if, in most large-scale crisis situations, the myth of centralized response structures is sustained by setting up and formally empowering crisis centers, pivotal policy decisions actually emerge from a multi-actor coordination process, in which consultation, negotiation, and outright confrontation are the orders of the day. Moreover, at the operational-response level, centralization is near impossible, because many dynamic, situation-specific, and urgent problems arise simultaneously at different places and nodes in the response network. These can only be handled adequately by operational leaders with sufficient mandate to take the actions they deem necessary. (Boin and Hart, 2003, p. 547)

Risky situations, emergencies, and crises are rhythmed by the different processes that govern the situation and its evolution. Each of them has its own time constant, during which it remains almost stable. We argue that analyzing the dynamics related to the threats, the targets and the response tasks, and using results to check the percolation of information inside the stakeholders’ network is essential to ensure a reliable adaptive management scheme associated with interpersonal interaction, as proposed by Wise (2006):

Adaptive management is not a panacea for solving all the problems (...). It is not a substitute for sufficient professional personnel who are well trained or for astute leadership and decision making. Establishing collaborative relationships also does not mean there is no room for formal organization. On the contrary, it means putting into place a formal framework that facilitates the interpersonal interaction across agency, intergovernmental, and intersectoral boundaries and at multiple levels. (Wise, 2006, p. 315)

Our fifth hypothesis is that in an emergency situation, the periodicity of crisis team meetings must be lower than the shortest periodicity of phenomena or actions, to ensure that everyone is aware of the current situation to take appropriate decisions.

1.5. Percolation and enactment

Weick (1988) introduces the notion of enactment, which corresponds to a twofold process: to act in a given context, the person chooses some elements of context and using his pre-conceptions, he orients his contextual elements and his action to confirm his preconceptions. He then uses this mental construction to act. The term ‘enactment’ is used to preserve the central point that when people act, they bring events and structures into existence and set them in motion. People who act in organizations often produce structures, constraints, and opportunities that were not there before they took action (...). An enacted environment has both a public and a private face. Publicly, it is a construction that is usually visible to observers other than the actor. Privately, it is a map of if-then assertions in which actions are related to outcomes. These assertions serve as expectations about what will happen in the future. At the heart of enactment is the idea that cognition lies in the path of the action. Action precedes cognition and focuses cognition. (Weick, 1988, p. 306–7)

From this reasoning, we deduce that at each “time step” in the development of a situation, each member of a crisis team enacts the situation his own way and this drives him in a given direction. In a network of players, this means that there may be different directions, given the different preconceptions of players and the way they act.

If action is the means to understanding, then the number and quality of actors available to do that acting and interpretation become crucial variables (...). If more people are in constant touch with the system, this will make it easier to detect and correct anomalies and also to implant more reliable environments (...). We are not talking about specialists isolated from one another. Instead, we are talking about heterogeneous teams of diverse people with sufficient mutual respect that they maintain dense interaction with one another. (Weick, 1988, p. 312–313)

Quoting Weick (1988), we propose a sixth hypothesis: an efficient percolation in the emergency network based on mutual respect allows stakeholders to share a common enactment of the current situation and manage it in an efficient way.

We argue that our theory based on these six hypotheses could operate at two levels: individual communication inside the crisis room and intra-organizational communication between the different teams and organizations that participate in the management of emergencies and crises.

2. The Haiti earthquake on January 12th, 2010

In order to validate the theory presented above, we have done a case study on the 2010 Haiti earthquake and more precisely on the behavior of an organization that avoided a crisis in this chaotic situation.

This earthquake caused devastating damage on housing and other buildings mainly due to the poor construction quality of most structures, despite its relatively moderate strength (Level 7 on the Richter’s scale, see fig. 2).

Quoting experts, local construction professionals are not trained to consider seismic activity and buildings are designed to cope with vertical forces only. Related to the earthquake, even low tangential accelerations (0, 2 G) were sufficient to collapse multi-storied buildings. Moreover, there were no construction rules in terms of quality of concrete and steel reinforcement, need for adapting foundations to the quality of soil, and avoidance of intervention on beams (like opening holes to pass tubes through).

In the streets, it was a vision of end of the world: people covered with white dust wandering in all directions. The worst was to see dead bodies under collapsed walls, in the shops, everywhere. We couldn’t move around, as all streets were blocked by tons of debris. (an employee)

That day, I discovered that seismic risk in Haiti was high, but nobody knew before. It’s important to know the risks to elaborate prevention and crisis plans, but we were not at all prepared to face such a situation. (a manager)
2.1. The context before January 12th

The Haïti subsidiary of the company is composed of 77 staff and 3 managers. The two main activities are:

- Distribution and selling of fuel and gas through a network of gas stations. Tank trucks belong to local transportation companies.
- Distribution and selling of LPG and refilling/checking of butane & propane bottles.

The company uses a storage depot located close to the «Cité Soleil» (a neighborhood known for its high criminality), near the harbor. Offices are connected to the headquarters downtown by a radio link for secure transmission of data.

The company is the only major business still working in Haïti. Its competitors are one local and one regional company. In 2009, the company organized an audit of gas and LPG installations, followed by investments to upgrade the safety level of hardware, procedures and staff. Those actions played a key role in the company's technical and human resilience when the earthquake hit Haïti.

2.2. Damage to the company's installations

The headquarters building suffered from the quake but didn't collapse. There were no casualties but staff couldn't stay inside and had to transfer their desks outside the building in the open parking and a few days later in temporary shelters.

Most of the tanks, gas stations and trucks were not damaged, so the activity could restart only a couple of days after the quake and participate in the rescue activities. LPG storage tanks were not damaged but some safety systems (water piping for fire protection) suffered, so this activity was not restarted until complete restoration and checking by company experts. Fuel and gas storage tanks were only slightly damaged but in the harbor, the piers were destroyed (see Fig. 3) so floating hoses were used to connect oil tankers to the storage tanks.

Only three days after the quake, tank trucks restarted to refill gas stations and to provide gas to authorities, UN teams and NGOs, participating in the search and rescue activities and in the recovery of food and goods transportation activity.

3. Methodology

Our objective was to understand why the management of that situation was efficient although the company was placed in a chaotic context. To set up the analysis method, we refer to the arguments proposed by Marks et al. (2001):

We argue that particular types of measures should be gathered at appropriate times and using measures that are most suitable for the nature of the construct being examined – all based on the knowledge garnered from a time-sensitive team task analysis. (…) A logical first step is to understand a team’s temporal rhythms and episodes and then to consider what, when and how teamwork processes contribute to critical performance outcomes. (Marks et al. 2001, p. 371–372)
In order to identify the activity cycles (Ballard 2009), data collection for this study was achieved through a set of interviews of key players. First, we have identified those key players in the three different parts of the organization that participated in the management of the Haiti earthquake: the Haiti subsidiary, the Regional headquarters in Panama, the company headquarters in Paris. During the interviews of this first group of people, a number of people from different departments were mentioned for their contribution to the management; these people were also interviewed. Finally, a total of 19 people were interviewed.

The company also provided a subset of E-mails exchanged among players during the crisis. This material was not exhaustive but representative of exchanges among players from the different sites all along the development of the situation, clarifying fungible times. It was useful to complete the analysis, especially to identify precisely technical matters and the chronology of events, communications, and actions.

The analysis of this material (interviews and E-mails) was achieved by structuring the data through three complementary approaches:

- Chronology of events, decisions and actions (fungible times).
- Identification and analysis of processes and communication patterns.
- Detailed analysis of episodes that focused attention of players (epochal times).

We used an analysis method (Wybo, 2008) originally designed to analyze the temporal development of complex situations as crisis, using episodes to structure the course of events, decisions and actions. This method allows the reconstruction of the global picture needed for sensemaking and learning lessons, but also the identification of individual visions and communications patterns among stakeholders.

3.1. Data collection from interviews

Each person was individually interviewed for about 1 h. Conditions of interview were presented at the beginning (objectives, validation, anonymity). First, the person was invited to tell the story, as he/she experienced it, the actions he/she achieved all along the development of the situation, and the communications he/she participated in.

After this first phase and depending on what he/she said, more precise questions were asked, to understand his/her motivations and to put observations, analyses, decisions and actions in their real context (“at that time, in that place, with those players”). Finally, the person was asked for his/her opinion on the management of this event and on the lessons that he/she learnt. The interviewee was also invited to propose improvements.

From the contents of the interview, the different matters addressed are organized in the transcription to facilitate data analysis. Our objective is that each transcription reflects as closely as possible the interviewee behavior and his/her relations with others.

This text is then sent to the interviewee for validation. He/she is invited to make changes if needed, to reformulate some sentences or to complete the text if it reminds him/her some memories. In most cases, players made only minor changes. Once the text of the interview was validated, it was made anonymous and the data used for analysis. Some of the sentences told by players that bring an interesting focus on such or such matter are used as quotations in this paper.

One could argue that there is a potential limit in the validation of our theory by using interview data, which is the main source of information we used for the analysis. In order to avoid the danger of confirmation bias to support a predetermined theory, we have used the complete set of data available to us (individually validated verbatim of all interviews and E-mails provided by the company) and not only those comments that support our ideas.

3.2. Analysis of the organization as described by the players

In this paper, we address the organizational patterns and activity cycles that were set up or emerged along the management of this event in order to validate our theory. The analysis started with the identification of the main processes that structured the management of the different crisis aspects and the study of their dynamics.

Each crisis situation is different, so there is almost no chance that a similar one reoccurs, but each individual process may be found some day in the future in other situations. That’s why the analysis is structured around a chronology of key facts, which gives access to a global view of “the story”, completed by an analysis of each process, structured by “episodes” quoted by the different players in which they participated, and of the information flow inside the network all along the development of the situation.

Each of those episodes forms a decision cycle: when facing a given situation/context and/or receiving some information, the player analyses it, takes decisions (including sending information to others) and those decisions have an effect on the evolution of the situation/context.

In agreement with our second hypothesis, this analysis made it possible to draw the percolation map, by merging the individual communication networks of each person and assessing how and when the different data and information were transmitted inside the network of stakeholders.

4. Managing crisis and restoring activity

4.1. Setting up a crisis organization

When the earthquake hits Haiti, it is 16h53 on site and 22h53 in France; witnesses and media provide the first alert signals that trigger reactions from French authorities and the company. In the next minutes, the crisis center of the French Ministry of Interior (COGIC) receives satellite images of the area within the framework of an international agreement with ESA (European Space Agency) for disasters monitoring. These images showing oil leaks around the harbor of Port-au-Prince, the COGIC alerts the company headquarters in Paris.
In the mean time, the exploitation manager of the Haiti subsidiary who experienced the quake in his office calls the regional headquarters in Panama and the company headquarters in Paris, using a satellite telephone, to give them an overview of the situation. These different communications validate our first hypothesis: the flow of information was fast enough to percolate inside the network (Haiti, Panama and Paris) and create a temporally coherent vision of the situation in Haiti.

One of the key matters that emerged immediately was the need to protect Haiti managers from the flow of calls coming from all departments of the company, creating stress and consuming resources.

**During the first hours, we have to repeat 10 times the same information, until we decided that Panama would be the only focal point to communicate. It was impossible to work. (A Haiti manager)**

After a first debriefing of the current situation, the managers in Haiti, Panama and Paris decided to set up a crisis team in Panama and to start its activity from the next morning. This first important decision to set up a crisis team and to locate it in Panama was taken on the basis of several aspects:

- Panama and Haiti are in the same time (6 h less than Paris) so working hours are the same on both sites; moreover, people know each other quite well.
- Panama regional headquarters is a small structure; managers have an experience in crisis management and easy access to communication media (satellite, phone, internet).
- Haiti subsidiary is put in a chaotic situation with technical, human and organizational difficulties, so they are in a more demanding position than in capacity to set up a local crisis team.
- Many stakeholders (from inside the company and from outside) are willing to collect information about the situation and support Haiti staff, but this may create a strong pressure on people and be time and resource consuming, so communications must be filtered to focus on essential matters.
- Paris headquarters personnel have at their disposal the huge resources of the company, but with a remote view of the situation and different working hours.

Once this crisis team was set up, its missions were identified:

- Get up-to-date information from Haiti to evaluate the current situation, receive their demands and answer their queries or transmit the demands in terms of resources to the Paris headquarters.
- Be the focal point of information requests from abroad about Haiti and answer queries without bothering local people.
- Organize a regular reporting process to inform stakeholders about situation changes.

In parallel with the crisis team in Panama, another crisis team was set up in Paris, to provide the company’s support especially for what concerns security matters and relations with French Authorities.

By setting in place this organization of communications, the first players defined the people to integrate in the crisis network and who should get what information.

From the analysis of the different processes set up to manage the situation, we identified that the lifetime of the different tactical information was at least 12 h: situation was evolving mainly on a daily basis. For the strategic information, concerning for example the request and delivery of company-level resources, lifetime was a matter of days or weeks.

Taking into account the situation’s dynamics, the three teams decided to set up a time frame for communications between them (see Fig. 4) that allowed each of them to organize its own actions during its working hours while respecting the time lag. Using our fifth hypothesis, we argue that this periodicity of meetings succeeded in ensuring the coherence of information among all players all along the development of the crisis and by that, allowed them to keep the control of the situation.

By organizing those efficient methods of circulation of information, percolation of information was ensured from the first day of the crisis until the end of the company crisis activities, around six weeks later. The Haiti crisis is still far from being finished for the population 2 years later; here we talk about the time when all the company’s installations were repaired and activity returned to its normal level.

This organization in three complementary levels (local, regional and corporate) proved efficient in setting up a reliable response to the crisis situation and in optimizing competences and resources coming from all departments of the company.

“Details of the timing of exchanges between Haiti, Panama and Paris were not written in an existing plan, but our plans describe what must be set up as soon as possible depending on circumstances” (a Panama manager)

The three linked nodes were the deputy manager in Haiti exchanging information with the deputy manager of Panama twice a day, each of them informing his local staff, and the crisis manager in Paris, exchanging information with the Panama deputy manager every day and disseminating information at the corporate level. The daily report produced by Panama was sent to a wider audience; it provided redundancy and the capacity to recover any past information.

5. The role of percolation of information in keeping control

5.1. Organizational patterns and crisis management

The crisis management strategy was based on three entities:

- The “field operations” in Haiti: the local manager and his deputy managers.
- The crisis team in Panama: the regional manager and his staff.
- The support team in Paris led by the crisis manager and the security manager.

This ad hoc strategy took into account the time lag between places and set up an efficient sequence of exchanging, working and reporting activities:

- A conference call Panama - Haiti at 11AM (Panama time).
- A conference call Panama - Paris at noon (Panama time, 18 h Paris time).
- A conference call Panama - Haiti à 6PM (Panama time).
- A daily report written in Panama around 7PM (1AM next day in Paris).

This scheduling is composed of two interlaced control loops: one loop twice a day between Haiti and Panama, faster than the speed of evolution of the crisis situation and allowing an excellent awareness level of the Panama crisis team, and one daily loop for communication and reporting, faster than the reaction time of resources management at the company level. Those observations validate our fourth hypothesis.
This organizational pattern included also three directives:

During the interviews, every single person mentioned his/her relations inside the company, generally created during his/her former missions in other countries where they had to deal with difficult situations. This informal network built along their career was a key resource for each of them when they needed advice, support or resources. These relations based on mutual respect and trust correspond to our third hypothesis: the energy threshold of people is very low (they are keen to receive information from their peers) and their energy level is high as they are confident in the relevance of information they send. This greatly contributed to the efficiency of the percolation process, as information exchange was not limited to the most critical one.

If we summarize these different aspects, we can see that time coherence was ensured: every person involved in one of the three entities has the same information as the others and when any piece of information changed, he/she was aware of it in due time. Moreover, the combination of permanent information coherence and systematic reporting allowed every stakeholder to perceive and make sense of the current situation and its evolution since the beginning of the event. This validates our sixth hypothesis.

6. Discussion

The organization pattern set up by the company during the Haiti disaster, combined with individual informal networks and good relations between people validate the six hypotheses of our theory, so we argue that this combination created the conditions for the company to avoid a crisis and keep control of the situation in spite of the surrounding chaos. This organization minimized response delays and uncertainty and ensured temporal coherence of information and appropriateness of actions. Moreover, all available resources at the local, regional and corporate levels were used at their best.

Our hypothesis is that for the company, this situation never escaped control and remained an emergency without escalating to a crisis although the surrounding context was chaotic. The coherence of information among stakeholders was a key to success in keeping control of the emergency situation and for avoiding crisis as much as possible.

During this crisis, each of us played the role he has to play. It worked and it was quite efficient because each of us didn’t play another role or intervened in someone else task. (Haiti manager)

In this paper, we have used percolation theory combined with temporal coherence to propose six hypotheses for a good management of emergencies reducing the risk of escalating to chaos and crisis. We argue that this model is applicable to a network of players at the local (crisis room) or global scale (company level), taking into account the dynamics of the different processes related to threats, targets and management tasks.

We argue that by using these six hypotheses, it would be easier to identify weaknesses in a crisis network and find appropriate measures to address them, for instance develop abilities to manage weak signals, promote mutual trust and respect, and set up communication schemes that speed up and secure the percolation of information where and when it is needed.

References


