A Framework to Capture Incidents during Emergency Situations

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ABSTRACT

Emergency organizations have contingency plans, which define responsibilities, resources, and actions to be performed in an emergency situation. However, unexpected incidents may arise and cause additional difficulty in the emergency control process. The knowledge that team members develop to deal with these incidents and keep the system 'functioning' improves resilience and response and is very valuable for such organizations. This research addresses the problem of how to capture the incidents and knowledge generated during the emergency response through a conceptual framework. The framework defines a structured process for preparation and capture of incidents during an emergency through direct observations, to assist in the capture and proper representation of the incidents to produce knowledge within other practitioners.

Keywords

Emergency response, incidents, contingency plans, learning.

INTRODUCTION

Emergency management organizations seek to improve their processes and response time to avoid loss of human lives and material losses, as well as to develop preventive measures to reduce the impact or, if possible, avoid the emergency. Organizations have emergency plans, which define objectives, responsibilities, resources, strategies and actions to be performed in an emergency situation. Most of the plans to deal with major events are based on the Incident Command System (ICS) process standard, defined under the Federal Emergency Management Agency (FEMA 2008). The ICS system is based on forms as the ICS 234 – Work Analysis Matrix (figure 1) that define operation objectives, strategies and tactics/work assignments. At the strategic and tactical planning level, where multi-agency planning takes place, the use of manually filled ICS paper forms, is still widely adopted.

During the development of planned actions, unexpected incidents may happen. These adverse events and/or unanticipated situations need immediate attention and may lead to changes in the plans at any level. As observed in CICC-RJ (Gomes F et al. 2014), in many of these situations, experts make decisions solve the problems in an ad hoc basis, not according what was previously defined by the plan.

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The knowledge that team members develop to keep the system "functioning" when dealing with these incidents improves system resilience, and is very valuable for the organizations. Dolif et al. (2013) found that tacit knowledge of experts is the main source of resilience for decision making during an emergency, especially when dealing with critical (in time) situations.

WORK ANALYSIS MATRIX ICS 234		
1. Incident Name		2. Operational Period From: To:
3. Objectives DESIRED OUTCOME	4. Strategies HOW	5. Tactics/Work Assignments WHO, WHAT, WHERE, WHEN
Outcome 1	Strategy 1.1	Tactics/work assignments 1.1.1 Tactics/work assignments 1.1.2
	Strategy 1.2	Tactics/work assignments 1.2.1 Tactics/work assignments 1.2.2
Outcome 2	Strategy 2.1	Tactics/work assignments 2.1.1 Tactics/work assignments 2.1.2
	Strategy 2.2	Tactics/work assignments 2.2.1 Tactics/work assignments 2.2.2
	Strategy 3.2	Tactics/work assignments 3.2.1 Tactics/work assignments 3.2.2
...	...	...

Figure 1. ICS 234 Work Analysis Matrix form.

Therefore a way to capture how people deal with unexpected incidents is needed, because strategies, tactics and work actions can be analyzed and evaluated for reuse in future plans and used as basic learning elements in the individual and team learning, providing lessons learned, and indicating good (or bad) practices.

This research addresses the problem of how to capture the incidents to recover the actions and the knowledge generated during the emergency response through a conceptual framework. The activity theory and concepts (Engeström, 2000) has inspired this research to find the constraints and contradictions, which emerge as a result of tensions within or between the elements (object, rules, subjects, tools) of an activity system. In the emergency domain such constraints manifest in the form of deviations from standard scripts, thereby threatening its coherence. According to Engeström, although activity systems are driven by a deeply communal motive, they are inherently contradictory. However to achieve the goals/objectives of the activity people must find ways to resolve contradictions.

The proposed framework defines a structured process for preparation of observations and capture of incidents during an emergency, through direct observations, and other cognitive task analysis techniques. It also assists in the proper representation of the captured information for learning purposes.

Background

Previous research in process systems indicated that even in high regulated environments like nuclear power plants, operator try to use rules and procedures to solve problems cause by unexpected incidents up to the moment that the activity system present constraints and contradictions that are resolved in an ad hoc basis, mainly based on experts knowledge and decisions based on pattern recognition (Carvalho et al. 2006). In this research the Carvalho and colleagues also found that the actual process that people make decisions and solve problems was not document at all.

In emergency domain, Mishra et al. (2014) discuss what they called "intuitive" (Type 1) versus "analytic" (Type 2) decision-making process of tactical commanders. They conclude that under time pressure commanders make more "intuitive" decisions, relying on their tacit knowledge. As the same people that respond to the emergency are responsible to fill the forms, there are very little information about how problems are solved at the end. They also found that "…information available is often not used to resolve uncertainty in decision-making and indeed information is often sought and used after the decision is made to justify the decision." So a non-formalized or explicit tactics plan appears during the emergency, creating new knowledge about what to do or NOT to do that should be made visible and readily available for a learning organization.

The search for detailed information after the occurrence of an emergency is a task that requires a considerable investment of time as well as the proper use of techniques for the identification and registration of information. It has been observed that the emergency management organizations have a limited knowledge management process, especially to learn about events and activities not covered by the plans.

Analyzing the operation of the Integrated Command and Control Center of Rio de Janeiro (CICC-RJ) during major events in Rio de Janeiro in 2013 (Gomes Filho et al., 2014) found that the lack of support tools to capture and analyze incidents and actions to improve plans, detect operational constraints, and enable learning was evident.

RESEARCH METHODOLOGY

Activity analysis related methodologies, such as ethnography Takaaki (2012) and Cognitive Task Analysis – CTA (Crandal et al. 2006) was used for capturing and analyzing data from direct observations. Field studies system (Gomes F et al. 2014; França et al. 2014) were carried out in the Integrated Command and Control System of Rio de Janeiro State (CICC-RJ) to understand how tactic commanders of the multiagency environment deal with incidents during big events, finding the constraints/contradictions between elements (object, rules, subjects, tools) of the activity.

After these field studies, a framework for incident capture based on direct observations and computerized collaborative support system was developed for application in C2 centers. The framework is develop to be used by incident observers that have a certain level of knowledge in this kind of environment. The methodologies that support the framework are ethnography, CTA and Critical Incident Technique (CIT).

As pointed out by Takaaki (2012), ethnography is a method to describe and model the phenomena occurring in a specific field, being a useful method in circumstances where people's actions and behaviors in the field are undertaken through complex interactions among themselves and with artifacts. Direct observation provides a description of events, people and observed interactions through detailed and accurate record of the events and actions. The use of CTA enables the analysis and understanding of cognitive functions such as perception, attention, memory, decision making, and judgment that complements direct observation. According to Crandall et al., (2006) CTA is used to understand and describe the reasoning and knowledge in complex situations including perception and observation activities. There are three main aspects to CTA: knowledge elicitation which refers to how to collect data, data analysis, and knowledge representation.

Finally, the Critical Incident Technique (CIT) technique created by Flanagan (1954) describes a set of procedures for collecting information about incidents that have special significance according to some defined criteria. There are five main steps in the CIT procedure: general objectives; review plans and specifications; data collection; data analysis and interpretation; and report.

To define the specifications and parameters of observation we used the results of previous observations in CICC-RJ and interviews with an expert in emergency response. A preliminary evaluation of the framework and correlated specifications was made by the same expert interviewed before. However, the evaluation of the framework is still under way, as it will be applied in simulations and real events, enabling a deeper reflection about the incident capture process. Therefore, the framework and resulting tools are still in preliminary testing in semi controlled environments.

FRAMEWORK TO CAPTURE INCIDENTS

The process for capturing incidents focusses on the direct observation of an ongoing emergency inside an integrated command and control center, and further description of events, decisions and actions. The data captured compiles results of observations, and also images, audio, and videos.

The framework, based on field observations, aims to assist the observation team through a process that guides the preparation, observation and description of incidents. Thus, the framework is divided into two stages: the preparation or planning of observation and capture of incidents as shown in figure 1. The overall goal is to structure the capture of the incidents by previously defined observation

specifications, e.g., work environment, emergency type, what should be the main parameters to be observed, the log structures, and possible representation forms for a later analysis, and so forth.

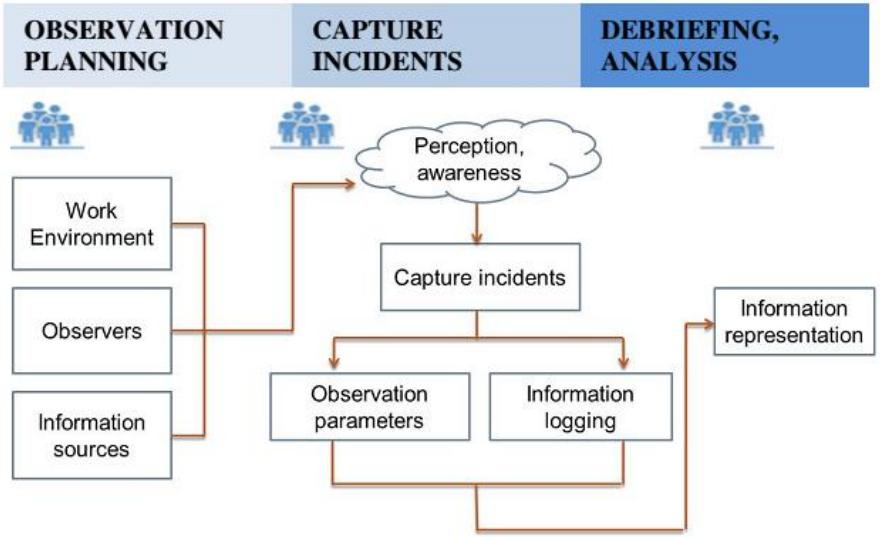

Figure 2. Framework to capture incidents

Planning the observation

The first step is to define the observation team, a group of people in the role of observers. Then a meeting where an overview of the general objectives of the observation are discussed and the observation plan is developed where some basic issues – specifications for observations – are defined. Table 1 describes three issues considered relevant in the observation planning process: understanding the workplace, the observations team itself, and the operational plan.

Capturing incidents

This is the central step of the framework. It aims to assist and guide the observers in capturing incidents in command and control centers. For this framework, incidents are defined as any event that causes a disruption in normal operations leading to divergence or contradiction of actions and the prescribed organization constructs (Carvalho et al. 2006). The goal is generates and records useful representations of the observed incidents.

Table 1. Specifications for observation

SPECIFICATIONS FOR OBSERVATION	DESCRIPTION
Understanding the work environment	
Actors	People in emergency management
Actors position	Position in the emergency room
Activities	Activities based on the plan
Info sources	Info sources available
Constraints	Information and physical constraints
Places to observe	Possible spaces for the observers
The observers	
Number	Define the number of observers
Profile/expertise	Expertise of observer
Position	Detail the positioning of observers
Support Material	IT Support, field notes, and other
The Plan	
Daily tasks	Analysis of the basic tasks during the event
Event/work matrix	Planned objectives, strategies and tactics

According to Crandall et al. (2006), the main difficulty in direct observations is the definition of what has to be observed and how to record observations. Therefore we need some sort of labeling or categorization of activities, and the use of certain forms for data collection. It is important to note that we are not supposing that observers will capture all incidents during an emergency, but some meaningful ones. Accordingly, table 2 describes some recommended parameters of observation, based on activity theory elements for a C2 system. In the case of less experienced observers it is especially important to specify the observation parameters in more detail. During the capturing process, the observed details of the incidents are recorded to create a database of knowledge or historical occurrences. At this stage it is important to register the most relevant information about the incidents related to the observation parameters shown in table 2.

The proposed framework seeks to structure the capture and representation of information about incidents using logic temporal sequences (timelines) as indicated by the Critical Incident Technique to make an evolutionary history to be comprehensible by other people. The data input and representation of information follows the basic idea of User Story Mapping (Patton,2005) shown in figure 3.

Moreover, given the complexity in understanding an incident and capturing relevant facts about it, there is a clear need to work in multidisciplinary teams with physically dispersed observers that share information and interact during observations. Thus, the framework supports the interaction among observers, where each recorded action is immediately available to other observers, so that each record can be complemented by the additional input of the observation team. Therefore the use of a computer supported collaborative work system increase the effectiveness of the observation process, recording and sending information about the events and promoting communication, enabling collaboration among team members.

In the first step the collaborative approach supports the planning of observations that must be visible to the entire team. In the preparation stage, Google drive can be used to store supporting documents to be shared during the observation process.

Table 2. Observation parameters

OBSERVATION PARAMETERS	DESCRIPTION What to observe?
Information sources	Operational Plan (ICS form) or equivalent Available video cameras showing the event Available incident recording tools such as databases Emergency indicators generated by electronic devices in the field Permanent review of media reports
Observable behavior	Movements, gestures, eye direction of commanders during the event
Communications	Tracking the staff communications: • Supervisors, planning, logistics and operations staff • Staff responsible for requesting and sending information • Staff in charge of disseminating information after meetings • Staff in charge of dissemination and follow up of critical information • Occurrence Reports •Informal conversations and information exchanges
Decision-making	Follow up of decisions: the options selection and the results of actions
Other activities	Follow up the activities in: • emergency meetings • understanding problems. • meetings in crisis room.
Human-machine interaction	Follow up actions on man-machine interfaces

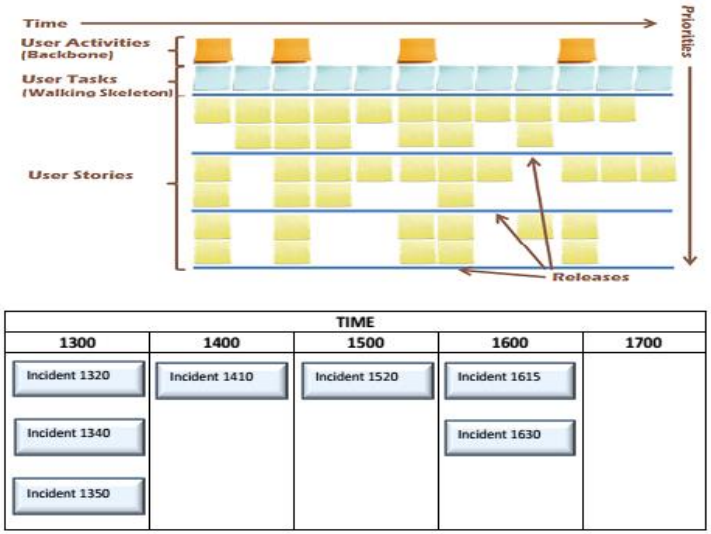

Figure 3. User story maps (Patton,2005) and incident representation

To capture information in an ongoing emergency the Trello tool is used. Trello is a free online task-oriented system for collaborative document management. It facilitates the updating and sharing information in real time and aligns overall team perception about of what is being done by each member through its notification system. Figure 4 shows a print screen of Trello interface (in Portuguese) where one incident is described in detail.

Capturing incidents aims to record contextual information and details about the strategies and actions taken for incident response, in an attempt to adequately answer questions like: who, when, where, what and how. Information that, after future analysis, enables a better understanding about the behaviors and awareness of the actors, availability of information sources, and so forth, used to cope with unanticipated variations in plans.

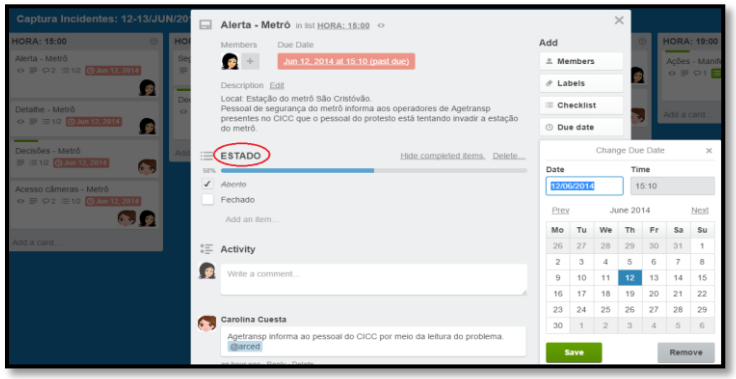

Figure 4. The Trello interface detailing incident capture

Figure 5 indicates some relevant information can be added in the plan after observations. When filling ICS form, only the strategy name appears, and the other relevant information about how strategies and tactics are conceived can be added after the result of the observations.

PRELIMINARY EVALUATIONS

The first test of the framework was conducted during a tabletop exercise in CICC-RJ. The exercise was the response to a big car accident in the city of Rio de Janeiro with the participation of 20 people with various roles in emergency response. There were also 3 people in the role of external observers to capture the action according to the framework. To obtain observers' perceptions of using the framework, 2 evaluation questionnaires were employed: one to explore the level of knowledge, experience and motivation of participants; the other one focused on the elements of the framework, insights and recommendations for its improvement. Initial results of the evaluation provide preliminary evidence that the use of the framework enables the capture of incidents, aggregating more information about what is really happening during the evolution of an event, highlighting the benefits of incident knowledge reuse.

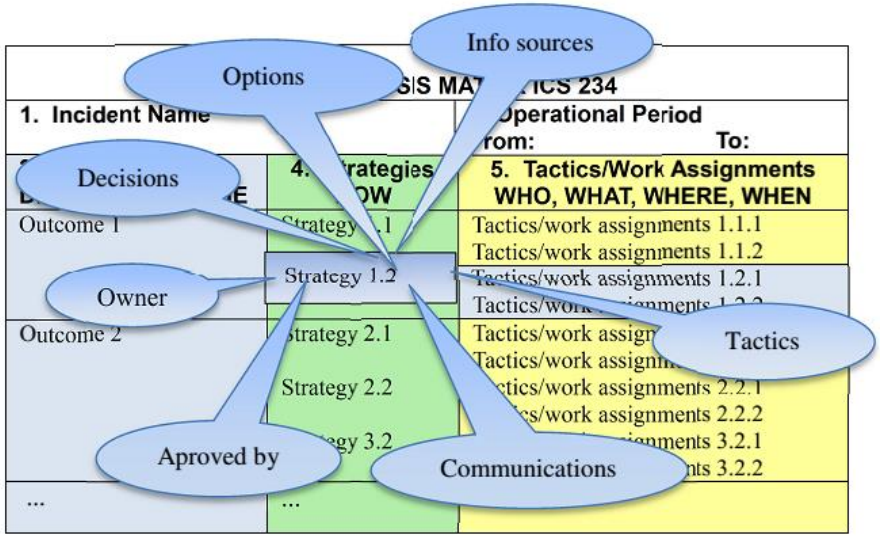

Figure 5. Contributions to the plan

CONCLUSION

Previous research in CICC-RJ indicated the need of capturing incidents during ongoing emergencies, identifying key elements for a deeper understanding about incidents for further learning and plans improvement. To address these issues we proposed a framework to follow up incident responses enabling a more complete and reliable processes for capture and recording information about incidents. The framework, based on activity theory, emphasizes the importance of permanent incident information capture and recording, in addition to the collaboration among the members of the observation team. We expected that the use of the framework aggregating new expressions in planning instances (strategies, tactics) enhances context traceability and planning awareness, enables selective expressions reuse in new plans, and reuse of incident knowledge for training. The features were implemented in prototype Web Tool (Trello) for a preliminary evaluation (still under way) by emergency management experts. Further tests and evaluations are on the way with the continuous use of the framework during simulations and in in real situations at CICC-RJ. Next research steps aim the inclusion of the feedback from experts in framework, and the development of a specific Web Tool for incident capture. Further research will look at the possibility to interact and exchange information with external (operational) observers and other systems for operational response and resource planning, for improve incident situation awareness, and the overall planning capabilities of the organization.

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