

# Approach to support Situational Awareness within Inter-Organizational Collaboration in Crisis Response

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## ABSTRACT

Regardless of the type of crisis and its complexity as well as the difference of culture, objectives and priorities of the multitude organizations involved, emergency response requires effective communication in order to achieve situational awareness within inter-organizational collaboration, make decision and achieve their own objectives. However, actors are challenged by several problems. Among them, weak interaction and information exchange, unavailability of information at the right time etc. Our contribution outlined in this paper is suggesting an approach based on an empirical study conducted in France. The objective of this approach is to mitigate inter-organizational communication

problems and support situational awareness (SA) by distributing needed information at the right time.

## Keywords

Collaboration, crisis management, information availability, inter-organizational communication, situation awareness.

## INTRODUCTION

Regardless of the type of crisis resulting from natural or man-made disaster, emergency responders (ERd) require maintaining awareness of the relevant information, in order to collaborate and achieve their activities successfully (Belkadi, Bonjour, Camargo, Troussier and Eynard, 2013; Schmidt, 2002; Steinmacher, Chaves and Gerosa 2013). However, the multitude organizations involved in crisis response (CR) are faced with many challenges and boundaries such as culture, terminology, objectives and priorities. All of this hampers the coordination and communication of the different information requirements for each particular need within inter-organizational collaboration. As result, this leads to issues in situational awareness, decision making and carrying out activities in addition to the time-consuming. Hence, awareness is an important factor for CR success. The concept of awareness varies with the variation of discipline; Belkadi pointed out relevant literature about awareness concept (Belkadi et al, 2013). In cognitive science, situation awareness is the perception of the elements in the

environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future (Endsley, 2000). In collaborative work, awareness “refers to a person’s being or becoming aware of something.” (Schmidt, 2002). Another definition given by Dourish and Bellotti: “awareness is an understanding of the activities of others, which provides a context for our own activity” (Dourish and Bellotti, 1992). Overall, even though the concept of awareness is still ambiguous, all concepts of “situational awareness” and “linked-adjective awareness” involve adopting the right information at the right time to the right actor in order to analyze information, make decision and achieve actions (Gorman, Cooke and Winner, 2006; Salmon, Stanton, Walker, Jenkins and Rafferty, 2010). However, awareness is often affected and hampered by communication process problems: what is communicated and how communication occurs (Damian, Marczak and Kwan, 2007).

In this work, we propose an approach to answer the principal question “How to mitigate intra- and inter-organizational communication problems and support situational awareness?”

This approach relies on distributing semi-automatically situational awareness to the different ERd at the right time and support inter-organizational collaboration in CR. As we could not predict all information in CR, we add new role of “supervisor” in the strategic level. The supervisor has the global situation awareness so that he manages the integration of the different information that is not supported by the system.

## RELATED WORK

Numerous studies were conducted to support intra-organizational communication and awareness; Location-Based Notification System for Police to enhance awareness about incident location (Streefkerk, van Esch-Bussemaekers and Neerincx, 2008), peer to peer system to support communication and alert between firefighter (Jiang, Chen, Hong, Wang, Takayama and Landay, 2004), information sharing prototype providing awareness about the most important roles in fire department (Prasanna, Yang and King, 2011). However, the fact remains that

these studies are restricted to one emergency service. For inter-organizational level we mention, Request-and-report system based on android devices supporting the information articulation which enriches awareness between actors in the field and the control centers by providing necessary information (Ludwig, Reuter and Pipek, 2013). Nevertheless, this work did not tackle the information articulation and the awareness in inter-organizational level. Ley proposed a centralized information repository of documents (.pdf, .doc) for all organization involved in which users are able to access to the information from different types and sources (Ley et al. 2013), but it still not sufficient. Actors have to request constantly the information needed while it could be other information that actors ignore its relevance to their activity. In the same align; Bui suggests a framework for designing a Global Information Network to improve communication, gathering and dissemination of information for the humanitarian assistance and disaster relief (Bui, 2000). In fact, we do not perceive clearly in this article how the dissemination was established. Regarding Sapareito and Antunes, an emergency-model should be capable to maintain the interdependencies between events, actors, actions etc and any other factors involved in the process (Sapateiro and Antunes, 2009), thus they proposed emergency response model to improve shared situational awareness. The Barhosa proposed a new role of “orchestrator” to coordinate information flows between multiple agencies and share awareness. The orchestrator takes care of the information needs that go beyond the boundary of a single agency (Barhosa, Janssen and Tan, 2011). However, with the massive information available in CR, it will be difficult for the orchestrator or liaison-officer to manage all this information. Additionally, it is not clear in this article how to help the orchestrator to affect the information to the different agencies. In the same align; Weber discussed the case of fire in Dutch-German border and the necessity of liaison officers to translate the different terminology (Weber, Deckers and Wilson, 2013). He states, this could be solved by ontology module shared by all stakeholders.

## RESEARCH FIELD

This qualitative research was conducted in department of Aube in France. We focused specially on professional actors and organizations involved in (CR).

**COMMUNICATION PRACTICES IN CRISIS MANAGEMENT (CM)**

Before presenting our methodology, we show an overview of departmental organization in CR (Figure 1).

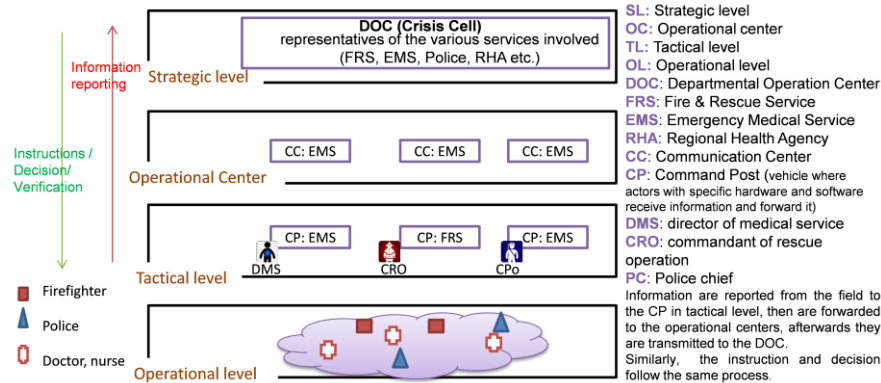


Figure 1. An overview of departmental organization

**METHODOLOGY**

To understand the inter-organizational communication practices and its impact on situation awareness, we conducted two qualitative research techniques: interviews (Table 1), real case/exercises debriefing (Table 2) and exercises observation (Table 3). We conducted at first, individual semi-structured interviews with different actors in order to understand their current communication practices and needed information in intra-organizational. In a second step of interviews, we focused especially on common information within the various organizations and information exchange in order to analyze the inter-organizational communication and awareness issues. We note that we did debriefings on real cases and exercises in order to highlight the general communication problems. We observed two exercises. In the first exercise (E1) we were four observers (one in OL, the second observer was in CC of EMS and two observers were in SL). This observation was focused on inter-organizational communication and information exchange in the different level. The exercise was video recorded in OL and we took notes in other levels. Besides, interviews were audio recorded and transcribed for subsequent

data analysis following the process of qualitative content analysis (Mayring, 2000). The major list of themes is: information availability, information exchange, awareness, decision making, activities achievement.

N°	Organization	Role
I1	Fire department	Commandant
I2	Fire department	Colonel
I3	Fire department	Group chief
I4	Fire department	Trainer at firefighter/former firefighter
I5	Fire department	Commandant of rescue operation
I6	EMS	Chief of emergency medical assistance service/ expert
I7	EMS	expert
I8	Police	Captain: Deputy officer of information
I9	Police	Colonel: commandant of police
I10	Consultant	Former firefighter/ expert

Table 1. Interviews

N°	Debriefing	type	Participants in debriefing
D1	Accident bus in highway	Real case	Expert -EMS
D2	Nuclear transport	Exercise	Expert-EMS
D3	Retirement home	Real case	Expert-EMS
D4	Storm 99	Real case	CRO

Table 2. Debriefings

N°	Exercise observation	Participants
E1	Shooting in commercial stores	FRS-Police-EMS-others
E2	Population evacuation	Red Cross

Table 3. Exercises Observation

**INTER-ORGANIZATIONAL COMMUNICATION PRACTICES: DATA ANALYSIS**

We analyzed the inter-organizational communication problems that hamper actors to achieve SA and we choose the relevant themes that are keys to answer our question (Table 4).

Missing awareness	Communication failures	Situation Awareness (SA)
<p><b>Actors' network</b>  <i>"There is a phase of chaos, who is the commander, on arriving on site, to whom ask what is going, we have to find the CRO..."(I6,E2)</i>  <i>"it is necessary to maintain a network of knowledge to communicate information rapidly"</i> (I10)</p> <p><b>Actors 'needs</b>  <i>The police know that there is an escape route, but they do not necessarily communicate..."</i> (I6)</p> <p><b>Activities interdependency</b>  <i>"There is a logistical dependence also related to information at the right time. We do not transmit the relevant information for the activity of the other at the right time"</i> (I6)</p>	<p><b>Weak interaction &amp; information exchange</b>  <i>"CRO cannot find an interlocutor from EMS to have a medical answer"</i> (E1)  <i>"We need to identify who is the interlocutor for each service and who is the decision maker"</i> (I6)  <i>"There is a transmission of information but not necessarily the right one[...] The transmitter may give fragmented information that are not exploitable "</i> (I6,D1)</p> <p><b>Information unavailability</b>  <i>. "We are not able to access to the field, we need to know the perimeter of exclusion, information about victims and what could we do"</i> (I6, D1)  <i>. "We realize that we are really advanced and we wait the vehicles of firefighter, that police give us the information of access... the transmitter do not give information at the right time"</i> (I6,D1)</p> <p><b>Information flow is slow</b>  <i>"The time is not the same in the field as in the CC of EMS, and in the DOC "</i> (I6)  <i>"We are not necessarily aware at the right time about the decisions made strategic level"</i> (I6)  <i>"There is a problem of information top-down, we are not aware about the major decision made in SL and they are not communicated to actors on field"</i> (I6,D2)  <i>"Sometimes, the Commander of rescue makes decision. However there is a delay to receive this decision"</i> (I6)</p> <p><b>Information reliability</b>  <i>"The prefect needs reliable information, thus he requests the verification and confirmation of information. Sometimes the red (Firefighter) reports a victim number, the white (EMS) reports another and idem for the blue (Police)."</i> (I6)  <i>"The identity of victims is the big problem. The crusaders information may be different from the different services"</i> (I8)  <i>"The non-verification of information may even generate the shock to the citizens and families of victims involved"</i> (I9).</p>	<p><b>Lack of SA</b>  <i>"We need global view to make decision"</i> (I8).   <i>"We make the tactical decision on the field, thus we must have a global view of the field to make the decision"</i> (I6)</p> <p><b>Decision making</b>  <i>"The phase of decision depends on the recognition phase, thus actors need reliable information"</i> (I6)</p> <p><b>Activities achievement</b>  <i>"ambulance drivers could not carry victims to hospitals because they are not aware about information of the escape route"</i> (I6)</p> <p><b>Time-consuming</b>  <i>"... it is the time-consuming when we do not transmit the right information to the right actor..."</i> (I6)</p>

**Table 4. Communication failures, its causes and impacts**

As a result, the main communication challenges are briefly:

- The interaction and exchange: Difficulties to interact between remote actors in intra-organization and inter-organization in all levels.
- Information unavailability: in OL and TL, Information is not inadvertently disclosed to its destination due to the missing of awareness.
- Information flow: it is slow in intra-organization top-down and bottom-up (see figure 1).
- Information reliability: Actors report from the field different information data for the same type of information (e.g. number of victim).
- Overload work: Actors in tactical level are overloaded by the mass of call to answer, the treatment of information, the transmission of instruction to the operational actors and report progress to their local center and strategic level.

All this intra- and inter-organizational communication failures are due to the missing of information awareness about:

- Actors' network: it is difficult for remote actors in operational and tactical level to interact with each other, neither in intra-organization, nor between actors from heterogeneous services. Therefore, it is tricky to know the principal actors from the different organizations to reach them and interact with each other if needed. (It is very important to know to whom request and give information as well as reach actors easily)
- Actors' needs: It is difficult for actors to know others' need as it requires being aware about their activities and their context. Additionally, actor provider pay the cost to be aware of others' need and provide information.
- Activities dependencies: Idem, this requires knowledge about others activities and its dependencies.

Overall, all this issues hamper actors to achieve SA, make decision and achieve actions at the right time. Consequently, this leads to the waste of time.

## APPROACH TO SUPPORT SITUATIONAL AWARENESS IN CRISIS MANAGEMENT

SA is influenced by communication failures. In turn these failures are due to the missing of awareness mentioned above. Thus we propose an approach to support situational awareness within inter-organizational collaboration. Hence this approach includes actors & resources 'network (ARN) to make liaison between resources, actors' role, organization, position etc. and decision makers. Then, since the sender cannot predict relevant information for others and time of needed (Dourish and Bellotti, 1992), we propose an approach which consists on collecting information automatically and distributing SA to the different actors in tactical level and operational level (Figure 2). The distribution depends on the particular actors' needs to make tactical decision (in TL) and achieve action (in OL) as well as giving global situation awareness in the strategic level.

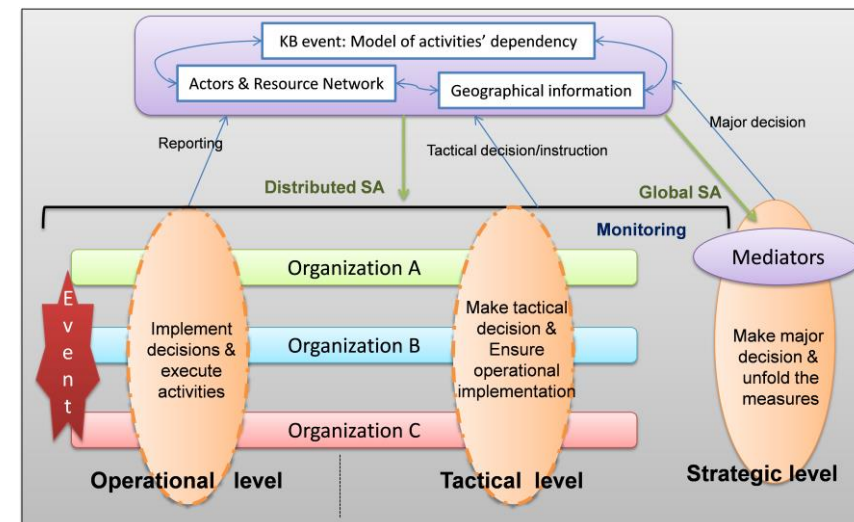


Figure 2. An overview of the distributing SA system

We collect automatically information in centralized system excluded the confidential information. This information is originally reported by the different

actors executing actions and exercising their activities. Indeed, each resource such as {decision, message of information, video, photos, data and unfolded logistics} is categorized under multi-level: principal activity and subsidiary activity. Then, we determine the needs of actors via modeling the major activities and sub-activities of all organizations and their dependencies with respect to the resource-task and awareness; the model of activities' dependency (MAD) was conceptualized following the activity-centered approach. Thus, MAD and the ARN enable the system to distribute SA.

This is an example of a short scenario from Exercise 2 (figure 3): The first team of EMS arrives on the field and need information about the situation. In the reality, it is very tricky for actors to reach an interlocutor from other service and find information to start their own activity.

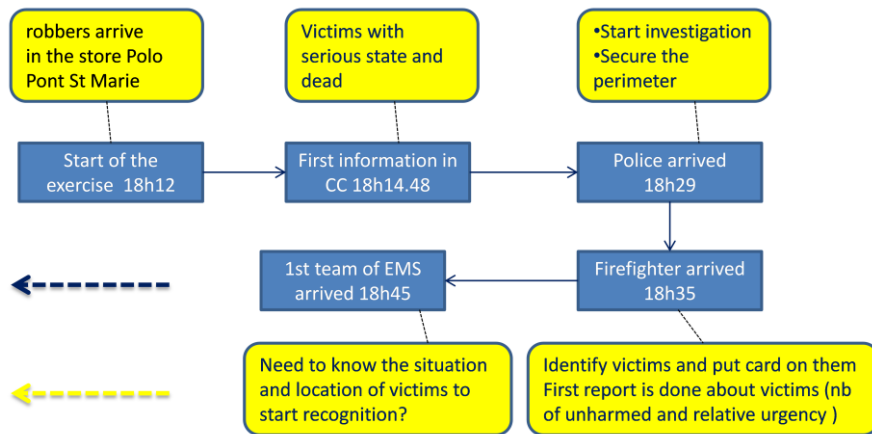


Figure 3 a short example of Scenario

Afterward, we illustrate a distributed situational awareness of EMS in TL using the proposed approach (figure 4).

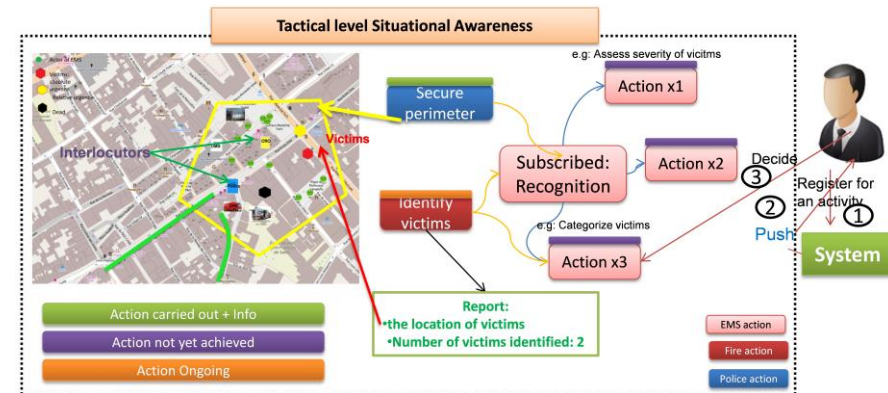


Figure 4 Illustration of Scenario: DSA for Responsible of EMS

The responsible of EMS chooses the activity he interests to do from the activities list. Thus, he registered at this activity (e.g. “recognition”) in order to be aware of all (and just) information needed to execute this activity. The system pushes via MAD all sub-activities of “recognition” within EMS (e.g. Assess severity of victims, Categorize victims). Additionally, the system reasons the dependencies in MAD and pushes all sub-activity and activities dependent to “recognition” whether they are in the same service or others (e.g. Secure perimeter, identify victims). Obviously, the responsible visualizes the resource of these actions. With respect to geographical information, they are visualized on the map. As a result the responsible is aware about what is going around him and could make decision about which action to achieve and choose in the ARN the suitable actor to execute this action. Similarly, actor in OL has the needed information to execute his action.

During dynamic CR, actors could need additional information that the system has not pushed or there is creation of new activity/ sub-activity that are not pre-defined in the MAD and some reported information that is not categorized etc. On account of all these possibilities, we suggest to add new role of "supervisor" to monitor all situation in the field remotely, to control the interaction and the integration of the different information that are not supported by the system in addition to the adjustment of the MAD. In this way the system learns from the



current crisis and updates the model of activities' dependency progressively.

## CONCLUSION

In this work, we point out the multitude inter-organizational failures related to the communication rooted in a lack of awareness about: actors' network (role, organization, position etc.), activities' interdependency and actors requirement. All these problems hamper SA achievement and lead to issues in decision making and action achievement. Thus, we proposed an approach to mitigate communication failures and distribute SA semi-automatically to the different actors depending on their particular needs. Moreover, we suggest adding a supervisor in strategic level who manages the integration of the different pieces of information that are not managed by the system as well as he monitors the entire situation remotely.

Currently, we develop some modules and in our future work, we will test the system with the end user to prove the effectiveness of this approach in crisis response. How this system mitigates the time-consuming and improves the achievement of situational awareness at the right time.

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