A Field Trial of a Collaborative Online Scenario Creation System for Emergency Management

Xiang Yao
New Jersey Institute of Technology
xiang.yao@gmail.com

Murray Turoff
New Jersey Institute of Technology
murray.turoff@gmail.coms

Roxanne S. Hiltz
New Jersey Institute of Technology
roxanne.hiltz@gmail.com

ABSTRACT

In Emergency Management and Business Continuity Planning, scenarios are a widely used tool. Existing scenario creation systems allow distributed groups to create scenarios together but have limited collaboration support. This study developed and evaluated a solution to provide various types of collaboration support around a knowledge structure at the core of a collaborative scenario creation system called Collario. Following the Design Science paradigm, it evolved through four iterations into a working prototype. Several evaluation methods, including protocol analysis and field study, were employed to evaluate the design effects and obtain user feedback. The results of the first field trial are described in this paper. They indicate that the system is useful to support creation and discussion of emergency scenarios in virtual teams and to share knowledge and experiences among geographically distributed emergency professionals and researchers. It was also found that the system is not hard to learn and use.

KEYWORDS

Scenarios, Collaborative Systems, Emergency Management

INTRODUCTION

The problem of devising complex scenarios is very important in the area of Emergency Management. However, Face-to-Face meetings – the most popular approach to this problem – are often difficult. The objective of this research is to design, implement, evaluate, and evolve a Web-based group support system to collaboratively design scenarios, particularly those that might be used for planning and training for emergency management. In a previous paper (Yao et al., 2009), the justifications for such a system were presented, as well as a description of the design of the system. This study follows the design science paradigm in conducting the research, which identifies the problems from practice, designs and evolves the artifact through multiple iterations, and evaluates the artifact back in practice. In this paper we very briefly review the goals, rationale and design of the system, and then present the results of a field trial using subjects experienced in emergency management. It is hoped that such a technology, when fully developed, will support not only Emergency Management, but a wide range of applications, such as interaction design, web marketing, etc.

MOTIVATION

In the fields of Emergency Management (EM) and Business Continuity Planning, scenarios and simulations are widely used tools for emergency preparedness planning, training and knowledge sharing purposes (Van de Walle, Turoff and Hiltz, 2009). The unique strength of scenarios is that they embed real-world uncertainties and complexities into plausible stories so that emergency plans can be made, reviewed, and practiced accordingly. In the EM field, scenarios are mainly used for three purposes: planning, training, and knowledge sharing. Examples in planning include Kahn (1960) who used scenarios as a tool to explore potential complexities of a nuclear war. In the business world, Royal Dutch/Shell has been using scenarios for strategic planning successfully for over four decades (Cornelius et al., 2005). In training, high-quality emergency scenarios can

Reviewing Statement: This paper has been fully double blind peer reviewed.

establish an Experience-Based Learning (EBL) (Kolb, 1984) environment for the trainees to practice their situation assessment and decision making skills to deal with emergencies without being physically present in the hazardous environments. . For knowledge management, how to exchange and share tacit knowledge is the most difficult challenge (Nonaka and Takeuchi, 1995).

To create and exercise complex emergency scenarios involves experts from a wide range of backgrounds. Collaboration is very important for the applications of emergency scenarios. Currently, face-to-face (FtF) meetings are the most popular collaborative environment to devise emergency management scenarios and conduct training exercises based upon them. However, the logistics, time of participants, and funds available to conduct "physical" meetings and training exercises are often prohibitive. Thus, there is a need for "virtual" teams to be able to devise and revise scenarios and to undertake exercises based upon them.

This research explores an innovative solution that includes (1) using a scenario knowledge structure to capture scenario knowledge components, (2) providing collaboration support to stimulate discussion and collaboration, and (3) developing Group Awareness (GA) tools to help users better understand the team, its expertise, and its activities. This new design approach should allow distributed emergency experts to create and discuss complex emergency scenarios, and to share their knowledge more effectively. This paper describes the procedures and results of the first phases in the design research that guides system evolution.

DESIGN REQUIREMENTS, GOALS, AND APPROACHES

There are two possible solutions for virtual teams to develop and discuss emergency scenarios. The first one is to rely on generic collaboration systems, such as E-Mail, Electronic Bulletin Board Systems (BBS), video conferencing systems, etc. The second is to develop specialized Group Support Systems (GSS) that provide special task and process structures to facilitate scenario creation. Our previous studies (Yao et al., 2005) showed that using generic collaboration systems to develop emergency scenarios can be inefficient and lead to problems like information overload. Because of the intrinsic complexity of emergency scenarios, we believe that the second approach would be more productive.

To elicit initial system requirements, one researcher observed four local Emergency Tabletop Exercises with participants ranging from dozens to several hundreds. Two of the exercises discussed Hurricane scenarios for the tri-state area and two of them discussed bomb (dirty bomb or regular bomb) scenarios in Jersey City, NJ. The processes of these exercises were analyzed to extract system requirements. From observing these exercises and meeting with emergency management professionals, the need to develop technologies to support virtual teams to discuss emergency scenarios is also confirmed.

To develop the collaborative scenario creation system, this research follows the design science paradigm and an iterative framework to initiate, design, implement, evaluate, and evolve the system (Hevner et al., 2004). This approach is efficacious for developing innovative artifacts with user interactions as an important component.

From the beginning, the collaborative scenario creation system has been envisioned as being able to achieve the following three major goals:

1. To aid distributed groups to work together to develop complex scenarios.
2. To allow members to share their ideas and to help improve the contributions of others
3. To develop a database of components for scenarios so it becomes easier to evolve and improve existing scenarios.

To achieve these goals, this research has so far gone through four research iterations. The first iteration was to design and choose the most appropriate visualization to display scenario details, which was the basis for the whole system. The Event Log metaphor was selected because of its familiarity to emergency workers, expandability, and ease to implement.

The second iteration was to implement the Scenario Event List to display scenario details using the Event Log metaphor approach. The component was evaluated using system demonstration and cognitive walkthrough. Two local emergency management professionals were invited for this round of evaluation. Potential values of such a system were confirmed. Feedback was taken for system improvement. The feedback was analyzed and integrated into the design.

The third iteration was to implement the collaborative workspace for scenario creation and discussion, based on the Scenario Event List. Several templates were created to obtain user inputs. Various types of Collaboration support were integrated with the Scenario Event List and various review templates. More feedback was collected and analyzed. Adjustments to the system design followed.

Finally, the fourth iteration integrated Group Awareness (GA) support into the system. At this phase, the system was ready to support a real group to work on collaborative scenario creation tasks. Two evaluation methods were employed in this iteration: Protocol Analysis and Field Study. Protocol Analysis was conducted to identify potential usability flaws in the system. Finally a field study was aimed at evaluating the system's usefulness and usability in a naturalistic environment. It is this field study which is highlighted in this paper.

DESIGN ELEMENTS

In addition to participatory observation and interviews, this research also used literature review to elicit system requirements. The literature suggests that as many as seventeen concepts or components are related to scenarios (Gordon, 1994; Quarantelli, 1997; Coates, 2000; McConnoll & Davies 2006). They are: Scenario, Theme, Constraint, Event, Notification, Situation, Potential Outcome, Parameter, Prerequisite, Resource, Resources Type, Alternatives Resource, Trigger, Assumption, Objective, Time, and Location. For the initial implementation studied in this research, only three of these entities have been implemented: Scenario, Event, and Resource. .

1. *Resource*: Resources represent roles, equipment, financial or other prerequisites to carry out an event.
2. *Event*: Events are natural or man-made activities, which might change the states of a system.
3. *Scenario*: Scenarios are series of events and situations to describe a possible or actual happening as the result of a scenario creation process.

These three elements are the most fundamental and crucial elements for any emergency scenario. Other elements, when not implemented, can still be described as plain texts. The difference is that unimplemented elements cannot be reused readily. For the initial implementation, the most important objective is to verify the feasibility and effectiveness of the design, not to provide a complete solution. Thus, we confined initial implementation to the minimal set of elements which still reveals the design essence. However, the same design method should be expandable to all the remaining elements, as they are integrated.

The system also has to provide support to stimulate team collaboration. The collaboration system provides many features, often based on templates to fill in, to facilitate collaboration in scenario creation. (For sample screens and more complete design details, see (Yao et al., 2009). These include:

- *Anonymity and Penname*: Hiding true identities might in some cases stimulate participants to discuss sensitive issues. Exercise administrators should be able to choose when to use pennames and when to use true identities.
- *Scenario Event List*: The scenario event list is the place where users see the scenario details. It implements an Event Log metaphor and displays scenario events in a table structure. The scenario event list is ordered by sequence numbers. Hyperlinks to the comments on the scenario events are embedded into the scenario event list.
- *Entity Lists*: Entity lists are the various list views that display the items of the scenario entities using a single list. These lists are on the first page displayed when users choose to browse items of a particular entity type. The lists contain hyperlinks to review entity details using entity review templates.
- *Entity Templates*: Definition and review of entity details are achieved through entity templates. Two templates are provided for each entity type, a definition template is to create new records and a review template is to review the details. Both templates can be entered through entity lists.
- *Field-Level Suggestions*: Field-level suggestions are one of several types of feedback which is attached to data fields provided in the review templates. These suggestions can be accepted by users with proper privileges.
- *Field-Level Historical Values:* The collaboration system can track all the historical changes of each data field. This function is useful to view how the values have been changed over time. The collaboration system also provides a way for users with the appropriate privileges to restore a historical value.
- *Scenario Element Reusability*: One important benefit from the implementation of a knowledge structure is the ability to reuse knowledge elements. Currently, reusability is supported through element lists and corresponding buttons. An improvement to the design would be to provide reusability through hyperlinks automatically added by analyzing the contents. This implicit way to provide reusability would be more flexible and intuitive.
- *Role Management:* The collaboration system currently supports three roles.

1. *Player*: A player is a person who can create new scenario contents, as well as giving comments and suggestions, or filling in blank fields.
2. *Team Leader*: A team leader is a super player who can override others' contents.
3. *System Administrator*: A System Administrator has the Team Leader's privileges for all the teams. In addition, a System Administrator can create new users and assign roles.

RESEARCH QUESTIONS

In April 2009, a field study was conducted to test the initial implementation. Objectives of this field study were two-fold. First, this field study served as the first step to formally test the usefulness and ease of use of the prototype system. Second, this field study served as another opportunity for potential users to give feedback. For the first research objective, this field study attempted to provide insight into four research questions. The first three questions are derived from technology acceptance models (Davis, 1989; Venkatesh and Davis, 2000; Venkatesh et al., 2003). According to these models, both perceived ease of use (or effort expectancy) and perceived usefulness (or performance expectancy) can determine users' behavioral intention to use a new technology. In addition, perceived ease of use also impacts users' perceptions regarding a technology's usefulness. Thus, to understand user acceptance of it is important to answer the following three questions:

- RQ1: To what extent will users feel the collaboration system is easy to learn and use?
- RQ2: To what extent will users feel the collaboration system is useful?
- RQ3: Will the users be willing to use the collaboration system? Why? Why not?

The last question is derived from the design science paradigm (Hevner et al., 2004; Vaishnavi and Kuechler, 2007), which emphasizes using evaluation conclusions from an earlier iteration as inputs to improve artifact design for the next iteration. It is this premise upon which the fourth RQ is based:

- RQ4: What lessons will be learned to improve the collaboration system?

RESEARCH METHODS

Subjects and Procedures

The subjects of this field trial were undergraduate students from an online course offered by a university in the southern U.S. enrolled in a course on Terrorism and Homeland Security, in the spring semester of 2009. The field trial was given to the students as an optional extra credit assignment; 11 of the 19 students from all over the world participated. These are not typical undergraduate students. Many of them have been working as Emergency Management professionals for several years. The following table summarizes the professional background of the participants.

Team	ID	EM Related Experiences	Years of Experience
Blue	8	A volunteer for CERT (Community Emergency Response Teams) and the Red Cross	N/A
	14	Not working, but was a police officer and a dispatcher providing first line response to emergencies	6 years
	16	Contract firefighter providing fire suppression and life safety inspections on military installations in Iraq	2 years
	18*	A manager in a large, tri-service, integrated Public Safety Communications Centre in Canada	15 years
	20	Undergraduate student majoring in EM	None
Red	11*	The manager of the Emergency Preparedness department at a Nuclear Power Plant.	8 years
	13	Readiness and Emergency Management for US Air Force (USAF)	6 years
	15	Junior undergraduate student majoring in EM	None
	17	An Amateur Radio Operator, or "Ham Radio Operator" and the Communications Officer in their local Red Cross Chapter, managing everything related with communication in the chapter.	15 years
	21	Healthcare Administrator, Financial Counselor in Healthcare. Also have worked as a Nurse (BS in Nursing) Psychology degree also (minor).	N/A

*: Team Leader

Table 1. Background of the Participants of the Field Study

The field trial was conducted as a second phase in a month-long course project to create and revise terrorist attack scenarios. In the first phase, all the students in this class were divided into two groups (Blue team and Red team). Each group was required to generate a terrorist attack scenario for a tabletop exercise without the support of the collaboration system. The students were not aware of the second phase when they were working on the first phase. After the two teams submitted their initial scenarios, the students were invited to the second phase to use the collaboration system to revise the scenarios. Students choosing to participate in the second phase were instructed to accomplish the following three tasks using the collaboration system:

- The team leaders should spend first 3-5 days to load their current scenario in the forms for events, resources, etc into the system.
- Each team then should try and make suggestions for improvement to their and the other team's entries using comments.
- Members of the original team should add actual changes to their scenario when they felt one of the ideas suggested or generated caused them to feel a change or addition should be made.

It was also announced that the final scenarios would be evaluated by the instructor and team with the better scenario would be granted an extra of 5% in the final grades.

Data collection

This research utilized both quantitative and qualitative data to answer the research questions.

- The participants were asked to fill out a post-survey after the final scenarios were submitted. The post-survey questionnaires were created by adapting existing UTAUT measurements for the four determinants: Performance Expectancy, Effort Expectancy, Social Influence and Facilitating factors (Venkatesh et al., 2003). In addition, the post survey also measured motivation (Maslow, 1954; Herzberg et al., 1959; Agarwal and Karahanna, 2000), leadership (George and Sleeth, 2000; Yoo and Alavi, 2003; Heckman et al., 2007), and trust (Javenpaa & Leidner, 1999; Coppola et al., 2004), because of their important impacts in affecting knowledge sharing and VT performance. These variables and their measurements are summarized in the "Subject Opinions" section.
- Participants' background and motivation levels are important intermediate variables impacting their usage and perceptions of the system. These factors were measured using pre-survey questionnaires. Furthermore, self introductions of the students were also collected to understand their background.
- System usage information was recorded automatically by the system. Such information was utilized to reveal how the contributions were distributed, and how the collaboration was carried out.
- Discussions and comments given by the participants were stored by the system and were used to triangulate with quantitative data, as well as to understand system-improvement suggestions.

RESULTS

Scenario Creation

Before using Collario, both teams had spent approximately three weeks to create team scenarios. However, both scenarios were succinct and lacked important details. Such scenarios might be used to direct a tabletop exercise, but they could not contribute much for knowledge exchange and sharing.

After using Collario, both teams were able to expand their initial scenarios significantly. Degree of expansion is shown in Table 2 using word counts and number of events. Word counts calculate the total number of words in

Parameter	Team	Before	After	% of Increase $(\frac{\#After-\#Before}{\#Before})$
Word Counts	Red	682	2876	322%
	Blue	305	1514	396%
Number of Events	Red	16	48	200%
	Blue	7	46	557%

Table 2. Degree of Expansion before and after Using Collario for Team Scenarios

a scenario. Number of events calculates number of messages contributed to a scenario. A message is a chunk of sentences describing an event (offense or defense) or a situation.

Not only were quantities of the scenarios increased significantly, but quality of the scenarios was improved too. More details were added to the final scenarios. More aspects of issues were discussed. The following Table 3 utilizes keywords to reveal added details for final scenarios.

	Scenario	Keywords (Initial)	Keywords* (Final)
Red Team	Dirty Bomb Detonation in Augusta Mall	Cesium-137, FBI, bomb, lie detector, law enforcement, Homeland Security Advisory System, Orange, Augusta Mall, Food court, Ceiling, glass structure, weather, wind direction, wind speed, parking lot, 9-1-1 calls, 5000 Rem/hr (~83 Rem/minute), radioactive plume, structural integrity, ambulances, fire trucks, victims, radiation protection personnel, GEMA, SC EPD, EOC	Fire Department, Police Department, Local EMA, Highway Patrol, GBI, Civil Support Team, Department of Natural Resources radiological team, Dept. of Health and Environmental Control radiological team, Evidence Response Team, Hazardous Material Response Unit, EMT's paramedics, BLS and ALS (basic life support & Advanced Life support), hot zone, hazmat teams, first responders, 800MHZ channels, IC, MCV (Mobile Command Vehicle), WMD, EMS, on-scene triage, secondary device, crime scene, chest pains, EM director, resources, man-power, conference call, SEOC, EMAC, media, press release, radiation protection personnel, EDICS (Emergency Deployable Interoperable Communications system), Amateur Radio, county jurisdictions, road blocks, Tent, radio operator, emergency net, Net control, warm zone, Red Cross, shelters, special needs shelter, nurse, caregiver, radio and television, Search and Rescue Teams, Radiological Decontamination Team, mobile decontamination site, decon team, mobile shower trailers, fire hydrant, Paper scrubs, counselors and psychologists, industrial generators, SCBA, health physics technician, make-shift tent, patience gowns, soap and water, gender specific mobile decontamination units, 500 CFM HEPA unit, HEPA filter, Joint Information Center, Chief Information Officer, blood work, Prussian blue, buffer zone, half-life, fluid electrolytes, Unified command, volunteers, information hotline, Red Cross liaison, EDWARDS satellite downlink, MARC (Mutal Aid Radio Cache), Portable refrigerated trailer
Blue Team	Bomb Exploding a Train Carrying Hazardous Cargo	Railway, hazardous materials, Chicago, CN Rail, Aurora, IL, rail traffic, NEM (Naperville Environmental Movement), radical extreme environmentalist, terrorist group, Manchester Road railway crossing, propane explosion, Metra public transportation system, casualties, wreckage, chlorine tankers, Winds, contaminants, residential district, lethal gas cloud	Emergency Communication Officers, Fire, EMS and Police, Dispatchers, first aid, community service officers, traffic control, public works, barricades, scene perimeter, bomb squad, terrorist attack, Edward Hospital, PPE, Chief on Duty (COD), IDLH, Naperville Bomb Squad, mutual aid, channel, Command Post, ICS, warm zone, hot zone, Chlorine gas, phosgene gas, Communications Center, public warning system, PIO, CHEMTRECH, REACT team, Community Emergency Response Team (CERT), shelter-in-place, news media, public services officer, Radio traffic, North Central College, Dupage Children's Museum, EOC, Evidence Response Team, Hazardous Material Response Unit, FBI, EPA, mask, news team, Red Cross, food, water, and resources, volunteer nurses, Salvation Army, PH Strips, Dukes Oil Serv Inc, Department of Public Utilities, public water system,

*: Keywords appeared in the initial column are not repeated in the final column.

Table 3. Scenario Keywords before and after Using Collario

From this table, it can be seen clearly that the final scenarios contain much more details than their initial counterparts. Many of the added details covered special response teams, resources, procedures, etc. Through creating and discussing scenario using Collario, such information was effectively communicated among the participants. More importantly, these details were added by different participants. This means knowledge sharing and exchange occurred effectively. Collario also allows users to create stand alone elements like resources and events. Distributions of various contributions are illustrated in Table 4. All except one Red team contributed. By far the most active member was the Red Team leader. The Blue Team had much more equalitarian participation.

	Blue Team						Red Team				
ID	**8**	**12**	**14**	**16**	**18***	**20**	**11***	**13**	**15**	**17**	**21**
# Scenario Events	2	10	10	8	10	6	36	0	6	5	0
# Stand-alone Resources and Events	2	2	0	0	1	2	7	0	0	7	17
Total # of Contribution	4 (7.5%)	12 (22.6%)	10 (18.9%)	8 (15.1%)	11 (20.8%)	8 (15.1%)	43 (55.1%)	0 (0%)	6 (7.7%)	12 (15.4%)	17 (21.8%)
Total Words	166 (5.7%)	647 (22.3%)	655 (22.6%)	369 (12.7%)	635 (21.9%)	431 (14.8%)	2711 (51%)	0 (0%)	185 (3.5%)	1734 (32.6%)	688 (12.9%)

Table 4: Contribution Distribution

Finally, Collario allows users to give comments and suggest changes in both field and record level. The number of such feedbacks per participant is shown in Table 5.

	Blue Team						**Red Team**				
ID	**8**	**12**	**14**	**16**	**18***	**20**	**11***	**13**	**15**	**17**	**21**
Number of Feedback	0 (0%)	4 (17.4%)	4 (17.4%)	0. (0%)	12 (52.2%)	3 (13.0%)	9 (36.0%)	4 (16.0%)	8 (32.0%)	2 (8.0%)	2 (8.0%)

Table 5: Feedback Distribution

Subjective Opinions

In this research, subject opinions were measured using post-survey questionnaires. Variables, their measurements, and results of the post-surveys are summarized in Table 6.

Variable	**#**	**Question**	**Mean**	**SD**
Voluntariness of Use	2	To what degree was the collaborative scenario creation exercise enjoyable to you? (1: extremely boring; 7: extremely interesting)	5.44	0.68
	3	To what degree was the collaborative scenario creation exercise relevant to your job responsibilities? (1: extremely irrelevant; 7: extremely relevant)	5.00	1.56
Time Devoted	4	On the average I participated:	2.56	0.50
Leadership	5	To what degree did the group leader make the group's roles clear? (1: extremely clear; 7: extremely unclear)	3.89	1.73
	6	To what degree did the group leader make the group's priorities and directions clear? (1: extremely clear; 7: extremely unclear)	3.78	1.47
	7	The group leader wisely anticipated workflow problems and takes necessary actions to avoid crisis? (1: SD; 7: SA)	4.44	1.17
	8	To what degree did the group leader bring a sense of order into the group? (1: very chaotic; 7: very orderly)	5.11	0.99
	9	Overall, the group leader did an excellent job: (1: SD; 7: SA)	5.78	0.92
	10	Overall, the functions of leadership were well served: (1: SD; 7: SA)	5.22	0.79
Trust	11	The people in my group were very trustworthy: (1: SD; 7: SA)	4.33	1.25
	12	We were usually considerate of one another's feelings on this team: (1: SD; 7: SA)	5.78	0.63
	13	The people in my group were friendly: (1: SD; 7: SA)	5.33	0.82
	14	I could rely on those with whom I worked in my group: (1: SD; 7: SA)	4.00	1.25
Performance Expectancy (UTAUT)	15	I find Collario is useful for creating emergency scenarios: (1: SD; 7: SA)	6.11	0.99
	16	I find using Collario is useful in promoting knowledge sharing and learning from peers: (1: SD; 7: SA)	6.00	0.94
	17	I find using Collario enables groups to create emergency scenarios more quickly: (1: SD; 7: SA)	5.78	0.79
	18	I find using Collario increases a group's collaboration and group wide understandings: (1: SD; 7: SA)	5.67	0.47
	19	I find using Collario increases the amount of group discussion about the contributions of individual members: (1: SD; 7: SA)	5.56	0.68

Table 6. Results of Post-Surveys (Part I)

Variable	#	Question	Mean	SD
Effort Expectancy (UTAUT)	20	I find my interaction with the group is clear and understandable when using Collario: (1: SD; 7: SA)	5.11	1.10
	21	I find it easy for a group to become skillful for using Collario: (1: SD; 7: SA)	5.13	0.78
	22	I find it easy to discuss scenarios asynchronously using Collario: (1: SD; 7: SA)	5.22	0.79
	23	I find it easy for me to learn to use Collario to discuss scenarios asynchronously: (1: SD; 7: SA)	5.78	0.92
Social Influence (UTAUT)	24	I believe my manager would support me to try the system: (1: SD; 7: SA)	4.67	1.76
	25	I believe my professional friends would support me to use the system: (1: SD; 7: SA)	5.44	1.26
	26	My group members give me a lot of help to use the system: (1: SD; 7: SA)	4.22	1.40
	27	In general, my group has supported me trying the system: (1: SD; 7: SA)	4.78	1.23
Facilitator Conditions (UTAUT)	28	I have the resources necessary to use the system at home as well as at work: (1: SD; 7: SA)	5.44	1.95
	29	I have the knowledge necessary to use the system: (1: SD; 7: SA)	5.67	0.67
	30	I have enough training before using the system to work on the scenario: (1: SD; 7: SA)	4.78	1.40

Table 6. Results of Post-Surveys (Part II)

From this table, it can be seen that the participants gave pretty high ratings to perceived usefulness and perceived ease of use. All the ratings for PE (Performance Expectancy) were above 5 out of 7, and all the ratings for EE (Effort Expectancy) were above 5 too.

The results also show that the system and the process of collaborative scenario creation contribute to knowledge sharing and exchange. Question 16 for knowledge sharing gets a high average rating of 6 out 7.

Comments on the Collaboration System

Subjects spontaneously gave comments on the usability issues of the collaboration system both during and after the exercise. For instance, on the second day of the exercise the red team leader posted: "The software does not look that complicated and we should be fine after the team members step forward." Although the instruction asked the team leaders to load their initial scenarios within the first 3-5 days, both of them were able to finish this step on the first day they started. After that, both teams were able to start discussing and improving their initial scenarios on their own. Other comments included, "It's easy to learn,' and "It is easy to work with." Subjects also gave positive comments on various usefulness issues about the collaboration system both during and after the exercise. For instance, "the ability to produce an information flow is very useful. I particularly liked the ability to share resources and events from other scenarios and insert them into a new scenario as appropriate." Another comment was, "The most useful feature was the ability to work off another person's input, something like a brainstorming session while creating the scenario."

LIMITATIONS AND CONCLUSION

The field study found that the collaboration system was easy to learn and easy to use. The subjects were given tutorials and they learned how to use the system to create and discuss scenarios quickly. No intervention was needed for the exercise to move forward smoothly. The post survey showed an average Effort Expectancy score of 5.31, on a scale where 7 means least effort and 1 means most effort. Subjects' comments also revealed that they felt the collaboration system was easy to use.

The field study also found that the collaboration system was useful in supporting collaborative scenario creation, information exchange, and knowledge base build-up. After the 10-day exercise, both teams significantly increased the size of the original scenarios. The majority of the subjects contributed new information to the final scenarios. In general, the subjects were satisfied with their experiences in participating in the exercise to discuss and improve the scenarios. They felt that this exercise gave them an opportunity to learn a lot from their peers. Best of all, their contributions were kept in the database and would not be lost after the exercise.

The major limitation of this first field study was the small sample size. In total, only eleven users divided into two groups joined the first field trial. Ten of them finished the pre survey and nine of them finished the post survey. With such a small sample size, no statistic analyses to test hypotheses have been conducted. The results from this field trial cannot be generalized to any other population.

Nevertheless, all the subjects of the first trial were working in or would be working in the Emergency Management field. They represented the collaboration system's targeted user group very well. In addition, the exercise utilized a realistic type of task that the subjects might have been and would be involved sometime in the future. As a result, the subjects' engagement in this field trial was very high. In addition, the small group sizes are probably typical of the size of working groups that would actually develop a scenario. Most importantly, for the initial test of a simplified prototype, the number of subjects was sufficient to identify strengths and weaknesses of the system, which is the main objective of design research. All these help to support the validity of the results.

Besides evaluating the collaboration system in its effort towards collaborative scenario creation, this field study also helped us to identify new problems and collect valuable feedback to improve the system. The problems and feedback will become inputs for future iterations to advance the development of the system. Anyone who would like to utilize the system in the future is invited to contact the first author.

CONTRIBUTIONS TO THE EMERGENCY MANAGEMENT FIELD

For the Emergency Management field, this research provides an easily accessible web application to support collaborative scenario creation and discussion in virtual teams. Several potential application areas might benefit from this system.

First, the system appears to have the potential to create high-quality exercise scenarios that will require further evaluation subsequent to actual exercise use. Creating high-quality exercise scenarios has been the most challenging part of conducting emergency preparedness exercises. As our society is getting more and more complex and interconnected, emergencies and disasters have become both more extreme and more unique or "creative", which requires emergency preparedness to be equally "creative" in planning, mitigation, and response. The collaborative system allows exercise builders to create emergency scenarios over a long period of time and with insightful minds from wherever they may be. It also allows exercise builders to play with different configurations to find out the most relevant deviations from the primary expectations. All these would help exercise administrators to create better exercise scenarios.

Second, such a system can help exercise administrators conduct scenario-based exercises on an on-going basis. Without the need to gather all the participants at the same location and time for an exercise, exercise administrators can use the collaboration system to launch an exercise whenever it is necessary with anyone they want, as long as they have a connection to the Internet. Such flexibility not only lowers costs and overhead as normally occur in traditional FtF exercises, but also makes it possible to continuously monitor and review emergency plans. In an era with change being the most prominent characteristic, this capability is crucial, because changes of the circumstances would nullify the foundations and assumptions of the plans quickly.

Third, the system can create an environment that stimulates information exchange and knowledge sharing. The knowledge management community has found that implicit knowledge is the kind of knowledge that is the most difficult to share (Nonaka and Takeuchi, 1995). To share implicit knowledge, it needs to be externalized and communicated (Kolb, 1984). However, some implicit knowledge, such as how to deal with uncertainties under dynamic environments, might not be communicated effectively as a reflection after the fact. This is why Experience-Based Learning (EBL) is important in training emergency responders. However, in reality, such opportunities are limited because of availability. The system provides an easy solution to recreate complex emergency situations that may not be easily accessible otherwise.

Fourth, the system can become a knowledge creation and refinement platform. It builds in a scenario knowledge structure, based on which different users would be able to contribute different knowledge such as resources and events, even though they might not know the whole scenario. The knowledge structure is such that knowledge can be reused by other people to create other scenarios. Efforts to create new scenarios would be reduced over time. It also provides deep collaboration support for the users to refine the contents of the knowledge. Altogether, it has the potential to become a knowledge creation and refinement platform for Emergency Management.

ACKNOWLEDGEMENTS

We thank Dr. Connie White of Jacksonville State University, Alabama, for introducing this system to her Homeland Security class. We appreciate Dr. White's students for participating in this field study.

REFERENCES

1. Agarwal, R., and Karakanna, E. (2000). "Time flies when you're having fun: cognitive absorption and beliefs about information technology usage." MIS Quarterly 24(4): 665-694.
2. Coates, J. F. (2000). "Scenario planning." Technological Forecasting and Social Change 65: 115-123.
3. Cornelius, P., Romani, M., and Van de Putte, A. (2005). "Three decades of scenario planning in Shell." California Management Review 48(1): 92-109.
4. Coppola, N. W., Hiltz, S.R., and Rotter, N. (2004). "Building trust in virtual teams." IEEE Transactions on Professional Communication 47(2): 95-104.
5. Davis, F. D., F.D. (1989). "Perceived usefulness, perceived ease of use, and user acceptance of information technology." MIS Quarterly 13(3): 318-340.
6. George, G., and Sleeth, R. G. (2000). "Leadership in computer-mediated communication: Implications and research directions." Journal of Business and Psychology 15(2): 287-310.
7. Gordon, T. J. (1994). Cross-Impact Method. Futures Research Methodology. T. J. G. Gerome C. Glenn, American Council for the UNU.
8. Heckman, R., Crowston, K., Nora, M., and Yeliz, E. (2007). Emergent leadership in self-organizing virtual teams. Proceedings of the International Conference on Information Systems (ICIS'07), Montreal, Canada.
9. Herzberg, F., Mausner, B., and Synderman, B (1959). The Motivation to Work. New York, NY, John Wiley.
10. Hevner, A. R., March, S. T., Park, J., and Ram, S. (2004). "Design science in Information Systems research." MISQ Quarterly 28(1): 75-105.
11. Jarvenpaa, S. L., and Leidner, D. E. (1999). "Communication and trust in global virtual teams." Organization Science 10(6): 791-815.
12. Kahn, H. (1960). On Thermonuclear War. Princeton, NJ, Princeton University Press.
13. Kolb, D. A. (1984). Experiential Learning. Englewood Cliffs, NJ, Prentice Hall.
14. Maslow, A. (1954). Motivation and Personality. New York, NY, Harper & Row.
15. McConnell, P., and Davies, M. (2006). "Safety first - scenario analysis under Basel II." Retrieved 2009, July 10, from http://www.gloriamundi.org/picsresources/pmmdorm.pdf.
16. Nonaka, I., and Takeuchi, H. (1995). The Knowledge Creating Company: How Japanese Companies Create the Dynamic Innovation? New York, NY, Oxford University Press.
17. Quarantelli, E. L. (1997). "Ten criteria for evaluating the management of community disasters." Disaster 21(1): 39-56.
18. Van de Walle, B., Turoff, M. and Hiltz, S.R., eds. (2009). Information Systems for Emergency Management. Advances in Management Information Systems Monograph Series (Editor-in-Chief: Vladimir Zwass). Armonk, NY: M.E. Sharpe Inc.
19. Venkatesh, V., and Davis, F.D. (2000). "A theoretical extension of the Technology Acceptance Model: Four longitudinal field studies." Management Science 46(2): 186-204.
20. Venkatesh, V., Morris, M. G., Davis, G. B., and Davis, F. D. (2003). "User acceptance of information technology: toward a unified view." MIS Quarterly 27(3): 425-478.
21. Yao, X., Konopka, J., Hendela, A., Chumer M, and Turoff, M. (2005). Unleash physical limitations: virtual emergency preparedness planning simulation training, methodology and case study. Proceedings of Eleventh Americas Conference on Information System (AMCIS), Omaha, NE.
22. Yao, X., Turoff, M., and Chumer, M. J. (2009). Designing Collario for continuous reviewing and practicing of emergency plans to ensure complex system safety. Proceedings of the 6th Conference on Information Systems for Crisis Response and Management (ISCRAM'09), Gothenburg, Sweden.
23. Yoo, Y. A., and Alavi, M. (2004). "Emergent leadership in virtual teams: What do emergent leaders do?" Information and Organization 14(1): 27-58.