How to Pick up the Needed Information about What Is Going Around Us: Information Awareness in Crisis Management

Amina Saoutal, Nada Matta and Jean Pierre Cahier

ICD/Tech-CICO, Troyes University of Technology, 12 Marie Curie, Troyes, France

Abstract: Emergency responders require maintaining awareness of the relevant information, in order to collaborate and achieve their activities successfully. However, the multitude organizations involved in crisis response 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 awareness, decision making and carrying out activities in addition to the loss of time. Hence, awareness is an important factor for crisis response success. This prompted us to ask the original question: How to pick up the needed and the relevant information about what is going around us to integrate and achieve our activity? In this paper, we present: (1) the results of this study on awareness issues, causes and effects in Inter-Organizational Collaboration in Crisis Management (2) We describe a semi structured system approach supporting Information Awareness, this approach help the different actors to pick up the needed and the relevant information about what is going around them to coordinate, integrate and achieve their activities.

1 INTRODUCTION

Emergency responders (ERd) require maintaining awareness of the relevant information, in order to collaborate and achieve their activities successfully (Schmidt, 2002; Steinmacher et al., 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 awareness, decision making and carrying out activities in addition to the loss of time. 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). Others researchers use the term awareness with an adjective in order to qualify its use in a specific context (e.g. peripheral awareness (Gaver, 1992; Bly et al., 1993, p. 34; Benford et al., 1994), general awareness (Gaver, 1991; Bly et al., 1993, p. 29), passive awareness (Dourish and Bellotti, 1992, p. 107; Dourish and Bly, 1992, p. 541) workspace awareness (Gutwin, 1997; Gutwin and Greenberg, 1999; Gutwin and Greenberg, 2002) etc.) In (Schmidt, 2002). Overall, even though the concept of awareness is still ambiguous, all concepts of '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 et al., 2006; Salmon et al., 2010). However, awareness is often affected and hampered by communication process problems: what is communicated and how communication occurs (Damian et al., 2007). The communication is not the only problem of awareness as people could communicate information without achieving awareness. The central problematic of this concept in collaborative work is how actors pick up what is

going on around them in order to integrate and align tacitly their activities (Schmidt, 2002).

Picking up what is going around could be by monitoring the activities of other actors, this involves observing directly their activities (co-located) or by communicating information in face to face or by tools when actors are remote. In our context of work, monitoring activities in inter-organizational collaboration in crisis management is difficult by face to face, as the crisis could be in a large space, actors are remote and could not observe others activities directly.

Thus actors need to be supported in order to be aware about what is going around. Bly conceived a media space to bring people together in a video, audio, and computing environment as it is important for informal interaction and general awareness (Bly et al., 1993), similarly, the Portholes experiment at Xerox EuroPARC, was conceived as an aspect of informal interaction. "Awareness involves knowing who is "around", what activities are occurring, who is talking with whom; it provides a view of one another in the daily work environments. Awareness may lead to informal interactions, spontaneous connections, and the development of shared cultures – all important aspects of maintaining working relationships which are denied to groups distributed across multiple sites" (Dourish and Bly, 1992, p. 541 in Schmidt, 2002). However, this concern social context work, not the ongoing activities within the cooperative effort (Schmidt, 2002). Being aware of what is going around is very large and wide; actors can be aware about others' activities that are not relevant to their own activity and it can lead to information overload. In addition, information overload makes actors under stress in the case of crisis management and affect the decision making and activities achievement. Thus, we use the combination information awareness: *as picking up only needed and the relevant information at the right time about what is going around us for a given context in order to integrate and achieve our own activities.*

Information Awareness means two things that are not separated: the first is that actors know and identify what they have to pick up around themselves and which is relevant for their activity; the second is that actors have to pick up what they have not anticipated previously and which is relevant to integrate and adjust their activity.

In this work, we propose an approach to answer the principal question How to pick up the needed and the relevant information about what is going around us to integrate and achieve our activity?

This approach is based on activities' interdependency model and relies on organizing information and occurrences of activities generated and performed by different actors and organizations involved in crisis management so that actors could pick up easily the needed information about what is going around them. The organization of this information and the identification of actors' need are based on modelling the inter-dependencies of the different activities (operations) between the different organizations. We believe that this approach will enhance information awareness as this model is flexible and can be managed during crisis response.

2 RELATED WORK

Numerous studies were conducted to support intra-organizational communication of information and awareness; Location-Based Notification System for Police to enhance awareness about incident location (Streefkerk et al., 2008), peer to peer system to support communication and alert between firefighter (Jiang et al., 2004), information sharing prototype providing awareness about the most important roles in fire department (Prasanna et al., 2011). However, the fact remains that these studies are restricted to one emergency service. For multi-organizations studies, 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 et al., 2013). Nevertheless, this work did not tackle the information articulation and the awareness between the different organizations in inter-organizational level. Ley proposed a centralized information repository of documents (.pdf, .doc) for all organizations 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. This approach may be relevant for decisional level when decision makers need internal and external information (e.g. water level, weather forecast etc.) for decision making. In case of actors in operational level, they could not search needed information easily from the repository as it suppose that they have to know what they will search for. However it could be other information that they ignore and which is relevant for their activities.

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 organized and established to allow to the actors picking up what. 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 and achieve collective 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 (Bharosa et al., 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 adress this information to the different agencies.

3 APPROACH TO SUPPORT INFORMATION AWARENESS

In order to propose an approach to enhance and support information awareness in inter-organizational collaboration, we proceed to understand first the collaborative practices in crisis management and studying the information awareness from the communication of information corner. Thus, we conduct the qualitative study in which we focus specially on professional actors and organizations involved in crisis management (CR).

We conducted interviews with different organizations, we participated to some exercises and we analysed experience-feedback documents about previous real cases.

3.1 Methodology

We conducted in a first step, individual semi structured interviews (Table 1) with different actors from different organizations involved in crisis (Fire, Emergency medical service (EMS), Police…) in order to understand their current practices on inter-organizational collaboration and highlight the root causes of communicating information problem that prevent meeting the different objectives and impact decision making. In a second step of interviews, we focused especially on information in common core among the various organizations involved. We note

that we did debriefings on real cases (Table 2) and we participated to two exercises as observers (Table 3). In the first exercise (E1) we observed the inter-organizational communication in the different levels: operational level (OL), tactical level (TL) in the field, the communication center of hospital and strategic level (SL) in prefecture (crisis cell, departmental operational center). 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).

Table 1: Interviews.

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	Assistant chief of emergency medical
I8	Police	Captain: Deputy officer of information
I9	Police	Colonel: commandant of police
I10	Consultant	Former firefighter/ expert

Table 2: Debriefing.

N°	Debriefing	type	Participants
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	Commandant of Rescue Operation Firefighter

Table 3: Debriefing.

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

3.2 Information Awareness Problems Analysis

In crisis management, the situation is very critical and actors have to pick up what is going around as soon as possible in order to integrate their activities and save victims. The plan and the procedure indicate that information about activities in inter-organizational collaboration is provided by communicating this information through the Command Posts (CPs) in the tactical level. However, based on our ethnographic data, the

communication of information in real situation of crisis management is not fluid. This is due to the problem of information flow; bottom-up and top-down, weak interaction between actors in inter-organization as well as the information unavailability due to the lack of awareness about others actor needs.

We present in detail the current communication and awareness problems hamper information awareness within *inter-organizational collaboration* in crisis management:

3.2.1 Weak Interaction between Actors

Monitoring activities in inter-organizational collaboration in crisis management is difficult. The crisis could be in a large space; actors are remote and could not observe others activities directly as well as the tools used are generally the radio which does not enable to achieve information awareness effectively. In the procedures, the CP of each organization should assume inter-organizational communication and information sharing about activities; however it is not always the case. CPs are not always established at the beginning of crisis, "*As the CP is not yet installed, there is a period of waiting and communication is very complex*" (I8). In this case, the only way to pick up what is going around is via interlocutor. Actors try to find other organization' interlocutor to pick up what is going around, whereas, it is difficult to interact between each other; as it is difficult to reach and determine who is in the field, the position of remote actors and actors' roles, we note that the roles are dynamic and an actor may have different role at each time: e.g. "*CRO cannot find an interlocutor from EMS to have a medical answer*" (E1)
"*We need to identify who is the interlocutor for each service and who is the decision maker*" (I6)
This issue is caused by missing awareness about actors' network "*it is necessary to maintain a network of knowledge to communicate information rapidly*" (I10).

3.2.2 Information Unavailability

Even if the CP are set up (e.g. after one hour of crisis (E1)), the information still unavailable due to the difficulty to manage and send the right information at the right time; in one hand, the CPs are overloaded by the treatment of many calls in radio as well as the transmission of information report to the operational center and to the crisis cell (e.g. Departmental Operation Center if the crisis is departmental). So this hamper communicating

information transversally. *(e.g "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"* (I6, D1).

In the other hand actors could not determine precisely the relevant information needs for others.
"*We realize that we are really advanced and we wait the vehicles of firefighter and that police give us the information of access… The transmitter does not give information at the right time*" (I6, D1)). "*There is a transmission of information but not necessarily the right one […] The transmitter may give fragmented information that are not exploitable*" (I6, D1).

This is due to the missing awareness about actors' priorities and objectives, in addition to the lack of awareness about actions interdependencies. Hence, the interlocutor of each organization could not determine the right information needed by other actors neither at each time they need it. (E.g. *The police know that there is an escape route, but they do not necessarily communicate…*" (I6)
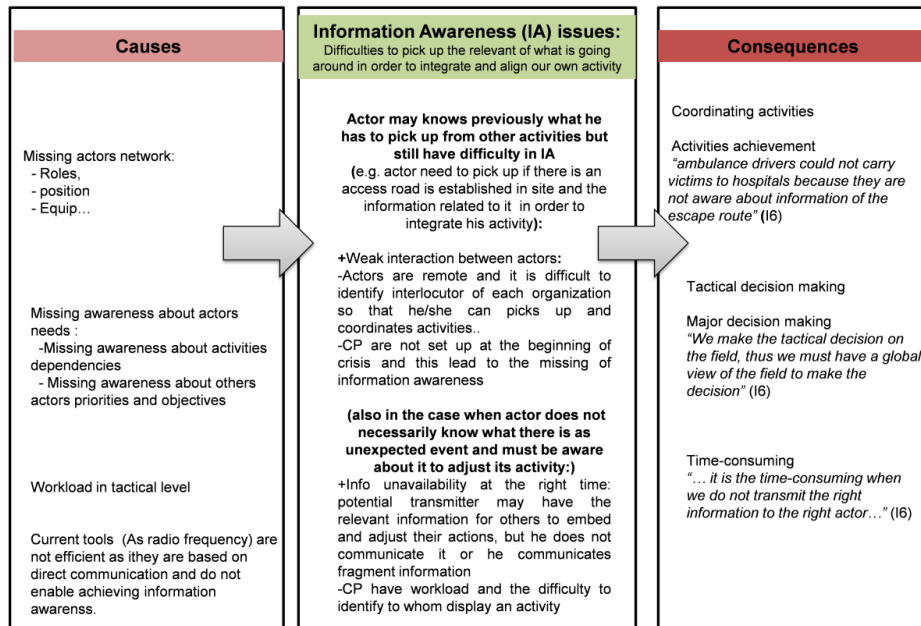"*There is a logistical dependence also related to information at the right time. We do not transmit the relevant information for the activity of the other at the right time*" (I6)

3.2.3 Information Flow (Top-down; Bottom-up)

Information flow is very long from operational (OL) to the strategic level (SL). It is as follows: for each organization, actors in OL send information report about their activities vertically to their own Command Post (CP) to make tactical decision. In turn information are reported to the different centers to inform them what is going on the field (actions carried out, resources required etc). Afterward, this information is reported to the SL (DOC). Consequently, all this, produces a shift phase between the different levels operational, tactical and strategic levels. This is due to the lack of tools that enable actors to pick up what is going around instantly. Hence, the major decision making and unfolded measures are affected. "*The time is not the same in the field as in the CC of EMS, and in the DOC*" (I6)
In other hand, actors in the field are not aware instantly about the major decision made in strategic level or the decision made by the Commander of rescue (in tactical level) to embed and align in the field. "*We are not necessarily aware at the right time about the decisions made in strategic level*" (I6). "*There is a problem of information top-down,*

Table 4: Information Awareness issues, causes and effects.

Causes	Information Awareness (IA) issues: Difficulties to pick up the relevant of what is going around in order to integrate and align our own activity	Consequences
Missing actors network: - Roles, - position - Equip… **Missing awareness about actors needs :** -Missing awareness about activities dependencies - Missing awareness about others actors priorities and objectives **Workload in tactical level** Current tools (As radio frequency) are not efficient as ithey are based on direct communication and do not enable achieving information awarenss.	**Actor may knows previously what he has to pick up from other activities but still have difficulty in IA** (e.g. actor need to pick up if there is an access road is established in site and the information related to it in order to integrate his activity): +Weak interaction between actors: -Actors are remote and it is difficult to identify interlocutor of each organization so that he/she can picks up and coordinates activities.. -CP are not set up at the beginning of crisis and this lead to the missing of information awareness **(also in the case when actor does not necessarily know what there is as unexpected event and must be aware about it to adjust its activity:)** +Info unavailability at the right time: potential transmitter may have the relevant information for others to embed and adjust their actions, but he does not communicate it or he communicates fragment information -CP have workload and the difficulty to identify to whom display an activity	Coordinating activities Activities achievement *"ambulance drivers could not carry victims to hospitals because they are not aware about information of the escape route"* (I6) Tactical decision making Major decision making *"We make the tactical decision on the field, thus we must have a global view of the field to make the decision"* (I6) Time-consuming *"… it is the time-consuming when we do not transmit the right information to the right actor…"* (I6)

we are not aware about the major decision made in SL and they are not communicated to actors on field" (I6,D2).
"*Sometimes, the Commander of rescue makes decision. However there is a delay to receive this decision*" (I6). Top-down and bottom-up, affect the global information awareness in SL and the major decision-making.

In table 4, we summarize the information awareness issues, causes and effect in inter-organizational-collaboration in crisis management:

To summarize: currently actors pick up what is going around through tactical level, this is not efficient as actors have to research an interlocutor from who to pick up his needs. In other hand the CPs do not transmit all information needed neither at the right time. Hence, picking up information awareness with current communication and awareness problem is not sure. Besides, actor transmitter (e.g CP in tactical level) and actor looking for information (E.g. actors in the field) may pay cost instead they benefit -in transmitting information and looking for interlocutor, information needed etc.). Second, actors can receive information that the sender believes relevant for them, whereas he cannot determine the relevance without the context of other own activity. Third, sender cannot predict relevant information for others and time of needed (Dourish and Bellotti, 1992).

3.3 Supporting Information Awareness in Inter-organizational Collaboration

To support information awareness we asked the question if it is relevant to support social awareness in order to enable actors the identification of "to whom displaying their activities" and identify "interlocutor from who to pick up what is going around". On analyzing the situation of crisis management, this solution will enhance interaction between actors. However, it is difficult in such situation with dynamic event; in addition action, the roles and responsibilities of actors in the field are dynamic, so defining a list of transmitter and receiver will not be exhaustive. Besides, the transmitter and the person who search for information may pay cost of time to transmit or request the information during executing their activities. Another reason is that actors could not monitor all this all this dynamism. Thus, we focus our solution on the core definition of awareness in the cooperative work as taking heed of needed information and other relevant occurrences in order perform and integrate interdependent activities.
Before we present our approach, we give some recommendations to support cooperative application for inter-organizational collaboration:
The crisis is a dynamic process of events and actions that are unpredictable, thus the systems should not automate all process.

The sender could not predict relevant information for others and time of needed. Thus we suggest a (1) system that distributes information within the context; information which critical to a decision or performing action: for instance, determine information by action or goal intended, location, and role etc. (2) the system must support audiovisual and geographical information. GIS could provide a good representation of data (3) Information must flow instantaneously bottom-up, top-down and transversally. (4) Use tools that actors are used to use (e.g. the Smartphone; actors use mobile phones in parallel with the radio) (5) keep the current systems used by actors (e.g. information system) and make an interoperable system that centralizes information in the common core and distribute the needed information to the existing systems.

What we propose is semi-structured system which collects information in the common core and distributes information awareness to the different actors in the different level (figure 1). The distribution rely on (1) model of interdependent action/activities that are defined

from the crisis response plan and previous experience. (2) The distribution considers also the model of actors' network, which includes dynamic role and responsibilities in addition to other meta-data (e.g. organization, time, function etc.). These models are explained in detail in (Saoutal et al., 2015). Briefly, empirical data shows that the most information needed to achieve an action are related to other set of activities or subsidiary of activity. Thus, we model the different activities -in common core-, sub-activities (actions) and their dependencies. When the information is collected in common core -we notice that this information is originally reported by the different actors executing actions and exercising their activities- then this different information such as {decision, message of information, video, photos, data and unfolded
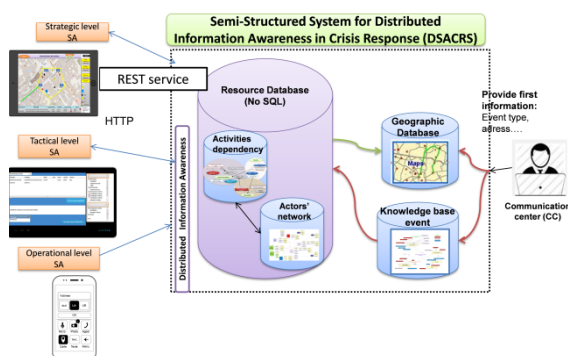
logistics} is organized under multi-level: principal activity -> subsidiary activity (see an example in figure 2). After that, we distribute to each actor context, the information awareness needed. To apply that, we consider the context by the set of information {the goal intention and/or the operation that he will perform, his location and his role} in order to provide the information provided by interdependent activities and provide also additional information based on his location and role. All this information is represented with metadata such as time, actor provider, responsibility, organization etc. This model is dynamic and updatable in which we can add, modify or remove activities, sub-activities and dependencies during crisis response, for that, we suggest to add a new role of "supervisor" who will monitor all situation in the field remotely, control the interaction and the integration of the different information that are not supported by the system previously and who will manage the dependencies as judged by the situation.

We are currently, implementing the prototype and developing the system using a user-centered design methodology to meet the end user requirement. The system will be implemented in heterogeneous tools (such as Smartphone, tablet, PC etc.) in order to facilitate the portability and the usability of the systems by the different actors: in the field (OL), in tactical level (TL) and in the strategic level (SL).

Some guideline to develop cooperative system for CR:

- We used the field studies in order to analyze the practice work and the current problem and needs of crisis responders. This was conducted by observation and interviews about specific issues (such communication and awareness) in order to pick up other problem/solution that they do not perceive and do not require.

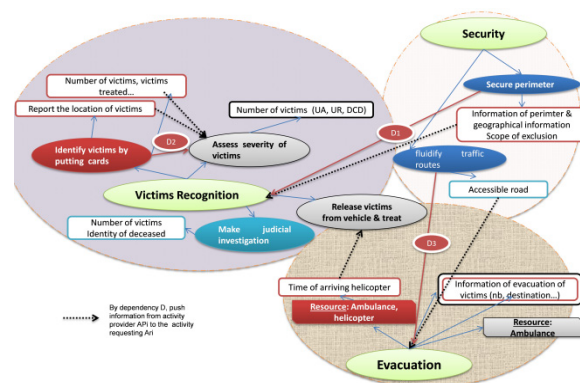Figure 1: Semi-Structured System for Distributed Information Awareness.

Figure 2: Example for Activities Interdependency and Information Structure.

Figure 3: Application for distributing Information Awareness.

- The prototype should focus on those functionalities which will handle the analyzed problem. Before developing, we propose to perform a scenario-based walkthrough with professionals based on a paper or other format of presentation explaining the solution. The goal is to see if actors with the proposed prototype, will accomplish their activities (in this case: we want to analyse of actor will achieve information awareness based on described scenario) and to have some professional feedback in order to improve the system.

- Technically, we can use distributed architecture which enable the functioning of many systems and provide information with different format to these system at the same time. One technical solution is to use the web service REST as its architecture is oriented-resource dedicated for distributed hypermedia and its services are implemented by HTTP-servlets. We suggest also using NoSQL database in order to support a massive number of transactions, data, users etc. and for their simple use and development.

In figure 3, we present the application for distributing Information Awareness. Responders in the field have the application in Smartphone which is attached to the actor's arm to facilitate sending report and doing their activities at the same time. When an actor send report (e.g. firefighter send information about victims' recognition - evaluation), this information is structured under the activity "recognition victims fire" and sub-activity "evaluation". The structure is previously established in the database according to the model of activities dependency. To facilitate the management of dependencies, we included in IA-activity, the information about internal operation output and the information about dependant operations output, so that actor could pick up all and just information related to the activity that he interested in. In this example, we have IA-Recognition which contains according to figure 2, recognition victims EMS, recognition victims firefighter and Secure perimeter, as actors that are interested to executing the recognition need all these information.

So when the EMS responder subscribe to IA-recognition, he will have access to this information and will be aware about the perimeter of security, what was done by firefighter, when, who, the victims previously treated, their localization through the visual information on map, which facilitate him to integrate and execute his own activity.

This model is manageable during crisis, supervisor could manage the information report that are not categorized and structured under operations as he has the global view of what is going around. He/she can assign this information to the suitable IA-operation as he prejudges its relevance for an organization or an operation. This role needs a minimum of knowledge about each organization, the objectives, culture etc.

4 CONCLUSION

In this work, we identify the multitude inter-organizational failures related to the information awareness issues rooted in a lack of awareness about: actors 'network (role, organization, position etc.), activities' interdependency and actors requirement. All this problems hamper IA achievement and lead to issues in decision making and action achievement. Thus, we propose an approach that addresses the problem of information awareness and how *"picking up all and only needed and the relevant information at the right time about what is going around us for a given context in order to integrate and achieve our own activities"*. This approach is based on activities' interdependency model and relies on organizing information and occurrences of activities generated and provided from different actors and organization involved in crisis management so that actors could pick up easily the needed information about what is going around them.

We believe that this approach system will enhance information awareness as this model is flexible and can be managed during crisis; add new activities and new interdependencies during dynamic situation of crisis so that actors could achieve information awareness about unanticipated occurrences. Actors could add in their system new operations (or an unanticipated event) and new interdependencies during dynamic situation so that actors could achieve information awareness about unanticipated occurrences.

In our future work, we will experiment the system to prove the effectiveness of this approach in crisis response, the mitigation of the time-consuming and the achievement of information awareness at the right time, to the right actor through the system in order to make decision and achieve action at the right time.

REFERENCES

Bharosa, N., Janssen, M. and Tan, Y.-H. (2011) A research agenda for information quality assurance in public safety networks: information orchestration as the middle ground between hierarchical and netcentric approaches Cognition, Technology & Work, Springer, 13, 203-216.

Belkadi, F., Bonjour, E., Camargo, M., Troussier, N. and Eynard, B. (2013) A situation model to support awareness in *collaborative design International Journal of Human-Computer Studies, Elsevier, 71, 110-129*.

Benford, Steven D., John M. Bowers, Lennart E. Fahlén, and Chris Greenhalgh (1994): Managing mutual awareness in collaborative virtual environments. In G. Singh, S. K. Feiner, and D. Thalmann (eds.): VRST'94: *Proceedings of the ACM SIGCHI Conference on Virtual Reality and Technology, Singapore, 23–26 August 1994. New York: ACMPress, pp. 223–236.*

Bly, Sara, Steve R. Harrison, and Susan Irwin (1993): Media spaces: Bringing people together in a video, audio, and computing environment. *Communications of the ACM, vol. 36, no. 1, January 1993, pp. 28–47.*

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

Damian, D., Marczak, S., and Kwan, I. (2007). Collaboration Patterns and the Impact of Distance on Awareness in Requirements-Centred Social Networks. *15th IEEE International Requirements Engineering Conference 59–68. doi:10.1109/RE.2007.51.*

De Souza, C. R. & Redmiles, D. F. The Awareness Network, To Whom Should I Display My Actions? And, Whose Actions Should I Monitor? *Software Engineering, IEEE Transactions on, IEEE,* 2011*, 37,* 325-340.

Dourish, P. and Bellotti, V. (1992) Awareness and coordination in shared workspaces. *Proceedings of the 1992 ACM Conference on Computer-Supported Cooperative Work - CSCW '92, 107–114. doi:10.1145/143457.143468.*

Dourish, P. and Bly, S. (1992): Portholes: supporting awareness in a distributed work group. In P. Bauersfeld, J. Bennett, and G. Lynch (eds.): *CHI'92 Conference Proceedings: ACM Conference on Human Factors in Computing Systems, 3–7 May 1992, Monterey, California. NewYork: ACM Press, pp. 541–547.*

Endsley, M.R. and others Theoretical underpinnings of situation awareness: A critical review Situation awareness analysis and measurement, Mahwah, NJ: Lawrence Erlbaum Associates, 2000, 3-32.

Fish, Robert S., Robert E. Kraut, and Barbara L. Chalfonte (1990): The VideoWindow system in informal communications. CSCW'90, *Proceedings of the Conference on Computer-Supported Cooperative Work, Los Angeles, Calif., 7–10 October 1990. ACMPress, New York, pp. 1–11.*

Gaver, William W. (1991): Sound support for collaboration. In L. J. Bannon, M. Robinson, and K. Schmidt (eds.): ECSCW'91: *Proceedings of the Second European Conference on Computer-Supported CooperativeWork, Amsterdam, 24–27 September 1991. Dordrecht: Kluwer Academic Publishers, pp. 293–308.*

Gorman, J. C., Cooke, N. J. and Winner, J. L. (2006) "Measuring team situation awareness in decentralized command and control environment". Ergonomics, 49 (12-13), 1312-25. DOI: 10.1080/00140130600612788.

Gutwin, Carl (1997): Workspace Awareness in Real-Time

Distributed Groupware. PhD dissertation, Department of Computer Science, *The University of Calgary, Calgary, Alberta, December, 1997.*

Gutwin, Carl and Saul Greenberg (1999): The effects of workspace awareness support on the usab- ility of real-time distributed groupware. *ACM Transactions on Computer-Human Interaction, vol. 6, no. 2, September 1999, pp. 243–281.*

Gutwin, Carl and Saul Greenberg (2002): A descriptive framework of workspace awareness for real-time groupware. *Computer Supported Cooperative Work. The Journal of Collaborative Computing, vol. 11, nos. 3–4, 2002. – This issue.*

Jiang, X., Chen, N. Y., Hong, J. I., Wang, K., Takayama, L., and Landay, J. A. (2004) Siren : Context-Aware Computing for Firefighting. *Proceedings of the Second International Conference, PERVASIVE 2004. Linz/Vienna, Australia, April 2004. 87–105. http://doi.acm.org/10.1145/503376.503378.*

Ley, B., Pipek, V., Siebigteroth, T., and Wiedenhoefer, T. (2013) Retrieving and Exchanging of Information in Inter-Organizational Crisis Management. In *Proceedings of the Information Systems for Crisis Response and Management (ISCRAM) (pp. 812–822).*

Ludwig, T., Reuter, C. and Pipek, V. (2013) What You See Is What I Need: Mobile Reporting Practices in Emergencies. *Proceedings of the 13th European Conference on Computer Supported Cooperative Work, 21-25, Cyprus.*

Mayring, P (2000). Qualitative Content Analysis [28 paragraphs]. Forum Qualitative Sozialforschung / Forum: Qualitative Social Research, 1(2), Art. 20, http://nbn-resolving.de/urn:nbn:de:0114-fqs0002204.

Prasanna, R. Yang, L. and King, M. (2011) Evaluation of a software prototype for supporting fire emergency response. *Proceedings of the 8th International ISCRAM Conference – Lisbon, Portugal.*

Robertson, Toni (1997): Designing Over Distance: A Study of Cooperative Work, Embodied Cogni- tion and Technology to Enable remote Collaboration. Submitted for the Degree of Doctor of Philosophy, School of Computing Sciences, *University of Technology, Sydney, 1997. 195 pp.*

Salmon, P. M.; Stanton, N. A.; Walker, G. H.; Jenkins, D. P. and Rafferty, L. (2010) Is it really better to share? Distributed situation awareness and its implications for collaborative system design Theoretical Issues in Ergonomics Science, *Taylor & Francis*, 11, 58-83.

Sapateiro, C. and Antunes, P. (2009) An emergency response model toward situational awareness improvement. *Proceeding of the 6th International conference on information systems for crisis response and management, Göteborg, Sweden .*

Schmidt, Kjeld (1994): Modes and Mechanisms of Interaction in Cooperative Work. Risø National Laboratory, P.O. Box 49, DK-4000 Roskilde, Denmark, 1994. [Risø-R-666(EN).]

Schmidt, K. (2002) The problem with ''awareness''. Introductory remarks on ''awareness in CSCW'', *Computer Supported Cooperative Work (CSCW): The*

Journal of Collaborative Computing 11(3–4),285–298.

Streefkerk, J. W., van Esch-Bussemakers, M. P. and Neerincx, M. a. (2008) Field evaluation of a mobile location-based notification system for police officers. *Proceedings of the 10th International Conference on Human Computer Interaction with Mobile Devices and Services - MobileHCI '08, 101. doi:10.1145/ 1409240.1409252*

Steinmacher, I.; Chaves, A. P. & Gerosa, M. A. (2013) Awareness support in distributed software development: *A systematic review and mapping of the literature Computer Supported Cooperative Work (CSCW), Springer, 22, 113-158.*