ORGANIZATIONAL KNOWLEDGE LEARNING AND DECISION SUPPORT FOR EMERGENCY AND SECURITY CHALLENGES

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Abstract
During emergencies communication is not adequate in terms of amount and quality of information and procedures due to the lack, under the confusion, of knowledge about the best response actions. In a large system, such as enterprise's logistics and transportation departments, identifying quickly appropriate individuals, communication channels and information to exchange, and having prompt access to relevant procedures and rules pose tremendous challenges. These challenges significantly affect the effectiveness of the organization's response. In this project we have investigated key factors to consider in the design of an effective communication system to enhance the organizational learning of a transportation agency. A prototype of a DSS for transportation emergency response was built to demonstrate the value of creating lines and backups of communication and command inside an organization. Conclusions about the usefulness of this prototype in a lab setting are described.

Key words:
Collaboration, Communication, Decision support systems, Emergency response, Mock drill, Security, Protocols

1. INTRODUCTION

The combination of several world events has brought a stronger focus to the areas of safety and security inside organizations and governments. The safety and security of individuals, resources, and information have become of great interest due to the disruptions in operations that an unplanned or unpredicted event can have on conducting everyday activities. Efforts have focused mostly on prevention of events by better planning while other have focused more on improvement of response efforts. Regardless of the type of organization, unplanned events can significantly affect and disrupt business operation, in turn damaging the economy of organizations.

At the center of this article is a project conducted for a transportation agency in Indiana to analyze, design, model, and develop a training program to better assist the organization in responding to emergencies. The environment under which individuals within a transportation agency or any governmental agency have to interact allows for errors, conflicts and mis-communication to arise due to the dynamic, possibly chaotic, and continuously changing nature of the decision making process often under extreme stress and time constraints. In an emergency scenario the availability, quality and credibility of the information require decision makers to constantly re-evaluate and re-assess their decisions in order to provide a better response to the rapidly developing events. The problems in this area are most often semi-structured, uncertain, incorrect, changing and include vast amounts of conflicting information.

The model was developed in the Production, Robotics, and Integration Software for Manufacturing and Management Systems (PRISM) Center at Purdue University with assistance from the Operations and Research Departments of the Indiana Department of Transportation (INDOT), the Indiana State Police, and State Emergency Management Agency (SEMA). The goal of the program was to identify existing problems with communication and decision making processes, while at the same time examining ways to improve the communication that takes place, support effective decisions, and develop techniques to enhance the effectiveness of the interactions with various agencies. The remainder of this article is organized as follows. Section 2 provides background on organizational learning and emergency response. Section 3 introduces the model and prototype developed. Section 4 discusses the implementation of the prototype. Section 5 discusses the results, conclusions and future developments for the prototype.

2. BACKGROUND

The ever-changing nature of today's world has switched the focus for responding to events, "New realities are now making strategy itself appear obsolete, turning businesses into adaptive systems that remain alert to shifting paradigms and play out different scenarios in a sense-and-respond mode" [1]. From 1998 through 2000 more than 65,000 emergency responders were trained, meanwhile in 2004 alone over 386,000 responders were trained with support form the Homeland Security Department spending over $200 million on their training, guaranteeing that employees are able to respond to changing environments and assuring that they are able to stay alert to new threats [2]

The Defense Advanced Research Projects Agency (DARPA) had, after the events of September 11, the "goal of empowering users within the foreign intelligence and counterterrorism communities with IT so they could anticipate and ultimately preempt terrorist attacks by allowing them to find and share information faster, collaborate across multiple agencies in a more agile manner, connect the dots better, conduct quicker and better analyses, and enable better decision making" [3]. An experiment conducted using information technology tools developed by DARPA showed the value of incorporating such tools in order to invert the trend by which most time in

the decision making process is spent doing research and producing reports and documents, rather than on analyzing the information available (i.e. time spent in research was reduced from 330 hours to 76) as shown in Figure 1 [3].

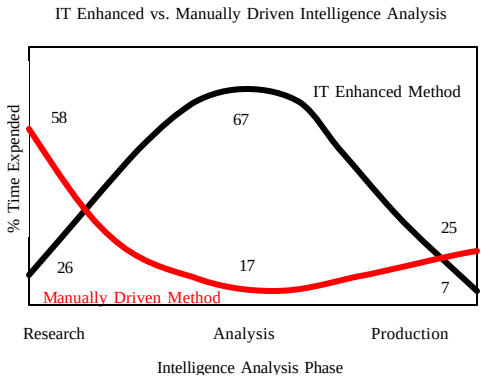

Figure 1: The value of IT in decision making

The value of real-time and supported decision making depends on the ability of organizations to quickly respond and adapt to changes due to technological advances, growing and changing customer demands, changes in the labor force, environmental and political concerns, societal impacts, security concerns and many others. [4]. A relevant study of the value of organizational learning and modeling is presented in [5]. In their work, the authors investigate the value of organizational learning in a *Fortune 500* transportation company, and identified it as a strategic resource for supply management. Furthermore, the authors identify a strong relationship between learning and cycle time, which can be a result of the ability to reach better decisions and minimize the time to obtain a viable and efficient (if not optimal) solution.

Modeling and simulation of emergency response has been identified as critical for organizations for many years [6]. However, it has not been until recently that the focus has shifted from purely modeling the emergency event to a more holistic approach of examining all aspects of emergency response from awareness all the way to response evaluation. A recent report by the Committee on Science and Technology for Countering Terrorism of the National Research Council identified "systems analysis, modeling and simulation" as the first of seven crosscutting challenges to be addressed in countering terrorism. The report states:

> "Systems analysis and modeling tools required for threat assessment; identification of infrastructure vulnerabilities and interdependencies; and planning and decision making (particularly for threat detection, identification and response coordination). Modeling and simulation also have great value for training first responders and supporting research on preparing for, and responding to, biological, chemical and other terrorist attacks."
>
> - National Research Council (2002) [7].

There are several on-going projects that focus on simulation for studying disasters as well as their effects and they include: emergency response planning, emergency response training, identification and detection, among others. In emergency response planning tools have allowed for the evaluation of strategies to respond to a disaster event, for example, a map analysis software that can be used to plan responses to events such as a forest fire [8]. Under emergency response training, Sandia National Laboratories developed a program called Weapons of Mass Destruction Decision Analysis Center to simulate war-room environments in an event of a terrorist attack to train public officials' response to a bio-terrorist attack [9]. In another example of a simulation system developed for emergency response training, a virtual reality application immerses first responders in a computer-simulated setting in which a biological warfare agent has been dispersed through a terrorist bomb [10].

A comprehensive framework is recommended to integrate modeling, simulation and visualization tools for emergency response by including planning, vulnerability analysis, identification and detection, training and real-time response support [11]. There are several common problems that organizations experience when dealing with emergency response as summarized in [12]. To address some of those challenges of organizational communication during emergency response, the authors developed CICERO, a computer-based incident management system using the Internet and networks to communicate and coordinate across the organization.

In a related research area, group decision support systems (GDSS) a lot of work has been done in exploring dynamic decisions, game theory, and conflict analysis. A continuous decision support system for conflict group decisions based on rules and rules-based reasoning was introduced in [13]. Often, traditional decision models used for GDSS focus on the methods to reach decisions while neglecting environmental changes during the decision making period [14]. A cognitive-based framework for decision training through investigation of the cognitive process and behaviors in the conflict group decision making process addresses some of the limitations previously defined and an agent based training environment is presented [15].

3. EMERGENCY RESPONSE TRAINING PROTOTYPE

A prototype model for the training of INDOT's managers and supervisors was constructed to identify methods to enhance the cooperation and collaboration that takes place under an unfolding emergency scenario. A series of events, 12 to be exact, were presented to two groups from different districts in the state of Indiana (Crawfordsville and Laporte). The events were a combination of common traffic occurrences, such as automobile collisions and snow removal, terrorist threats, and simultaneous occurrences of several terrorist attacks.

Events are released to distributed groups following a predetermined time arrangement in order to allow the members to discuss and determine their plan of action. While this process is taking place, the groups have access to a decision support system that will be discussed in more detail later in this article. Also accessible at that point are a number of suggested actions for the group's selection, which had been generated by the design team. Finally, participants enter their plan of action to respond to an event. All events and responses are recorded for later analysis and discussion by all participants to identify methods to enhance the communication during the emergencies (Figure 2).

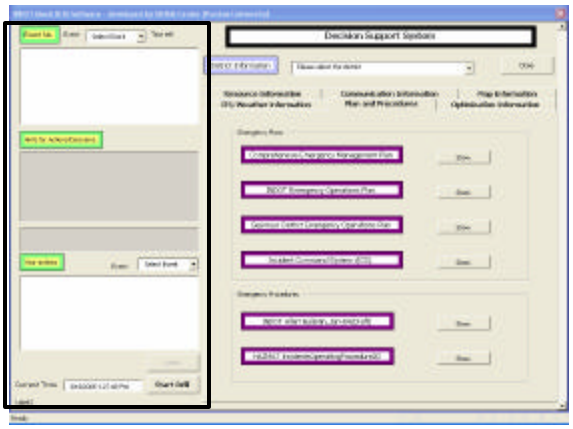

Figure 2: Emergency Response Training Prototype

The Decision Support System (DSS) is divided into several areas for each of the available districts, containing information that is relevant to the respective district. The areas are: resource information, communication information, map information, ITS/weather information, plans and procedures, and an optimization screen.

Resource Information Support: The resource function allows users to access information contained in a resource database. Among the information included are: a list of all vehicles, machines, equipment organized according to the categories to which they belong. Once the user selects the district and the category and type of equipment, the system provides the number of resources available in each sub-district. A user then selects the resource required and the contact information to request it. This information is provided to the user to guarantee an expedited process in securing the resources needed to handle specific emergency conditions. The user is then able to request resources to be transferred or moved from one sub-district to another by identifying the type, number, district and sub-district. Finally, a log of all requested resources is kept to better trace the number and type of resources requested, already assigned, released, or being transferred (Figure 3).

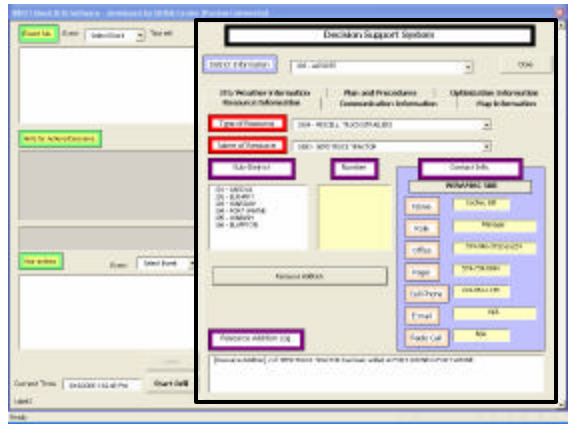

Figure 3: Resource information support

Communication Information Support: This function enables the user access to contact information for personnel at the central office, and the distributed office levels. The information provided includes the individual's position in the organization and their contact device numbers, email and availability for contact during each day. The system allows for a user to review multiple levels deep in trying to find backup personnel inside the organization to communicate with in case other people are unavailable at that time (Figure 4).

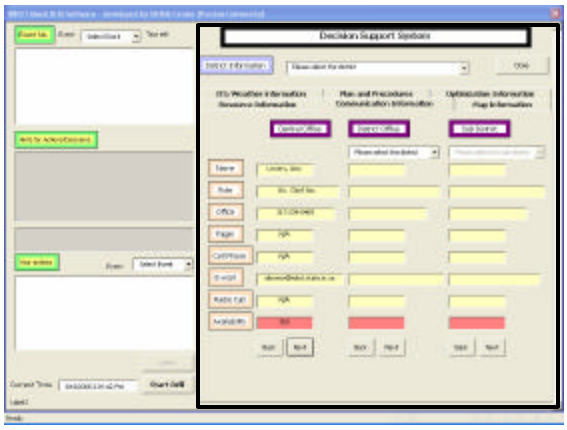

Figure 4: Communication information support

Map Information Support: This function enables user to access maps for all relevant districts and sub-districts. The maps are of significant importance in case traffic is to be re-routed. Furthermore, the maps also help users identify the correct location of the events in order to better determine access roads to get to the location, and also to identify communities that might be affected by the events to notify other governmental agencies and sub-districts that need to be informed (Figure 5).

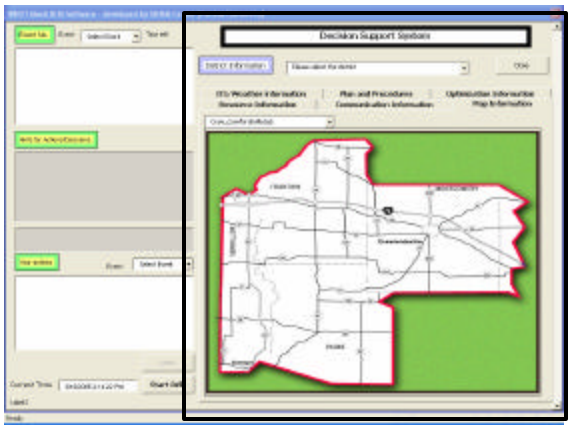

Figure 5: Map Information Support

ITS/weather Information Support: Weather information allows users to identify the conditions in the area to be able to determine the operability of the roads in order to assess the safest way to direct traffic or schedule operations such as re-routing of vehicles, snow removal, or closure of roads. In addition, this intelligent transportation system (ITS) information is incorporated to provide users with real-time feed from different locations in the area to better inform them of the conditions at those specific locations. For the prototype, however, only snapshots from different area locations were used to represent sensors and live feed. The cameras in Figure 6 represent some locations for which ITS information is available, so that users can access them by clicking on the icons.

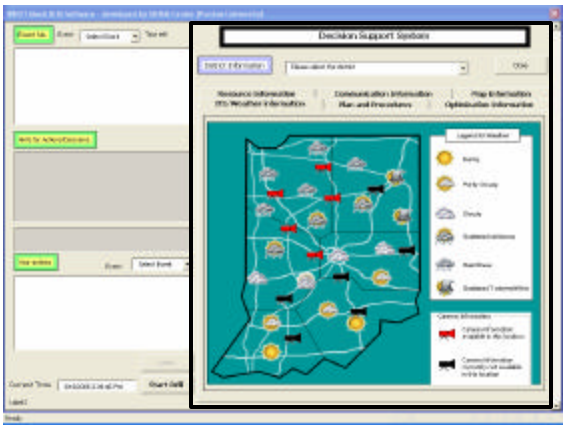

Figure 6: ITS/weather Information Support

Plans and Procedures Information Support: This function enables users' access to regularly available documents for use by the organization. Among the documents included are: a comprehensive emergency management plan, emergency operations plans, the Incident Command system Plan, a district specific emergency operations plan, HAZMAT operations procedures and an alert bulletin (Figure 7).

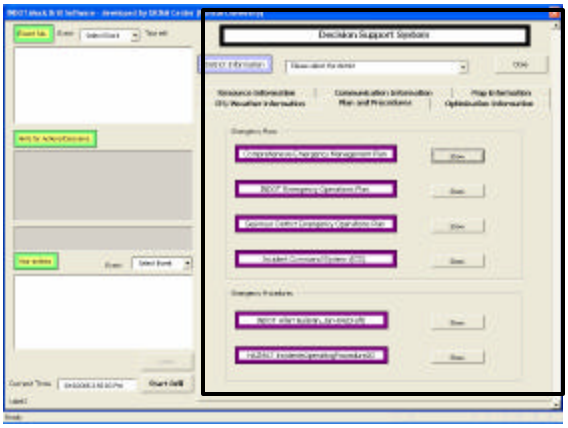

Figure 7: Plans and Procedures Information Support

4. PROTOTYPE IMPLEMENTATION

In an effort to assess the effectiveness of the prototype, a mock drill was conducted with the participation and cooperation of INDOT, SEMA and the Indiana State Police. Two groups were formed with representatives from several participating districts, and representatives from the state police, SEMA, and the Counter-terrorism task force invited to serve as evaluators. Additionally an evaluation team was formed to oversee the entire training drill. The events unfolded at specific times to guarantee that teams had enough time to discuss and agree on the decision to activate or deploy and enter into the computer their plan of action to respond to the each specific emergency event. All decisions were recorded in a log database to be used for analysis by all participants in a debriefing session conducted immediately at the end of the mock drill, and for longer-term analyses and re-use.

5. RESULTS

The mock drill was designed as a low-cost, useful opportunity to verify a transportation agency's capabilities, procedures, and preparedness to handle a simulated emergency situation, involving a combination of terrorist attacks, natural hazards (snow), and severe traffic accidents. It also enabled observation and self-examination of strengths and weaknesses in case of a significant security and safety emergency scenario. The prototype developed is in its second version. It will be employed again by other organizations after additional changes are made based on input from all participants so far, to better serve the needs of the users. Some of the changes implemented include a link between related resource combinations in order to not only assign resources but also address issues of qualified personnel. Also included will be an optimization interface to provide users with information on how to minimize costs and transportation time from and to event locations.

Based on the feedback provided by all participants, the prototype has served its purpose of identifying methods to improve the communication inside the organization when responding to emergency events by identifying with whom to communicate, the most appropriate resources and methods to secure effective communication, the best actions to be followed and the procedures and plans to follow in order to mitigate trouble events. By identifying the appropriate people with whom to communicate inside the organization, the correct information to share, and the ways by which to share it, an organization can create lines and backups of communication and command to better serve the mission of the organization and guarantee that errors and conflicts are avoided.

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