Crisis Management: A collaboration model
for unstructured activities

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Abstract

Unstructured activities emerge in organizations for several reasons. Particularly in emergency situations and crisis management scenarios, the organization's procedures and information systems may not cope with the information and collaboration requirements imposed by the evolving unplanned situations. To overcome these needs, users engage in informal relationships and make use of their tacit knowledge. In this paper we present a collaboration model aiming to assist these unstructured activities, while improving their consistency and effectiveness. The proposed approach relies in the collaborative development of Situation Awareness, constructed from a set of Situation Matrixes organizing the different informational dimensions that characterize the evolving situation. The paper also describes a prototype implementation of the proposed model.

Introduction

The existing work processes in organizations are supported in a continuum of structured and unstructured activities (Sheth, Georgakopoulos et al. 1996; Bernstein 2000). Unstructured activities usually emerge from a lack of support of existing IS and/or organizational procedures to deal with unplanned situations.

The most common approaches to IS development focus on identifying the structure of work processes (actions, action sequences, roles, responsibilities, resources allocation, etc.) to produce a specification and then an implementation. However, many unknown *a priori* variables, both external (e.g., market dynamics and natural disasters) and internal (e.g., deficient requirements analysis, latent problems, or lack of flexibility) are among the factors that may lead to unstructured situations. Within these unstructured

situations we include exception handling, business process reconfiguration and crisis management.

To get the work done when facing such unstructured scenarios, people usually engage in informal relationships and make use of their tacit knowledge in an opportunistic manner, which quite often reveals as a source of innovation, creativity and flexibility.

We find in the research literature several projects addressing business process reconfiguration and exception handling (Kammer, Bolcer et al. 2000; Mourão and Antunes 2007). The research reported in this paper goes beyond this specific context towards the much more complex crisis management. We characterize crisis management activities in the following way (Markus, Majchrzak et al. 2002):

- No best structure or sequence
- Typically distributed
- Dynamically evolving
- Actor roles unpredictable
- Unpredictable contexts

A crisis management situation concerns the need to support emergent and highly flexible work processes and, when necessary, dynamic redesign of the whole organization.

Crisis management may be more frequent in some kinds of organizations than others. For instance, in organizations such as news reporting, due to the flexible nature of work there, the occurrence of unplanned situations is relatively high. Another example concerns organizations specifically dealing with crisis management (e.g., civil protection, firefighters), where even contingency plans may be challenged by particular situations and dynamics, promoting the emergence of mutual adjustment activities.

Although, as stated, there are a number of scenarios with similar requirements for unstructured activities support, there are also some specific characteristics that may influence the kind of support required, e.g., the existence

(or not) of: a support organization, adequate training, clearly defined hierarchical structures and chains of command, group support and decision support tools, cross-organization cultures regarding coordination and collaboration, geographic dispersion, and time criticality.

The concept of resilience, which may be characterized as a comprehensive endeavor towards increased organizational resistance and flexibility dealing with exceptional and emergency situations, has recently emerged (Hollnagel and Woods 2006; Sheffi 2006; Cocchiara 2007). This concept encompasses every aspect related with increasing organizational resistance and flexibility, meaning that technology and in particular information systems should be analyzed and designed to incorporate resilience concepts and contribute to organizational resilience.

(Hollnagel and Woods 2006) define the goal of *resilience engineering* as the capacity of maintaining control when facing complex and unpredicted situations. (Sheffi 2006) also emphasizes that every disruption in normal functioning should contribute to organizational learning; and it is more important to infer new work structures rather that recover usual ones. The resilience engineering should be regarded as an important and innovative approach to information systems development, at least because the traditional approaches have revealed many imitations regarding resistance and flexibility.

Considering our concrete research objectives, we aim to increase organizational resilience by focusing on the technology support: developing a model and tool supporting collaborative unstructured activities in emergency situations.

In the next section we review this problem in more detail. Section 3 will present some related work. In Section 4 we describe in detail the proposed collaboration model. In section 5 we make some practical considerations about the collaborative tool and its implementation. Finally, we discuss the work done so far and present directions for future research and development.

Problem Statement

As mentioned previously, when dealing with unstructured situations, several tools and resources should be brought together to engage people using their tacit knowledge and establishing informal relationships. In fact, many effective collaborative structures used in emergency situations are not present in the organizations charts. People very heavily rely on their own networks of relationships to find information about emergent situations and make decisions. In social literature it is often stated that people know what they know, due to whom they relate with. Social networks are formed due to common interests, background, expertise, available time and other contingencies (Clark and Bernnan 1991).

Regarding technology support, nowadays we still cannot provide flexible/agile software tools that may be reconfigured or redesigned at run-time to accommodate unexpected and unpredicted requirements emerging in dynamic real life situations. Many unpredicted situations are solved with a mix of activities inside and outside formal organizational rules, procedures, tools and systems. Due to the fact that each involved actor may have his/her own perception of the emergent situation, creating a shared understanding context of what is going on may be quite difficult. Nevertheless, a shared understanding of the situation is fundamental to bring some coherence and efficiency concerns to unstructured activities.

Considering the technology support to the construction of such shared understanding, we defend Situation Awareness (SA) (ESSAY 2000) as a major requirement. We note however there are a number of cognitive factors affecting SA, such as perception, attention, workload or training that are difficult to tackle with technology (Endsley 1988).

An additional difficulty to SA technology support is to devise information sharing, coordination and collaboration mechanisms avoiding work overhead, seamlessly integrating with current work practices and minimizing the gap between the perceived and the real emergent situations.

So, finally, the problem we address in this research is: how to provide collaborative support to SA in organizations operating with unstructured activities and dealing with emergency management, under the general goals of organizational resilience. We are assuming that people operating under such circumstances are highly professional and trained with the proposed technology.

Related work

From an analysis of the proceedings of the International Community on Information Systems for Crisis Response and Management conferences (ISCRAM) between 2004 and 2006, some recurrent concerns may be identified: Shared awareness of crisis situations, information and knowledge management, information representation, usability and interface design concerns. A study conducted by (Milis and Walle 2007), based on Belgian and German companies (about 3.000), inquiring about the types of crises they face and characterizing the respective mitigation strategies, emphasises communication and information management. (Kanno and Furuta 2006) conducted an inquiry about the informational needs in emergency situations, which emphasised the construction of SA as a major endeavour.

Also related with this issue we find a number of additional research highlighting: contexts representation (Zacarias, Marques et al.; Bouquet, Ghidini et al. 2002; Zacarias, Caetano et al. 2005; Brezillon 2006; Brezillon 2008), social networks (Gasson 1999; cross, Borgatti et al. 2000; Liben-Nowell and Kleinberg 2003), situation awareness (Gutwin and Greenberg 2002; Pinelle and Gutwin 2003; Harrald and Jefferson 2007), exception handling (Kammer, Bolcer et al. 2000; Mourão and Antunes 2007), technology adoption (Bansler and Havn 2003; Bygstad 2005), and

visual representation (Erickson 2001; Erickson, Huang et al. 2004; Thomas and Cook 2004).

Although constituting valuable contributions, we should make some remarks about the above studies. Respecting contexts modelling and social network analysis, these works typically do not address real-time enactment, which is mandatory in our context. As mentioned earlier is this paper, the problem addressed by our research goes beyond dealing with business process exceptions, towards support to emergent work processes heavily relying on unstructured activities. In respect to awareness studies, the vast majority of research conducted so far has been focused on contents delivery (e.g., awareness of objects' changes), while we emphasize a process perspective (coordination and collaboration processes).

(ESSAY 2000) proposed the following crisis management life cycle phases, which are relevant to characterize the process perspective:

- Avoiding
- Preparing to manage
- Recognizing
- Troubleshooting, decision making, problem solving
- Action
- Post-mortem analysis
- Relating all of the above

We adapt the proposed crisis management model in (ESSAY 2000) which consist an highly relevant contribution to our approach (Figure 1).
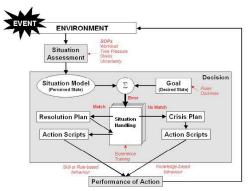

Figure1: Crisis management model (adaptation of (ESSAY 2000))

Regarding crisis management, our research addresses the "recognize, troubleshooting, decision making, problem solving" and "action" phases. Adopting the model shown in Figure 1, our research specifically concerns the situation model and its relationships with action scripts.

Adopted Approach

We assume people dealing with unplanned scenarios rely on a SA artifact to organize their actions and social networks, to collaborate and internalize information (Nonaka and Takeuchi 1995). We also assume the usefulness of the SA artifact lies in the capability to represent the unplanned scenarios and action scripts, as such representation influences "perspective making" and "perspective taking" (Boland and Tenkasi 1995).

The proposed model supports the construction of SA by sharing individual assessments, facilitating collective sensemaking activities and providing situated framing (Gasson 1999; Gasson 2004).

We utilize the well-known Swiss Cheese model (Reason 1997) to organize SA. The Swiss Cheese model posits that for an accident to occur, an alignment of holes in different layer of defenses must occur. We defend that in order to construct SA, the involved actors should be able to align different layers of awareness in a way very similar to the one adopted by the Swiss Cheese model. Regarding the representation issues of SA, we adopt a perspective proposed (Miles and Huberman 1994), using several types of matrixes to represent qualitative information: concept cluster matrixes, empirical matrixes, and temporal or event driven matrixes. We therefore defend the use of Situation Matrixes (SM) to correlate the perceived dimensions of the situation (such as goals/actions and actions/actors, see Figure 2), and combine the SM with the Swiss Cheese model to organize those dimensions into a SA artifact. The dimensions of the circles that mark the correlation, are directly related with how strongly is perceived that correlation.

As situations evolve, more information may be brought into the SA (e.g., more actors involved, more actions proposed, more situation attributes considered as relevant) and organized in existing and new dimensions.
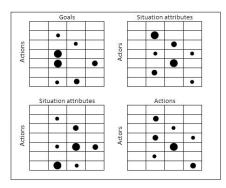

Figure 2: Situation Matrixes

Typically the situation develops in different contexts of action (CA). A CA will be characterized by different information needs, e.g. focusing on a specific goal, action and actor. To address this issue, we propose the creation of multiple views over the SM. These views constitute a filtering mechanism capable to deliver the relevant subset of information to a specific user/group in a specific CA (Figure 3).
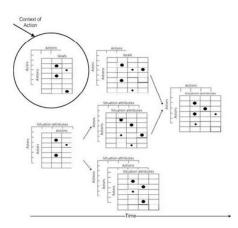
Figure 3: Contexts of action evolution

Time always plays an important role in situation assessment. So, in order to improve SA we must also support retrospective analysis of the SM evolution. In summary, we define SA as the whole collection of SM managed by a group of people according to: (1) the aligned layers of awareness; (2) the situation matrixes, with their situational dimensions; and (3) the progression of time.

Implementation

Nowadays, organizations distribute work across multiple applications and tools, some empowering personal activities (e.g., office productivity tools) and others empowering coordination and collaboration (like Workflow Management or Enterprise Resource Planning systems). An issue emerging in research is what kind of system/tool to deliver in order to support SA. Will it be a completely new and independent tool, or it will be just an artifact, smoothly integrated in existing tools and systems?

Despite this discussion, we focus our concerns in the SA (re)presentation issues. One key aspect to consider is related to the user interface: users should easily obtain an overview of the situation in which they are involved, and should efficiently manage the relevant awareness information. At this time we are focusing our work at a more operational level, concerning how awareness information is maintained in the field of action. For this reason, our user-interface target is a mobile device such as Personal Digital Assistants (PDAs). The developed prototype is presented in Figure 4.

Keeping information up to date in such unstructured activities without adding overhead work presents some difficulties (Erickson, Huang et al. 2004). For instance, status reports and action assessments are hard to track due to their dependence of explicit user declarations. To address this problem, we adopted a pulling strategy. As SA information becomes old, users are prompted to report their validity, combined with a visualization schema to express the degradation of the quality of the information presented in the system.
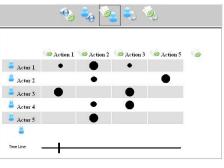

Figure 4: Prototype

Discussion and Future Work

In this paper we make a contribution to the support of unstructured activities in unplanned or unpredicted situations, with particular focus in emergency situations. Our contribution mainly defends that a collaborative SA model is essential to develop a shared understanding of an unplanned situation. The proposed model also emphasizes concerns with delivering the relevant information to the right user(s) in the right context of action. To do so, we proposed an approach based on situation dimensions, inspired by the Swiss Cheese model for accidents (Reason 1997) and their correlation. This correlation is done by a collaborative construction of a set of Situation Matrixes (SM). Similar collaborative approaches exist and are already used in some domains. For instance, flight operations adopted a Crew Resource Management (CRM) training, which concerns not so much the technical knowledge and skills required to fly and operate an aircraft but rather the interpersonal skills used for gaining and maintaining situational awareness, solving problems and taking decisions. The CRM approach fosters a climate and a culture where the freedom to respectfully question authority is encouraged, aiming to reduce the discrepancy between what is happening and what should be happening.

The next steps in our work will focus on the following problems:

- Collaborative management of SM
- Develop the SM filtering mechanisms
- Adapt the proposed model to different hierarchical levels

We are also further developing the prototype to be able to conduct some real experiments. Once we accomplish that objective, the model evaluation should be made. As referred in (Markus, Majchrzak et al. 2002), once a new system is introduced to support a work process, the actual way of conducting that process changes. When systems are introduced in an organizational environment, some tend to think that the work will be done fundamentally in the same way, although more efficiently and quickly. This is rarely true, as the work changes often in an unintended, unanticipated and often undesirable way. In order to validate the proposed model we must evaluate its usage against organizational elements like (Vyhmeister, Mondelo et al. 2006):

1. The nature of work (quality, task specialization and temporal aspects);
2. The individuals (role identification, stress, perceived status, job satisfaction);
3. The organizational communication (efficiency, communication type between organizational levels, volume, job monitoring methods, and job perception);
4. The interpersonal relationships (social interaction quality and quantity, social reinforcement, number of sociometric relations and communication hierarchy);
5. The interdepartmental relationships (conflicts, cooperation, independence, and departmental limits);
6. The organizational structure and processes (physical limits and organizational adaptability).

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