An Ontology-Based Tool for Collaborative and Social Sensemaking

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ABSTRACT

Sensemaking activities of social networks involve network exploration and representation so, visual tools are designed to support these two activities. Existing social network analysis tools are usually weak in supporting complex analytical tasks and also in providing a collaborative environment for interaction. The analysis of data using a visual tool is rarely a task done in isolation, it tends to be part of a wider goal: that of making sense of the current situation, often to support decision-making. This paper discusses the storytelling design of a software environment to support organizations in sense-making activities and to support accidents investigation. A case study ACR-C describes petroleum industry employees investigating the root cause of an accident issue observed in one (or more) platforms. It is used throughout the paper as an example of human computer interaction where the ontology becomes a tool with domain knowledge to assist expert persons building a root cause tree leading to accidents. The framework will also provide with a collaborative recommendation module assuming that the users build up clusters based on their similar analysis in rating of items. A case study ACR-C describes petroleum industry employees investigating the root cause of an accident issue observed in one (or more) platforms. It is used throughout the paper as an example of human computer interaction where the ontology becomes a tool with domain knowledge to assist expert persons buildind a root cause tree leading to accidents. This paper reports the experience gained in ACR-C, a project that aims to support knowledge management (KM), sharing and reuse across different media in oil & gas industry. We report the storytelling design approach adopted and the design phases that led to the first prototype. A user interface was designed to assess how different levels of data, information and knowledge were mapped using alternative visual tools. The results show that a clear separation of the visual data analysis from other sense-making subtasks helps users in focussing their attention and comprehension of root causes of the problem. Further work is needed to develop more fully intuitive visualizations that exploit the richer information and make the multiple connections between data more easily accessible.

Categories and Subject Descriptors

H.5.2 [**Information Interfaces and Presentation**]: User Interfaces; D.2.2 [**Software Engineering**]: Design Tools and Techniques; L.1.3 [**Knowledge and Media**]: Ontology/Taxonomy and Classification

General Terms

HCI

Keywords

collaborative analysis recommendation, social network, root cause analysis, ontology

1. INTRODUCTION

There is an important effort of oil and gas industry to reduce the number of accidents and incidents. There are standards to identify and record workplace accidents and incidents to provide guiding means on prevention efforts, indicating specific failures or reference, means of correction of conditions or circumstances that culminated in accident. Besides, oil and gas industry is increasingly concerned with achieving and demonstrating good performance of occupational health and safety (OHS), through the control of its risks, consistent with its policy and objectives.

Even if the focus on risk management is increasing in our society, major accidents resulting in several fatalities seem to be unavoidable in some industries. Since the consequences of such major accidents are unacceptable, a thorough investigation of the accidents should be performed in order to learn from what has happened, and prevent future accidents.

Today, with the advances of new technologies, accidents, incidents and occupational health records are stored in heterogeneous repositories. During the last decades, a number of methods for accident investigation have been developed. Each of these methods has different areas of application and different qualities and deficiencies. This poses a top priority challenge for oil & gas industries that are looking for innovative ways to design human-computer interaction, in order to extract knowledge from masses of data.

Besides with the recent advances in technology, there is an emerging presence of social media and social networking systems. The reason is that despite there is an increasing interest in the exploration of social networks, there does not exist a concrete dataset that includes both explicit bonds of personalized characteristics among users and a collaborative annotation of items. This is due to that most social media systems do not allow for free access to all user profiles or lists of friends.

Moreover, the need for computer supported collaboration has grown over the last years and made collaboration processes an important factor within organizations [1]. This trend has resulted in the development of a variety of tools and technologies to support the various forms of collaboration.

Managing conflicts in human-computer interaction poses a set of challenges beyond those encountered in dealing strictly with software. Some familiar issues arise such as asymmetry in capabilities and responsibilities distributed processing and information storage limited resources and a high cost of exchanging information. Some of the works in the HCI field are [10], [11], [8],[12]

Confirming the above, there exist several research projects in this area and MIT Deliberatorium Project from the MIT Center for Collective Intelligence is one of them, i.e [6, 7], arguing the importance of the aggregated value of collaboration process.

Given the incentives of the widespread adoption of social networks for collaborative recommendations and of the lack of some previous study that directly addresses the problem of efficiently integrating the added- value knowledge provided by those networks in the field of collaborative recommendation, we propose a the storytelling design of a collaborative environment [2] to support oil and gas industry in sense-making activities. We extend a similar work proposed in literaure [3]. Our case study ACR-C describes petroleum industry employees investigating the root cause of an accident issue observed in one (or more) platforms. It is used throughout the paper as an example of human computer interaction where the ontology becomes a tool with domain knowledge to assist expert persons building a root cause tree leading to accidents. The framework will also provide with a collaborative recommendation module assuming that the users build up clusters based on their similar analysis in rating of items. A model will learn based on patterns recognized in the rating analysis of users using clustering, Bayesian networks and other machine learning techniques will be applied.

2. ROOT CAUSE ANALYSIS

The Root Cause Analysis is a methodology that proves to be essential for any organization, especially for industrial operations that needs to eliminate the recurrence of failures and accidents. [5]. Root cause analysis is not a single, sharply defined methodology; there are many different tools, processes, and philosophies for performing RCA [9]. However, several very-broadly defined approaches can be identified by their basic approach or field of origin: safety-based, production-based, process-based, failure-based, and systems-based.

- Safety-based RCA descends from the fields of accident analysis and occupational safety and health.
- Production-based RCA has its origins in the field of quality control for industrial manufacturing.
- Process-based RCA is basically a follow-on to production-based RCA, but with a scope that has been expanded to include business processes.
- Failure-based RCA is rooted in the practice of failure analysis as employed in engineering and maintenance.
- Systems-based RCA has emerged as an amalgamation of the preceding schools, along with ideas taken from fields such as change management, risk management, and systems analysis.

3. PROPOSAL: ACR-C

The ACR system aims to assist in the investigation by identifying the root causes of anomalies, and lead the user to create, query and visualize trees root cause, considering the need for data entry during the process. The system guides the user in the investigation of the root cause of an anomaly, through questions and the construction of a fault tree, an interactive walkthrough. It permits the creation of a collaborative environment of research, using an ontology on accident investigation as a thread of communication and cooperation among the actors who participate in the investigative process group.

The ontology permits the use of a common language for the actors in the investigative process group. ACR tool allow not only to investigate the root cause of accidents but also to have an aggregated register to be used for future or past analysis. It also provide with an interaction blackboard where user communication takes place. To accomplish with the hypothesis presented we built an explicit domain ontology in order to allow a common communication among participants. Sometimes in the early commitment decision process occur an early arrival to conclusions or the failing to share views on research, so a domain ontology allows facts coexist avoiding conflicting information. It also make clearer the information underlying the conclusions of each of the participants, and it does not impose coordination of actions between participants.

3.1 ACR-C: Domain Model

The ontology system ACR contains classes, attributes, domain values, causes, facts and assumptions to create the concepts and constraints of the system, and also their knowledge structure. See 1.

Concepts in the ontology are used to define objects collections with similar characteristics. In the case of ACR, main concepts are identified as:

- **Fault Tree:** It is the high level concept representing the domain on discourse. It is composed of causes, hypotheses, evidence and observations of failures (facts) related to the occurrence of an unwanted event, called anomaly.
- **Anomaly:** Description of an undesirable event or situation which results or may result in damage or failure, affecting people, the environment, equity (own or third party), products or processes.

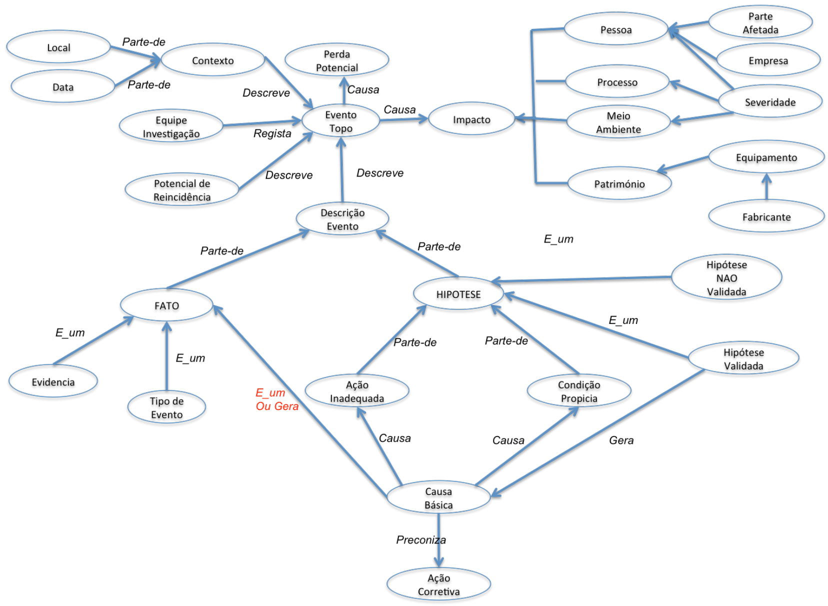

Figure 1: ACR-C ontology

– **Deviation:** Any action or condition that has the potential to lead to, directly or indirectly, damage to people, to property (own or third party) or environmental impact, which is inconsistent with labor standards, procedures, legal or regulatory requirements, requirements management system or practice.

  * **Behavioral deviation** Act or omission which, contrary provision of security, may cause or contribute to the occurrence of accidents.
  * **Non-behavioral deviation:** Environmental condition that can cause an accident or contribute to its occurrence. The environment includes adjective here, everything that relates to the environment, from the atmosphere of the workplace to the facilities, equipment, materials used and methods of working employees who is inconsistent with labor standards, procedures, legal requirements or normative requirements of the management system or practice.

– **Incident:** Any evidence, personal occurrence or condition that relates to the environment and/or working conditions, can lead to damage to physical and/or mental.

– **Accident:** Occurrence of unexpected and unwelcome, instant or otherwise, related to the exercise of the job, which results or may result in personal injury. The accident includes both events that may be identified in relation to a particular time or occurrences as continuous or intermittent exposure, which can only be identified in terms of time period probable. A personal injury includes both traumatic injuries and illnesses, as damaging effects mental, neurological or systemic, resulting from exposures or circumstances prevailing at the year's work force. In the period for meal or rest, or upon satisfaction of other physiological needs at the workplace or during this, the employee is considered in carrying out the work.

- **Fact:** It's some event about which there is no doubt. It is an event that has been observed by the research team and, at first, was direct cause of the anomaly. During investigation, however, it is possible for the user to reclassify a fact turning it into developing a hypothesis.

- **Hypothesis:** It is an assumption that makes the occurrence of an event that may have contributed to the occurrence of the anomaly.

  – **Confirmed Hypothesis:** Kind of hypothesis whose evidence, explicit in the model or only in the mind of the user, leading the user to decide to confirm it turning it into a cause or root cause.

  – **Hypothesis in development:** Hypothesis type which is still being investigated.

  – **Hypothesis cancelled:** Kind of hypothesis whose evidence, explicit in the model or only in the mind of the user, take the user to decide to discard it, transforming it into a hypothesis denied and ending a line of investigation.

The rest of the concepts and its relations can be seen in Figure 1. It is considered as a basis for the use of root cause analysis in investigative processes or hypothesis. With the export interface, the customer can add to the information that has already been registered in the tree, as well as request an export of a specific tree.

3.2 ACR-C: Interaction Model

They are computer systems designed to enhance the performance of work in groups. These computational tools

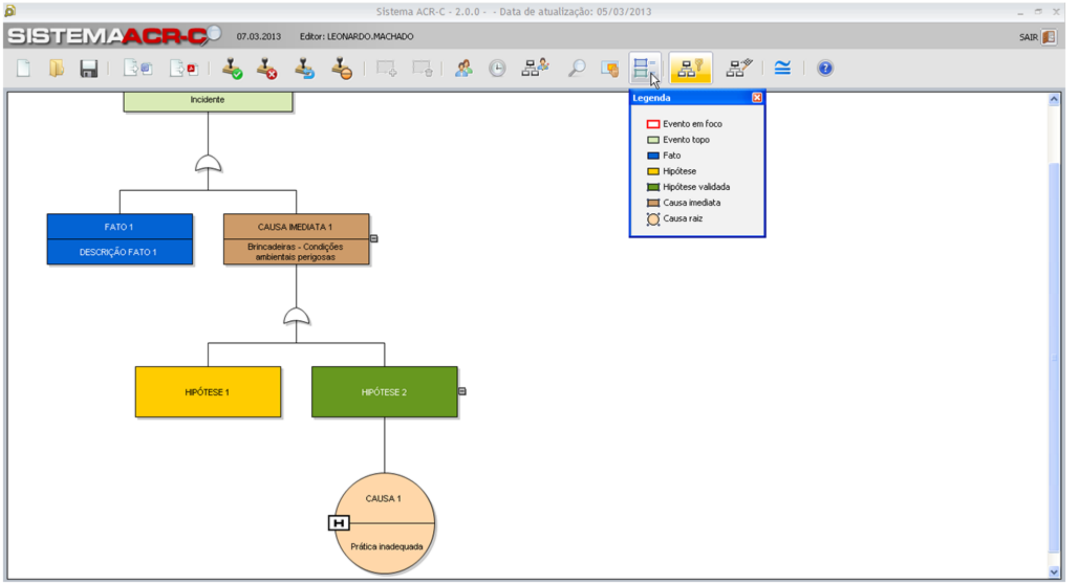

Figure 2: ACR interface.

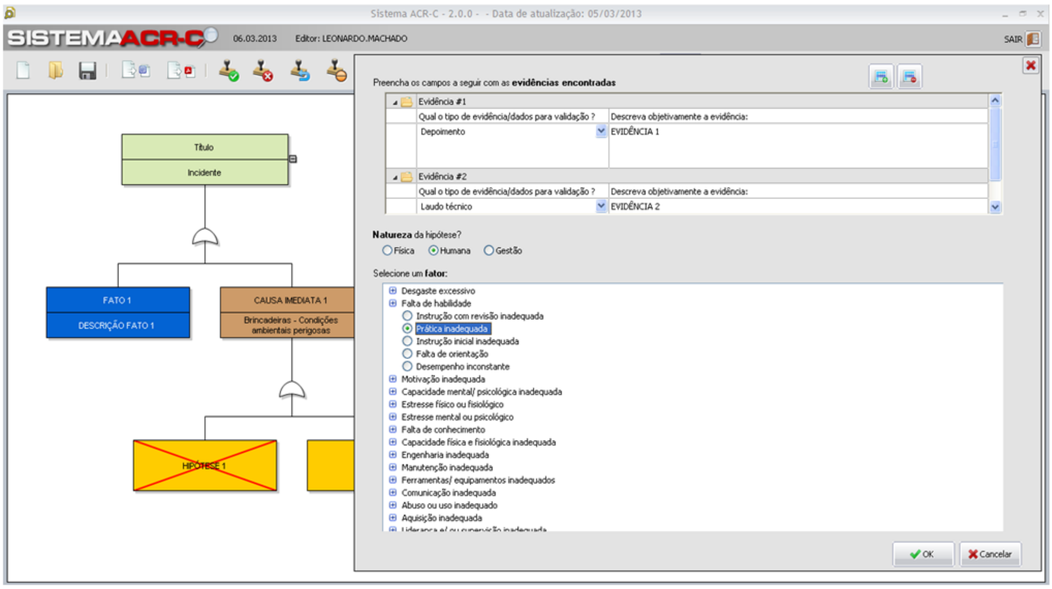

Figure 3: ACR interface. Entering evidences

should be modeled in order to foster interaction among participants, serving as a facilitator for coordination, collaboration and communication between participants that make up the group, both in the same location as at spatially different locations [4].

It takes the user to describe the anomaly (accident / incident / deviation), create chances and give evidence, to confirm or rule out a hypothesis. Evidence given a chance by the user, during the investigation, can serve as input for the user himself decides to quit, or follow, in particular line of research. The development of hypotheses lead to the root causes of the problem.

This aggregated value provides an environment where technical specialists could collaboratively solve problems and identify and share best practices. This tool was modeled for accomplish an easy and comprehensive user interaction.

The main characteristic is that the system acts as a blackboard where all the communication process between actors take place with the information organized in fact- hypothesis method because actors have an a common environment to collaborate, synchronous or asynchronous. See 2 and 3.

4. CONCLUSIONS

This paper describes a preliminary work in the creation of a collaborative environment for accident investigation, using an ontology-based system as a thread of communication and cooperation among the actors who participate in the investigative process group.

We built an explicit domain ontology in order to allow a common communication among participants. It also allows facts coexist avoiding conflicting information. It also makes clearer the information underlying the conclusions of each of the participants, and it does not impose coordination of actions between participants.

A case study was presented to illustrate the functionalities of the system and also how the interaction presents different colors for entities linked to the same hypothesis turning very easy the comprehension.

As future work we are still working on the collaborative recommendation module that will assume users build up clusters based on their similar analysis in rating of items. A model will learn based on patterns recognized in the rating analysis of users using clustering, Bayesian networks and other machine learning techniques will be applied.

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