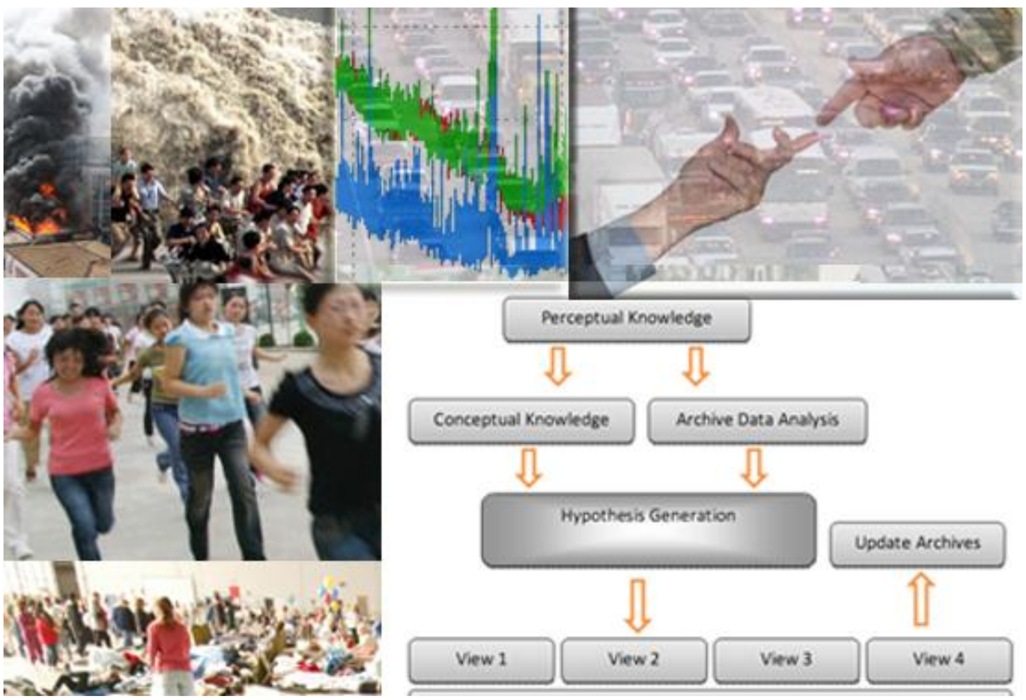
CHALMERS



Intelligent Interface for Crisismanagement

Master of Science Thesis

Nihal Siriwardanagea

Erick Oduor

Department of Computer Science and Engineering

CHALMERS UNIVERSITY OF TECHNOLOGY

Göteborg, Sweden, October 2010

{Concept for an Integrated Intelligent Interface for Crisis Management}

Erick Oduor, Nihal Siriwardanagea.

Examiner: Dr. Fang Chen

Chalmers University of Technology

University of Gothenburg

Department of Computer Science and Engineering

SE-412 96 Göteborg

Sweden

Telephone + 46 (0)31-772 1000

Department of Computer Science and Engineering

Göteborg, Sweden October 2010-10-18

The Contents

Part 1

Part 2

Expert Systems for Crisis Management

Introduction

How an EDSS works

Review existing systems

- **Crisis Commander**
- **Geo Chat**
- **Geo Conference**
- **CATS Aims**
- **WIS**
- **RAKEL**
- **Microsoft Vine**

Related Projects

- **SICMA Project**
- **Emergency Support Systems**
- **OASIS Project**
- **SAE (SAAB security)**

Why Integrated Crisis Management Support System

Situation Picture

Part 3

Thesis Concept

- **Assist DM**
- **Communication Support**
- **Risk and Vulnerability Support**

Vision for the Concept

- **Step 1: Information Gathering**
- **Step 2: Analysis**
- **Step 3: Decision Making**
- **Step 4: Monitoring**

Thesis Objective

- **Support System flow**
- **Vision for decision support**
- **Intelligent visualization**
- **Visualization guide**

User and System requirements

- **System evaluation**
- **Summary**

Conceptual Model and Update from ISCRAM conference presentation

Conclusion

- **Knowledge Base**
- **Future works**
    - **Scenarios of action**

References

Part 1

(Background Information)

Introduction

A crisis

The origin of the word "Crisis" comes from a Greek word "Krisis" which means judgment or choice. This term varies depending on the context or research disciplined it used in. Mainly it is the art of making decisions in a harsh environment in order to minimize or overcome the effects of the event. This process can be identified as number of activates such as Planning, Incident immediate responding, recovery effort and mitigation (Kash, et. al., 1998). The planning is done in order to obtain the real feeling of a crisis event and to get to know what should be done in such events.

A crisis may also be defined as any unplanned event that can cause death or significant injuries to employees, customers, or the public; shut down the business; disrupt operations; cause physical or environmental damage; or threaten the facility's financial standing or public image. (Maynard, 1993).

A crisis can be categorized considering its effect to the society; In this regard it can affect a large society or organization and sometimes a crisis could be limited to a specific area. Generally, the actions and measures taken to neutralize the crisis are dependent on the scale of the crisis and the duration that it will take to manage the crisis.

Crisis Management

Crisis management is a series of functions or processes aimed to identify, study and forecast crisis issues, and set forth specific ways that would enable an organization to prevent or cope with a crisis, (McClure et. al., 1999).

Deciding on which actions to undertake during a crisis situation due to the stress and excitement that couples the situation makes it much more difficult for the stakeholders to work according to laid down rules. A continuous approach of proactive planning is recommended to prepare a manager to deal with the control of unpredictable situations. Occasionally when crises are ignored they quickly spiral out of control. A case in history is the Three-Mile Island nuclear plant in the United States that experienced warning signals that indicated nuclear reactors were at risk of a meltdown when hundreds of alarms went off to signal a potential crisis. With no planned instructions as to what should be done first. The crisis wasn't acknowledged in the beginning and therefore became a chronic event.

From the warning stage we step into the Acute Crisis stage. For most crises it is much easier and more reliable to take care of the problem before it becomes acute, before it erupts and causes possible complications. (Mittrof, 1996)At this point the damage has already occurred meaning that it could only be controlled

If not addressed, then the acute crisis stage evolves into the chronic crisis stage.

Past experiences of the different stages of a crisis

The BSE and Mad Cow Health scares

The discovery of BSE in Canada's cattle on May 20, 2003 led to lost market access for Canadian cattle and beef in many countries. The Canadian cattle industry is extremely export dependent, and the loss of almost all of major export markets had a devastating impact on the country's economy (Loppacher, 2004). Over a year later, many of those markets had still not removed their restrictions on Canadian cattle and beef. The severity of the restrictions and their long- term continuance were far in excess of what was recommended by the international organizations that set the standards for trade in animals and animal products. This led many in the Canadian industry to wonder why sanitary barriers were imposed on their cattle industry. However to understand how the situation quickly ran out of hand we look at what the Observer (Loppacher, 2004) described as "a PR disaster" because the BSE crisis "was brought about not so much by BSE itself as by attempting to explain it". The crisis was a result of ineffective management of information and poor communication. (Adams et. al., 2006)

The first and widely recognized mistake was the Government's decision to announce a possible link between BSE and CJD without having a plan of action to deal with it (Tennyson, 1996). Next, was pointing the finger at the experts who failed to reach any consensus on how to explain the health scare, the Government dithered and the media carried out their own debate, resulting in more uncertainty as speculation escalated. During the Mad Cow scare in Britain, McDonald's obviously understood the need to react quickly at a time of crisis - they wasted no time in taking action to ban British beef - and in letting this be known. It was classic crisis management - adopting a better safe than sorry policy since in a crisis situation, the perceptions of consumers are reality.

The Oral Contraceptives Health Scare

The U.S.A Government's issue of a warning that certain brands of oral contraceptive were twice as likely to cause blood clots, which could be life threatening, threw millions of women into panic. These women immediately contacted doctors' surgeries and family planning clinics - and this was the way in which many doctors heard about this crisis (Paton and Violanti, 2000). Failure by the government to manage or control communication showed that there had been no planned response to the report-based information. With lack of this vital piece of reassurance information needed to calm down the crisis, Doctors had to deal with a situation of panicking clients in huge unexpected droves that they had not planned simply because they too had not been briefed prior to the announcement, and key people were not involved. Action to reassure people should have been well laid through a contingency plan even before the announcement was to be made. Thus a crisis spiraled out of control as a result of poor communication from the U.S. government.

The Kista Blackout

March 11 2001 was a memorable day for the people at "Kista" Stockholm, the silicon valley of Sweden. In the early morning the power supply for the whole municipality went down and this continued for two days. The consequences of this power failure were dramatic for the residents in Kista. It seriously affected business, public administration as well as the daily lives of the residents of over 100 000 in eight districts of southern Stockholm.

The reason for the power failure was a fire on 110kV power cable which was located 330 meters inside a cable tunnel. In this crisis scenario major actor was Fire Department at Stockholm and they were responsible for put out the fire. Kista situation was an extraordinary event for the Stockholm Fire Department. It took 48 hours for them to bring the situation to a completely normal situation. The fire department in Stockholm got the news about the fire from the local radio news. There were two telephone lines to contact the fire department but both of them had failed to work due to the power failure. Thirty-five fire fighters engaged in the fire extinction exercise under extremely hard conditions. They had to reach the fire which was 30-40 meters below the ground with limited visibility.

During the crisis services such as heating, ventilation, fresh water supply, sewage pumping had ceased to function. The citizen who suffered from power failure could not cook meals, or access to the radio, TV or internet. Moreover traffic controls at tunnels subways went out of order and Public health, Public order, Public safety were threatened during the blackout.

During the Kista-blackout there was no serious injury to people, but the incident showed the vulnerability of the technical infrastructure which is extremely depends on the vital functions of the modern society. The Brika energy was responsible to update the public on the crisis situation. They did not perform this to the satisfaction of the public and as a result the public trust on the crisis management activities was reduced. Therefore, Kista blackout is a good example of the importance of communication between different actors that were supposed to handle the crisis. If there was a good communication, the actors could have been able to coordinate the appropriate within reasonable time.

Important factors in the management of a crisis

Preventive efforts

A recommended effort that would go a long way to enhance effective handling of crisis would be preventing such an occurrence at the earliest possible time. Preventive measures deal with sensing potential problems, (Herrero and Pratt, 1995). Before categorizing a process that could be considered to be a potential crisis, there should be a laid down structure to enable easy standardization across many platforms. What is imminently more sensible and much more manageable, is to identify the processes necessary for assessing and dealing with future crises as they arise (Birch, 1994). This process involves planning steps and procedures coupled with decision making techniques that set base for an effective information's system. If well executed it would gather appropriate data from the environment, interpret this data into opportunities and challenges, and provide a concrete foundation for strategies that could function as much to avoid crises as to intervene and resolve them.

A crisis can be discovered at an earlier stage using a technique called strategic forecasting. **Strategic forecasting** primarily involves predictions that are based on assumptions that the organization is capable of adapting to new situations whenever they will occur. The notion of strategic forecasting is to predict and assess the impact of major or broad trends in a general scenario of crisis management prediction, (Mayer and Schoorman, 1995). The next interest would be how to deal with unexpected scenarios. This is addressed through **Contingency planning.** Where alternative plans are put into place if events do not occur as expected. Also as similar to contingency planning is **Issues analysis;** whose purpose is to alert company decision-makers to be aware of evolving trends in the external environment of an institution. This would be in areas such as environmental protection demonstrating that certain companies will eventually be forced to change methods of production, energy sources used and products manufactured so as to avert crises.

Addressing a company's preparedness to crises involves putting in place well laid scenarios that describe framework on how to handle situations that might occur at some unexpected point in time. This could be achieved through scenario analysis. **Scenario analysis** is an attempt to describe in detail a sequence of events which could possibly lead to a prescribed end-state, or alternately, to consider the possible outcomes of present choices. A scenario is a hypothetical sequence of events designed to draw attention to causal processes and decision points. Scenarios may pertain to management succession in the case of a plane crash or death, take-over attempts and other disasters. For example, in April 1993, a dozen executives from the USA died, along with Commerce Secretary Ron Brown, in a plane crash on the way to Bosnia to initiate trade relationships. A study shows that 34 percent of the companies surveyed had no succession plans. An example of general motors' prescribed seven step scenario as explained by (Naylor, 1983) is given below:

- a pair of scenarios (best case and worst case);
- alternative courses of action;
- the outcome of the various strategies;
- the same procedure for the worst case scenario;
- (3) and (4) to analyze the desirability of each case situation;
- the strategies for the second scenario of the first step; and
- results for each of the critical factors analyzed

Crisis intervention

When a symptom is "spotted" the executive's objective as a crisis manager is to seize control swiftly and calculate the most direct and expedient route to achieving a resolution of the crisis (Darling *et al*., 1996). Dow Chemical's officials believe that the first 24 hours are the critical ones for a business facing a crisis. If the company does not quickly respond in that time to provide the public with genuine information, the firm will be judged "guilty until proven innocent". An important step towards dealing with any crisis is effective use of communication. A company that freely shares information stands the best chance of weathering difficulties (Mitroff *et al*., 1996). The US Air recognizes that when its crisis plan goes into effect, leadership within the company becomes a coordinator of aid and information to the families concerned. During this communication phase, honesty is valued to a great extent (Donoho, 1994). First impressions are of major importance when crisis strikes and often getting the company's case across to key stakeholders is best done directly (Birch, 1994).

An example of how this strategy was used effectively was when a syringe was found in a Pepsi bottle; cross-functional teams examined the claims, sorted out the facts, and then forwarded accurate information to the sales force who then communicated the facts discovered to the customers. This enabled a quick recovery from this catastrophic event. In another example that occurred in 1983, Johnson & Johnson had a major crisis to deal with when some customers died from having taken cyanide-laced Tylenol products. The company responded quickly and forcefully. It spent a great deal of money on repurchasing millions of capsules from stores and customers, and on retooling its packaging, with safety and protection of the consumer in mind. This act of displaying concern to the situation and care for its customers and commitment to the corporation's ethical standards, the firm was highly regarded after the episode than it had been before. (Jackson and Shantz, 1993)

Before a crisis starts there are certain basic efforts that a company should make. These efforts focus on two steps that include establishing a crisis management team, and appointing strategic teams for scenario analysis.

Establishing a crisis management team

Before a crisis occurs, a crisis management team with a clear command should be formed. This group should plan to meet every six months or so to discuss how to respond to potential crises (Carver, 1989). The said teams should be cross-functional, so as to get input from all aspects of the business, identify every possible disaster they can imagine the company facing, as well as possible responses, and identify potential crises and determine how vulnerable the company is to them. According to their respective risks contingency plans should be made in regard to the magnitude of the risks identified by these task forces. The high risk crises should have a full crisis plan developed while for lesser risk crises, a smaller contingency plan should suffice. The plan's main focus should be on protecting people, communication and mitigating damage to facilities. Once developed, all stakeholders need to be kept informed, through regular review and testing of the plan continuously.

Appointing strategic teams for scenario analysis

A continuous contingency planning over a period of time in the absence of a crisis requires the establishment of a team for scenario analysis. Quite often, companies tend to discontinue the effort due to cost saving after doing it a few times without the occurrence of a crisis. It is advisable to always continue with this analysis and rehearsals since this can facilitate a significant pay-back at the time of a crisis. Early address of crisis situations ahead of time by issues analysis and scenario creation is one of the recommended steps to focus on. Next step involves acknowledging a crisis, and communicating affectively with constituent groups because this would reduce image and reputation damages if the situation happens to spiral out of control. However, the primary success comes from prevention, preparation and intervention.

Resilience is an active process of self-righting, learned resourcefulness and growth – the ability to function psychologically at a level far greater than expected given the individual's capabilities and previous experiences. To encapsulate a paradigm shift that accommodates the analysis and facilitation of growth. One misconception that should be noted is the perception that with good preparation there would be no arising of unexpected disappointments during a crisis, (Paton, 2007). In risk homeostasis, (Adams, 2006) describes how a perceived increase in safety can reduce the risk attributed to a hazard, increase risk behavior and render individuals more vulnerable to negative stress effects. What is required is an over-arching framework that, rather than prescribing outcome expectations, accommodates a range of possibilities, these should include both the good and bad. A need for the systematic analysis of both resilience and vulnerability is also indicated by the possibility of their having a contingent relationship with growth and distress. For example, while expectations about experiencing positive reactions to disaster work can represent a valuable coping resource, such beliefs may increase vulnerability when emergency workers cannot do anything to save lives or prevent destruction. (Earle, 2004)

Risk Management.

Risk management typically involves some mixture of anticipation ("looking forward") and resilience ("bouncing back"), thus conferring upon risk management models the potential to in cooperate perspectives that cover both positive developments and distress (Poortinga and Pigeon, 2003). Understanding of risk should include vulnerability as a fact that counts for differences in individual susceptibility to negative hazard effects. Vulnerability is the combination of characteristics of a person or group in terms of their capacity to anticipate, cope with, resist, and recover from hazard impacts that threaten their life, well-being and livelihood. (Brown, 1979)

Psychological hazards as a function of vulnerability and resilience

In risk management models a hazard denotes a chance phenomena capable of causing harm. In relation to the study of disaster stress, it's represented by the disaster characteristics or demands encountered by those in response and management roles. Organizational hazard and risk assessment typically focus on possible exposure to industrial (e.g. fire); natural (e.g. earthquake) and environmental (e.g. toxic waste) hazards, this level of analysis should be sufficiently detailed for psychological hazard analysis (Paton et. al., 2006).

In order to develop an effective model it is required that the resilience and vulnerability characteristics that influence outcomes ranging from growth to distress are identified. Resilience is comprised of three components.

- dispositional,
- cognitive, and
- Environmental.

Dispositional vulnerability and resilience

- Vulnerability could be grouped into biological, historical antecedents and psychological. Biological vulnerability factors include changes in physiological reactivity as a consequence of prior disaster exposure. An example would include genetically-based predispositions such as autonomic reactivity. (Paton, 1999)
- Historical antecedents, includes learning history, socioeconomic status, and pre-existing psychopathology. Finally,
- Psychological vulnerability, describes learned behavior including avoidance of threat situations, social skills deficits leading to problems obtaining and utilizing social support, hyper-vigilance of threat-relevant cues, and inadequate problem-solving behavior. Vulnerability can also be influenced by the person's history of disaster experience

Cognitive resilience: coherence, meaning and training

There is a need to develop procedures, and expectations, that accurately reflect the disaster operating context in which expertise is applied. The relative infrequence of disasters means that developing the capability to impose coherence and meaning on disaster work experiences requires the use of simulations that model the demands, competencies and contextual factors likely to be encountered. Simulations afford opportunities for individuals to review plans, develop technical and management skills, practice their use under realistic circumstances, receive feedback on their performance, increase awareness of stress reactions, and facilitate rehearsal of strategies to minimize stress reactions. While training can facilitate resilience, the comprehensive realization of the ensuing benefits will be influenced by the extent to which they are sustained by the operating environment.

Environmental resilience:

Professionals and individuals who oversee disaster response duties form cohesive social groups with a unique culture. Such groups' operation modes influence resilience and vulnerability to some extent (Paton and Bishop, 1996). When disaster workers perform well in a crisis situation then resilience is exhibited as a positive resource.

In terms of organizational characteristics and managerial behavior vulnerability to disaster stress reactions is influenced by organizational characteristics such as management style, reporting procedures and bureaucratic flexibility (Alexander and Wells, 1991). To sustain staff, and constitute a resilience resource, management procedures should be designed specifically to manage response and recovery plans (Paton *et al.*, 2005).

Resilience sustenance can be greatly increased by managers who provide feedback to staff through talking about their personal experiences (Alexander and Wells, 1991). Providing a framework for the positive resolution of their experiences can be facilitated by assisting workers to identify the strengths that assisted in previous disasters. This would assist manager's resilience by smoothing the transition back into routine work.

The figure on the next page shows the interrelationships that define how resilience and vulnerability could affect an individual during the period which they gain experience of working in a disaster recovery situation.

Proposed risk management model for disaster stress.

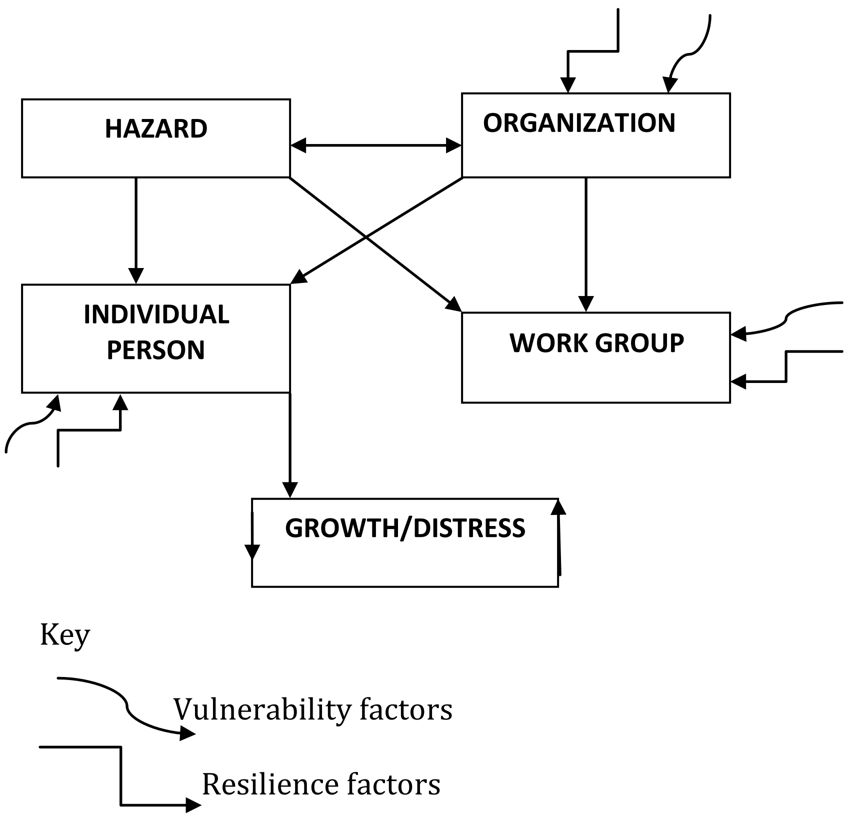


Figure 1

Communication

Even though all the factors explained up to this point are critical in handling of a crisis situation. The equation becomes incomplete unless effective management of information at a time of crisis is added to the equation (Lion et. al., 2002). In the current environment; governments, public services, utilities, local authorities, charities, trade unions and countless other institutions and non-profit bodies are as dependent upon goodwill for success as those in the commercial sector

(Haywood, 1994). This makes the component of information vital to effective management of a crisis.

One basic rule that would improve communication during a crisis is the importance of telling the truth. Rather than let the media network speculate (Hardin and Higgins, 1996).The media network should be used as an opportunity to disseminate information while leaving no room for speculation - “if you can’t tell the stakeholders something, it is advisable to explain to them why it is not possible to address their concerns (Gonzalo and Herrero, 1995). Communication in disaster situation is more so important since bad news is very newsworthy and more sensational.

When Greenpeace staged its high-profile stand against the sinking of the Brent Spar oil platform, it not only posted information on the Web, but was reported to have airlifted sophisticated filming equipment and a satellite down station on to the rig, so that they could provide their own updates directly to news outlets. Quick information coverage means that it is unlikely that there will be a time delay between an incident and the resulting media coverage. This emphasizes the need to react quickly at a time of crisis, and to let all parties know immediately about the action you have taken.

If, despite the best plans to avert it, a crisis happens, it is important to “Ensure that all communications are targeted at all audiences and not just at the media, with appropriate contact lines or enquiry personnel” (Haywood, 1994). Separate help lines staffed by trained personnel should be ready at the same time as media information. As well as effective management of information to the media, arrangements must be made for effective management of information to all concerned parties, including members of the public

Community Role

In this part of the article, we look at the ways in which the communities affected by a crisis can be prepared to avert or handle a disaster effectively. In societies susceptible to experiencing adverse impacts from, for example, volcanic, wildfire, and seismic activity, the management of the associated risk is afforded a high priority. A key component of risk management is encouraging the adoption of protective measures (e.g. storing food and water, household emergency planning) to reduce the risk of injury and damage and facilitate people's capacity to cope with hazard consequences (Paton, 2006). Despite the efforts of emergency planners, based on the assumption that providing people with information about hazards will motivate the adoption of protective actions, people living in communities at risk from natural hazards continue to demonstrate poor knowledge of risk mitigation procedures. (Blaikie et. al., 1994)

Because of the complexity and uncertainty associated with natural hazards, information on mitigation measures typically comes from the societal mechanisms established for this purpose. That is, from civic emergency management agencies. (Driskell and Salas, 1996)

The greater the uncertainty they face, the more people attribute weight to their trust beliefs about a source of information. Trust influences perception of other's motives, their competence and the credibility of the information they provide (Earle, 2004). As such, trust would be expected to play a prominent role in mediating relationships concerned with acquiring information about, understanding, and taking action to mitigate infrequently-occurring natural hazard consequences.

When dealing with natural hazard issues, people rely on sources related to emergency planning with whom they have a general relationship that extends beyond natural hazard issues. Hence, the quality of trust developed in general contexts in relation to people's experience of council/civic services, their dealings with council officers may influence trusting in the context of risk communication about infrequent natural hazard events.

Situational factors

With respect to whether trust influences people's decision making, two aspects of the situation factors have been identified as being important. The first concerns familiarity with a situation. The second involves the availability of information about the situation.

The importance of social trust is inversely related to familiarity with the hazard, and the availability of information about the hazard. As frequency and experience increase, the more information will be directly available to the person or accessible from within their community, negating the need to acquire and evaluate information from other sources. Consequently, it is only in unfamiliar situations, in which reliance upon external expert sources is greater, that trust in the source of information becomes a component in decision making about mitigation (Mayer et al, 1995).

Trust

Levels of social trust will be predicted by community characteristics that reflect the capacity of community members to acquire and use information to confront the uncertainty they face (Knox, 1970). This can be illustrated by the following example.

Auckland is built on a volcanic field that last erupted some 650 years ago. It has a return period of 600-800 years. Future eruptions could occur anywhere in the city, ensuring that volcanic risk is comparable for all residents (Paton, 1999). A combination of the rarity of eruptions and the need for specialized information from civic emergency management agencies to understand the hazard and how to deal with complex and diverse consequences renders this scenario an appropriate one for the analysis of the role of social trust in risk communication. That is, people are reliant on expert civic sources to acquire information that is not readily available elsewhere. (Rippl, 2002)

People's concept of environmental risk is influenced by others' views, as are the choices they make regarding its mitigation (Earle, 2004). Consequently, people must have access to social contexts within which discourse about any issue can take place. Importantly, because it involves tapping into social activities that people elect to undertake, community participation ensures that any discussion will occur in a social context whose characteristics will be consistent with participants' norms, values and expectations.

Participation, per se, will not necessarily allow people to assess the utility of the information they receive. That is, community members need some means of evaluating information in a way that reduces their uncertainty and facilitates their ability to act in ways consistent with their needs and expectations. One way in which this can be achieved is by defining the problem for which they seek information. It is the consistency between the expectations formed through problem definition and the information received that help people understand uncertainty. (Siegrist, 2002)

Empowerment

Empowerment describes citizens' capacity to gain mastery over their affairs and confront environmental issues while being supported in this regard by external sources rather than being led by them or having solutions thrust upon them, (Eng and Parker, 1994). Empowerment reflects the quality of reciprocal relationships (social justice) between community members and between community members and societal institutions. (Speer and Petterson, 2000)

The quality of these relationships will define the degree to which responsibility is devolved to community members. The more citizens perceive their needs as having been met through their relationship with civic institutions, the more likely they are to trust them and the information they provide and use it to formulate and act on plans to mitigate risk. (Johnson-George and Swap, 1982)

Predictors of Trust and Empowerment

Trust is contingent on situational cue (familiarity/information) availability. For example, bushfire residents described information sharing (rather than hazard experience *per se*) as an important determinant of the development of a culture of preparing within the community. When dealing with infrequent natural hazards, information will be evaluated in terms of people's generalized beliefs regarding trust in the social institutions providing information. Risk communication is not just about providing information. The social construction of risk and its management must be considered, and future research should encompass both the information made available and the community and societal contexts within which it is disseminated. Currently, risk communication programs in many areas do not create contexts conducive to either encouraging discourse about natural hazards or facilitating citizens' active involvement in developing and implementing sustained mitigation practices, (Marris et. al. 1998).

When emergency management agencies engage community members about hazards, levels of trust, satisfaction with communication, risk acceptance, willingness to take responsibility for their own safety, and collective commitment to confront hazard consequences will increase.

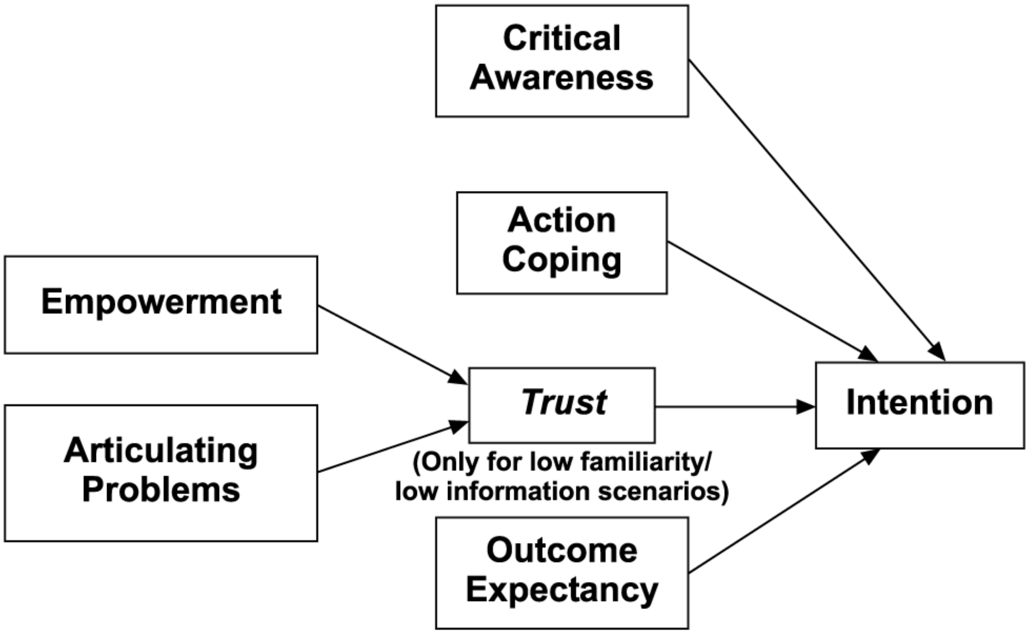


Figure 2

Summary of predictors of intention to adopt natural hazard preparedness measures trust as a predictor of preparedness intentions in high familiarity/high information bushfire and low familiarity/low information volcanic and earthquake scenarios. (Paton, 1996)

Part 2

Expert systems for Crisis management

Introduction

Time and again in our daily lives, we experience news of people who have lost their lives or property as a result of a natural or a man made catastrophes. The extents of such crises vary extensively from those that cause a small public scare, to those that create unprecedented destruction of resources and uncountable loss of lives as was seen with the Tsunami or the hurricane Katrina; and the most recent example is the earthquake that struck in Haiti. Crisis management is important in the mitigation of such unexpected occurrences.

There are many systems that have been developed or are still being developed to facilitate crisis management support for communication and decision making. In our paper, we examine some crisis management tools' effectiveness in assisting crisis decision makers with the provision of timely information that would enhance effective management of a crisis. We also provide an argument for a crisis management support system that would provide a uniform interface across multiple user applications (Li and Wang, 2009) to allow for its wide use. Most crisis scenarios always involve chaotic scenes that require communication and decisions to be made quickly (Hallberg and Jungert, 2009).A structured knowledge based decision support system for crisis handling (Andrienko, 2007) is needed to assist in such scenarios where the crisis management personnel are under immense pressure to provide guidance in handling an abnormal situation.

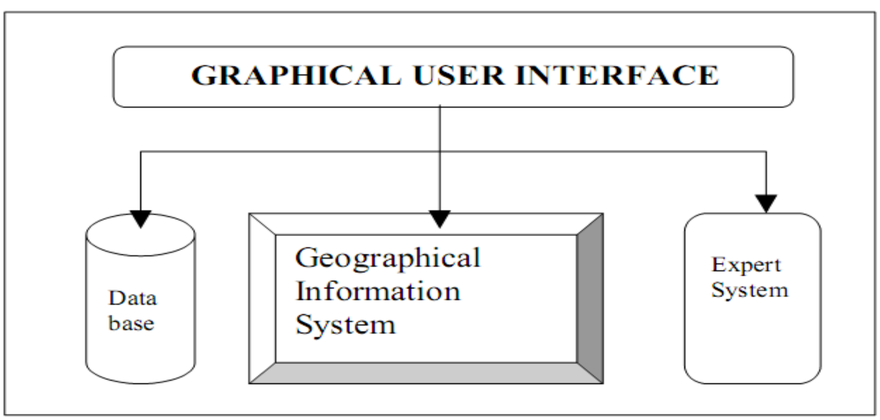
How an Expert Decision Support System (EDSS) works

The EDSS is an integrated system that contains a Knowledgebase, a set of expert rules, and software packages. The expert rules are designed to react against some selected crisis situations. This example that we are describing here is used for a forest fire extinction situation. Mainly this system consists of four components; Graphical User Interface (GUI), Geographical Information System (GIS), the Expert system and a Database. Once the System receives data from the GIS, it analyzes the data that exists in the database and the results are then produced from expert systems (Belkhouse, 2005). The data analysis results are aimed to produce the following output.

- Identify the environmental conditions during a crisis
- Simulate the elevation level of a crisis to decision makers
- Identify the possible threats to escalation of a crisis
- Suggest response scenarios to manage the crisis

The forest fire scenario is used to test the functionalities of the EDSS system (Figure 4). The real fire situation is captured in to mathematical equations. The behavior of the fire is analyzed against the predefined computer model and existing data available in the database. The database is planned to grow as the EDSS experience more and more scenarios.

Up to here, seems the section is not end yet.. something more is needed!



The System architecture of EDSS

Figure 3

A review of some Existing Crisis Management Expert Systems

A crisis Management Expert system can be defined as software that provides data information about a crisis situation to the crisis management authorities. This information in turn helps the authorities in their duty to make decisions that will help manage the crisis the front end systems which immediately communicate with the crisis management systems and update the crisis management authorities. Table one shows a summary of the crisis Management expert systems that we reviewed in terms of their information intergration ability.

Crisis Commander

The Crisis Commander is software that was developed by "Svensk Krisledning AB" and is currently used in over 32 countries. It is an incident management program which is used during a crisis to monitor and control plans, logs and decisions that are made. It can be use in a number of situations such as natural disasters, IT system failures, or in the monitoring of criminal activities.

The Crisis Commander facilitates the time reduction between knowing about a mission's critical situations and doing something about it. This leads to improved operational efficiency and informed decision making. The software uses a generic framework to coordinate the events between different levels of users in an organization. It allows free flow of information between different actors in different locations to assist in the crisis management decision making process. The communication platform used that include:- telephone, e-mail, and mobile phone ensures that all the actors that are involved in the crisis management process can be reached relatively quickly.

How it works

The Crisis Commander consists of a Database, a Web server, an Application server and supporting client environment. Users access the system through a client browser which can be on computer, mobile phone or PDA. The application server and the database are connected to the web server. This web server replies to the client requests through the internet.

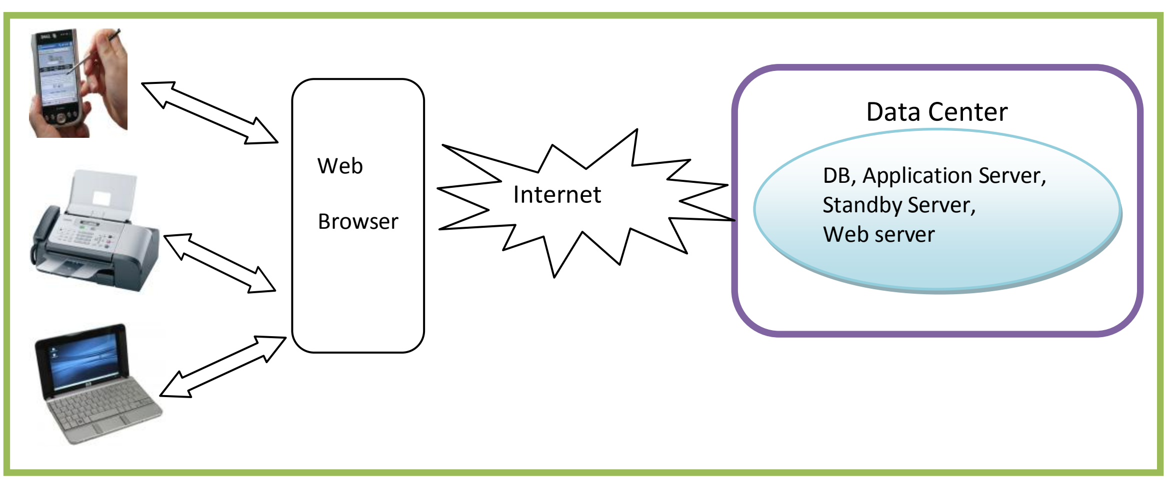


Figure **4.** The Crisis Commander Application overview

The system interface is organized with a Mission Control Center (MCC) which facilitates larger organizations to operate with multi-system Crisis Commander Configurations. This allows the organizations to manage multiple crises simultaneously. The Dash Board provides the user upper level management over all incidents at once. The emergency webpage is a communication tool which needs a minimal computer literacy to operate and it is supported with Voice over Internet Protocol (VoIP). The Advanced Emergency Notification System is a sub system of Crisis Commander which is capable of issuing emergency warning to the users. These warning messages pass as email messages, short text messages, fax messages and voice messages to mobile phones. There are a number of document types and templates supported by the Crisis Commander. Mainly the document templates which can cater for disasters related to serious Accidents, Pandemic Outbreaks, Mobilizations, IT-disasters, Media Crisis and Virus outbreaks. Crisis Commander was used in number of large scale incidents such as Asian Tsunami disaster, during Flood in US, Factory fires, IT-disasters in USA, Europe and Asia.

System	**Producer**	**Users**	**Information Integration**	**Review**
Crisis Commander	Svensk Krisledning AB	-used in IT system faults, -Incident monitoring and management program for monitoring crisis, -Used in 32 countries	-uses generic framework to coordinate events between different levels of users. -used with telephone, email	-uses traditional modes of communication. -Needs to be adapted to future advance in technology
GeoChat	PCI geomatics	-links cross organizational virtual teams to a central point for team members handling a crisis. -Used by Decision Makers to visualize a remote team on a maps surface	-Uses applications such as cell phones, SMS,PC, AND Servers	-Uses traditional crisis communication means Needs to be adapted to future advance in technology.
Microsoft Vine	Microsoft	-users log into windows live account. - used with windows xp.	-can be used through email, text messages and alerts. –there's plans to	-Lacks wide integration with already existing information sharing avenues.

			integrate with social networks i.e. Twitter, land lines etc.	– Needs to incorporate non windows users
CATSaim	BAE systems	-Used since 1998 -used by first responders. - used for large scale disaster management. – used for incident reporting	-Uses Mapping applications. – GPS tracking. –Internet , radio call	-Overly dependent on internet applications.
WIS	SEMA Swedish Emergency Management System	-Used by Swedish authorities. - county councils, Municipalities and voluntary organizations	-Internet based information system for sharing and filling.	- Needs to incorporate maps. -Needs interface design improvement
Rakel	Swedish Civil Contingencies Agency (MSB)	-used in the public order security management in Sweden. - Users are more than 35000. –used by police, prisons and coast guard	-Uses radio communication for organization -aims at uniform information sharing among user organizations	-Has potential to be used across many borders since it uses EU standards during manufacture.
Geo Conference	inSTEAD	-supports decision maker through Q&A format. - Used for public security enforcement. -Used by the Nuclear Agency of Canada.	-Uses a client web-server application.-consists of a synchronized workspace for sharing information amongst users.	-information synchronization reduces need to travel to crisis site. -server limitations from increased data dependence is a big step back

Table 1

GeoChat

GeoChat is a flexible open source group communications technology that lets team members interact to maintain shared geospatial awareness over multiple platforms, or networks through SMS, email, or a map surface through a web browser. It was developed by inSTEDD (Innovative Support to Emergencies Diseases and Disasters). This software application enables the formation and linking of cross-organizational virtual teams to a central point. The aim of this connection is to include everyone with a role to play in a crisis management situation. Then, regular interaction with one another to maintain a shared understanding of current plans, and new developments, while mobilizing teams to respond, arrive on site, and join forces to coordinate relief efforts would be effectively accomplished. Through the use of this application, individuals are able to visualize their remote team on the surface of a map because of the software's ability to translate location names to positions. The individuals can then interact with each other using cell phones that are capable of sending and receiving SMS messages. The software works on PC, Mac, or Linux PC that are capable of running Mozilla Firefox. For its users, GeoChat Server is available both as a free download service and as a hosted service for a certain fee.

The main hindrance to embracing this tool without much ado lies in the fact that it is web and phone based. Phone-based conference calls are expensive, and during the response phase, telephony networks may be damaged or so overloaded by those attempting to reach loved ones that it's difficult to place a call. Whether for lack of Internet access, hardware, cost, interoperability, or network capacity, crisis communications technologies in use today often fail to meet the needs of the team by failing to include one or more members in the flow of critical information.

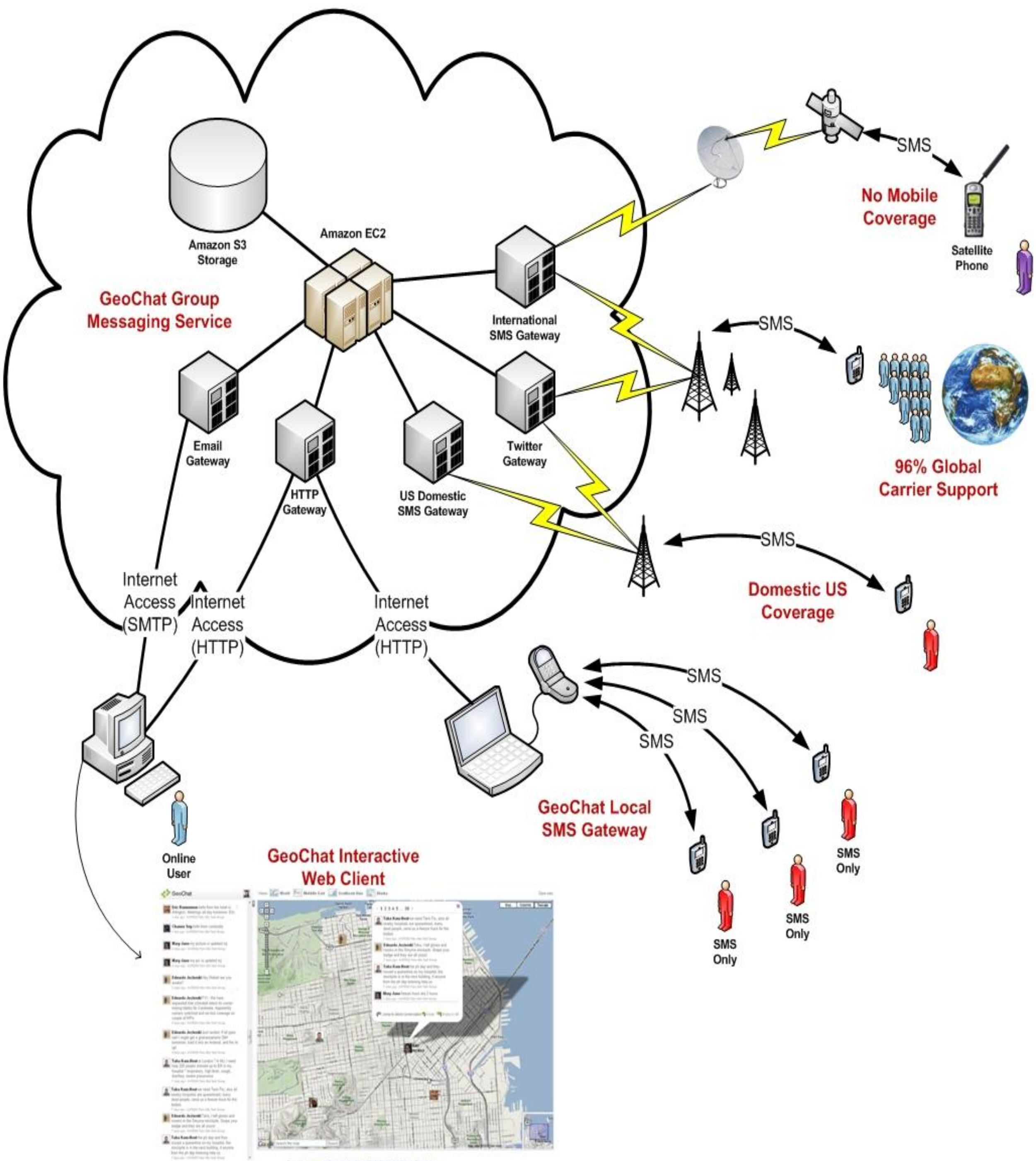


Figure 6: GeoChat

Diagram obtained from http://instedd.org/geochat

GEOCONFERENCE[1]

The Geoconference tool is a client web-server application that consists of a shared, synchronized workspace (maps and imagery) that can be accessed in real time. It was developed by TGIS Technologies Inc. that is a subsidiary of the PCI Geomatics. Conceptually the workspace has a background map of layers from a variety of sources and a foreground containing pointers controlled by session participants, labeled with annotations (point symbols, lines and polygons)

Through a web based collaboration awareness that provides a channel through which stakeholders can support decision-making in real-time through a question-and-answer format. This tool can greatly improve coordination during an emergency situation. As such it would be beneficial to institutions that require urgency in the coordination of communication and technology during emergency response and preparedness scenarios. Other institutions that would also benefit greatly from this tool include those in the public security enforcement area such as the State and local governments. The Nuclear Energy Agency Canada (Accident Reporting and Guidance Operational System- ARGOS) is one of the users of this software.

A quick review of this tool reflects its importance in the simultaneous sharing of geographical data such as maps in a cost effective way since costs related to travelling are greatly reduced.

On the downside, apart from the effort needed to learn how to install, configure and navigate this tool, server limitations that arise from increased data dependency are issues that raise concern on the effectiveness of this product in terms of scalability during a crisis situation.

[1] http://www.geoconnections.org/projects/geoinnovations/2002/TGIS/index.htm

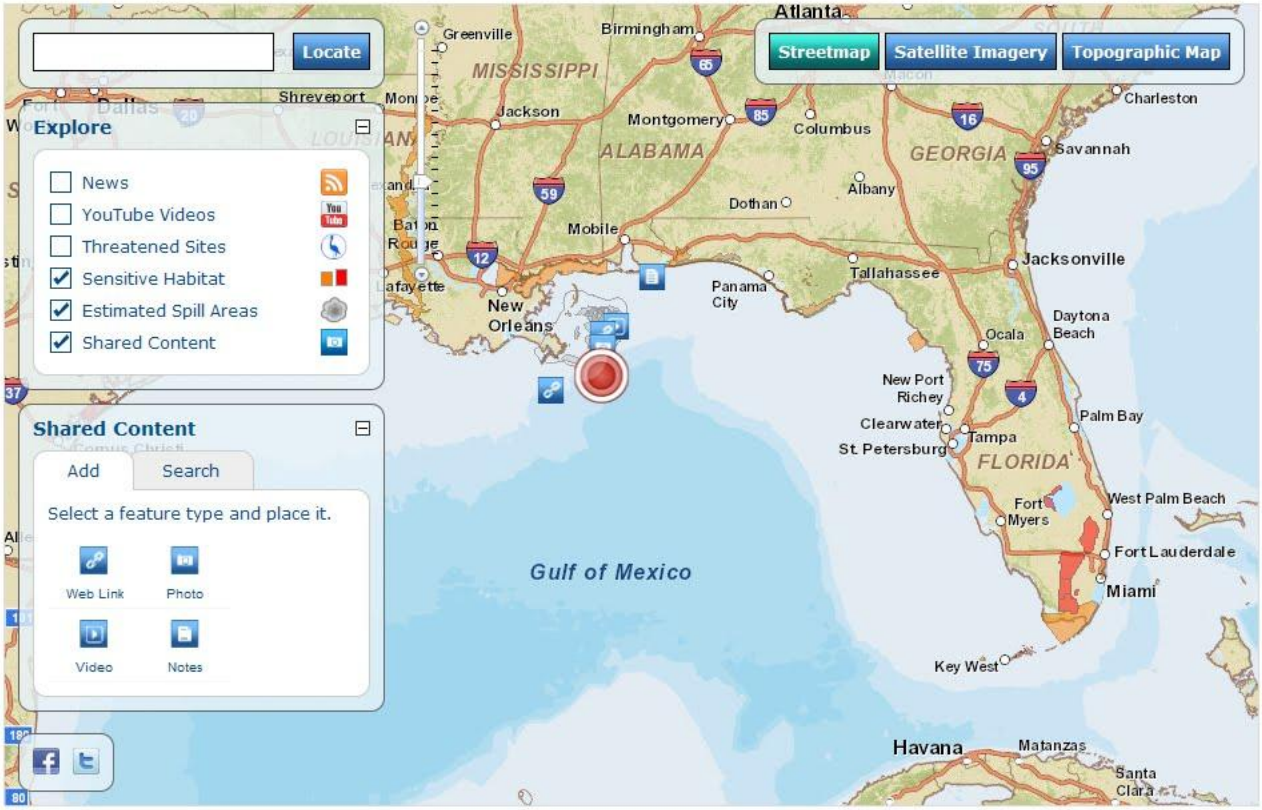


Figure 7. Interface for Geoconference

CATS (Adaptive Integrated Management Systems)

CATS Aims is a disaster relief planning, training and operational support system that provides an automated tool for first responders and emergency management to prepare and respond to a disaster. Large scale disasters such as hurricanes, terrorist operations and the events that follow (flooding, fire, riots, mass evacuations, etc.) require close coordination between multiple agencies and precise management of personnel and equipment.

After the occurrence of a crisis, the people involved in the rescue activities need a reliable source of information that can be easily disseminated to other stakeholders at the right time. It is in this regard that CATS with state of the art map applications, GPS tracking and incident reporting first responders send and receive information to/from an Emergency Operation Center. Stakeholders use the real time information from the field with geospatial data, asset data and disaster modeling to make better decisions. With a wide range of capabilities that include resource planning and utilization, Crisis management and decision support assistance and what if scenarios, this product have the potential to provide the operation plans required during disaster management.

According to the manufacturer's website[2] the system can be used via the internet, as a radio call, or as a mobile hand device. The system has been in use since 1988. The system is also described to be scalable, and easy to tailor to particular users requirements.

However the main issue of contention is the major dependence of the system on the internet. This in turn creates the major problem of what happens when the internet goes down during a crisis when communication using the system is needed most.

WIS

WIS is a national, Internet-based information system created to facilitate information sharing between players in the Swedish emergency management system before, during and after a crisis. The Swedish Emergency Management Agency (SEMA), commissioned by the government promotes the use of the Internet as an information channel in emergency management. The Internet is utilized in several ways that jointly facilitate emergency management and lead to improved coordination of emergency information during the occurrence of a crisis.

WIS (Web-based Information System) is a non-hierarchical information sharing tool with a journal feature. Sharing of information, categorization, searching and filtering of information is performed based on the needs of the respective entities. WIS 1.6 is optimized for Internet Explorer 6 and Firefox 2. Information over the Internet is encrypted (128-bit SSL). WIS is designed to handle non-classified information. Distributed user administration in WIS is conducted by each entity. WIS is prepared to exchange information with other systems. WIS is provided free of charge by SEMA to government agencies, county councils, municipalities, voluntary organizations and private entities having duties during emergencies. SEMA's goal was to launch WIS2 with improvements that would enhance adaptation of the user interface to modern web technology and implementation of map support.

The need to travel to Stockholm and navigate the learning curve required for the effective use of this software, coupled with the inability to share classified information through this application limits its success in a situation where there would be need for the users to exchange classified information to avert or control a crisis. It would be a major step forward if this application could be accessible through other means apart from complete reliance on the internet.

RAKEL

RAKEL is a radio communication system for organizations in Sweden working with public order, security and health. It was built and is managed by the Swedish Civil Contingencies Agency (MSB).The estimated amount of users when the roll-out of the system is completed in 2010 is approximated to reach 35.000.

[2] http://www.baesystems.com/ProductsServices/bae_prod_cits_aims.html

The software is mostly used by government authorities such as the Police, Coast Guard and the Swedish Prison and Probation Service, but there is a fast growing interest from local Swedish municipalities to use RAKEL for many of their services. The Swedish police piloted the use of this software in southern Sweden in 2005 and after a six month period embraced its effectiveness. Even certain private organizations with tasks important to Swedish Crisis Management such as electric companies were expected to join this line of users at some point. The RAKEL system is based on TETRA Technology. TETRA stands for Terrestrial Trunked Radio and is a European standard developed through ETSI, the European Telecommunications Standards Institute. The supplier of the RAKEL system is a consortium made up of SAAB, EADS and Eltel Networks.

Coordinated and integrated emergency management in man-made or natural disasters can help save lives. The lack of this type of smooth coordination brings to mind the events of the tsunami in 2004. Thus RAKEL aims to improve adequate prevention, preparedness and warning procedures and solutions during a crisis through uniform information channels amongst the Swedish organizations that use it.

As a part of the consortium that supplies RAKEL, EADS solutions provides adequate means for effective emergency management, which includes shared process designs and action plans for a collaborative response. In addition, the integration and upgrade of all kinds of warning systems – such as stationary or mobile sensors – ensures a higher standard of security.
Based on these advanced EADS technologies, emergency action plans and rapid crisis-response measures can be implemented on a uniform platform both within Sweden and Europe.

MICROSOFT VINE

The inspiration for developing the Microsoft Vine service came during the Hurricane Katrina catastrophe, when a Microsoft general manager named Tammy Savage began examining ways to help communities ready themselves for disasters. Vine's Slant is community management and emergency preparedness.

How it works

One downloads a dashboard application and then logs into a windows live account. Vine's interface takes the form of a map where geo tagged notifications pop up if a new story or public safety announcement sourced from 20000 news sources as well as the national oceanic and atmospheric administration (NOAA) happens in a specific location. Vine lets a user control the information he or she wants to send out by organizing a particular user's contacts into groups; it also lets one decide who can send information to them. Currently the service is only available for computers running Windows XP with SP2 or Windows Vista 32- and 64-bit editions.

Microsoft vine operates through three forms of communications: emails, cell phone text messages and alerts that are sent and received through Vine's client software. Microsoft has plans to make Vine a widely used service. They plan to integrate its use to widely used networks such as in Twitter social networking site, landline telephones, and special needs devices such as Life Alert- (a Personal Emergency Response and Home Medical Alert System company that saves lives from catastrophic outcomes, using a unique technology to provide superior home audio monitoring protection to people with disabilities).

One advantage of this software as explained by Savage is that during a crisis not all communications systems typically go out at once. Text messaging often is most reliable in the first 24 hours after a disaster, and just when cell phone batteries are starting to die other services like power and Internet access often get restored. On the contrary though, Vine's need to rely entirely on internet connectivity could hamper rescue activities if the internet goes down during rescue activities. Furthermore the time needed to navigate the learning curve coupled with scalability issues need to be addressed effectively as this product develops.

RELATED EUROPEAN UNION PROJECTS

SICMA[3] project

Research Initiative

The SICMA poject was undertaken under the European union Framework Programme 7: Security Research Call 1 .The countries involved in this project are Italy, Poland, Ireland, Germany, Israel and Denmark. The project started on 1st March 2008 and should end on 31st August 2010.

The first challenge of this project was to ensure that governments, first responders and societies are better prepared prior to unpredictable catastrophic incidents using new, innovative and affordable solutions. And the second challenge is to improve the tools, infrastructures, procedures and organisational frameworks to respond and recover more efficiently and effectively both during, and after, a crisis.

Mission

The project aims at improving crisis manager's decision-making capabilities through preparation response, and decision making support. Preparation will consist of assisting in the identification of the best way to employ available assets, the limits of the achievable response and the effectiveness of different cooperation procedures. Response involves providing a forecast of scenario evolution, proposing doctrine-based solutions and evaluating the effects of alternative decisions. Decision-making support will be provided through an integrated suite of modeling and analysis tools.

Objective

The SICMA initiative's main objective was to Improve Health Service crisis manager's decision-making capabilities through an integrated suite of modeling and analysis tools that would provide insights into the collective behavior of the whole organization in response to crisis scenarios through the activities of:

- different services (e.g. police, medical care, rescue forces, fire fighting, etc)

[3] http://www.ess-project.eu

- interacting vertically (i.e. with components of the same organization) and horizontally (i.e. with components of other organizations)
- in a complex environment

The overall response to the crisis depends not only on the quantity of the individual entities but also largely on how those entities cooperate in harmony with one another through the entire scenario.

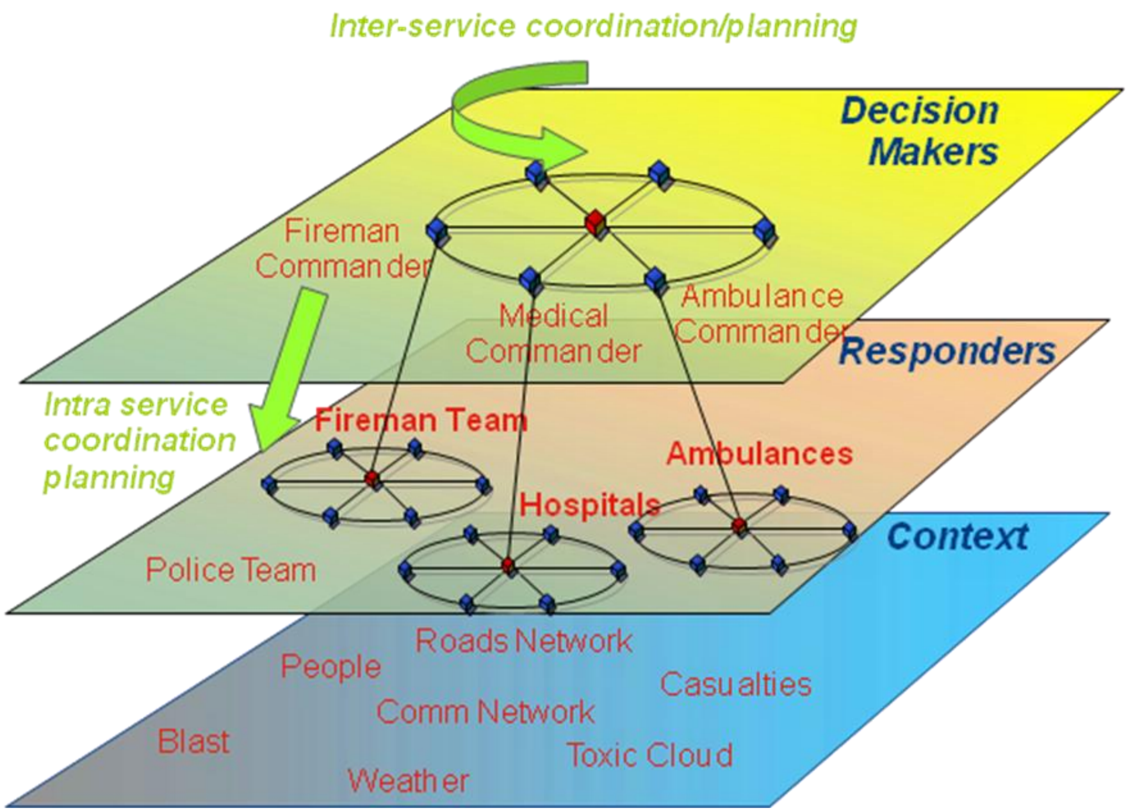


Figure 8

The Key research aspects of this project are:

- Bottom-up modeling approach
- Build independent model components and then combine them
- Unpredictable factors modeling
- Human behavior, mass behavior
- Procedure support

On completion of the SICMA project, improved coordination between the various stakeholders in the crisis management environment should be greatly improved as compared to how it was before the initiation of the project.

OASIS Project[4] - Crisis management

The Open Advanced System for Improved crisis management was a European Union project Proposal number: 004677. Performed through the supervision of **Jean-François GALLET as its technical coordinator**

The project ended in 2009 and defined a routemap to interoperability. It has focussed on defining a solution that is flexible and will allow integration to legacy systems. The consortium actively engaged with user's communities to ensure the work undertaken was of direct benefit and could be easily integrated with existing systems. The project managed to accomplish the establishment of the foundation of a joined up European Emergency Response system in motion.

Which year to which year, who are the partners? What is the situation now?

The OASIS project's target was the following aspects of crisis management.

- Real Time aspect, responsiveness
- In the field and in the control rooms
- Inter-operability, collaboration

The project also aimed to connect all the actors in the crisis management chain by taking into account the operational organisations and the systems which would be available for use in the coordination of their duties. A flexible and open system integrating COTS components and standards to benefit from dual-use technologies was proposed to be used in this project.

[4] **http://www.oasis-fp6.org/index.html**

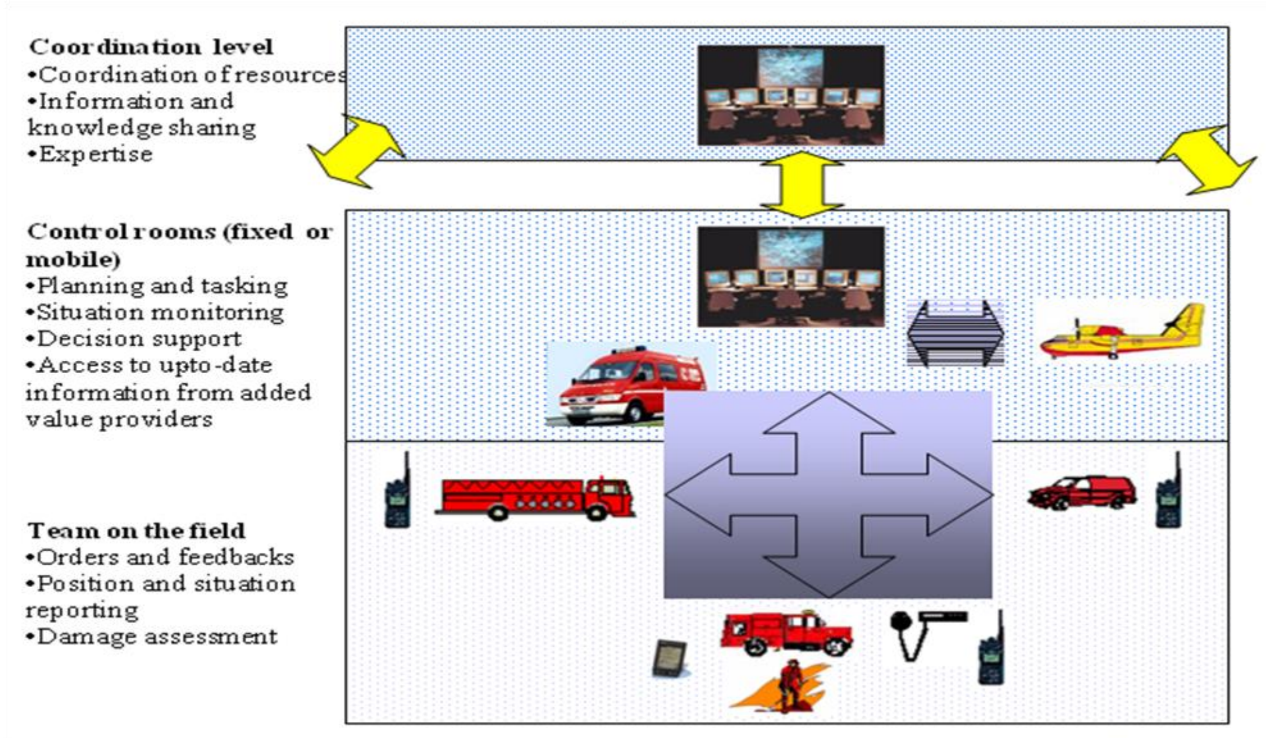


Figure 9: OASIS functional coverage

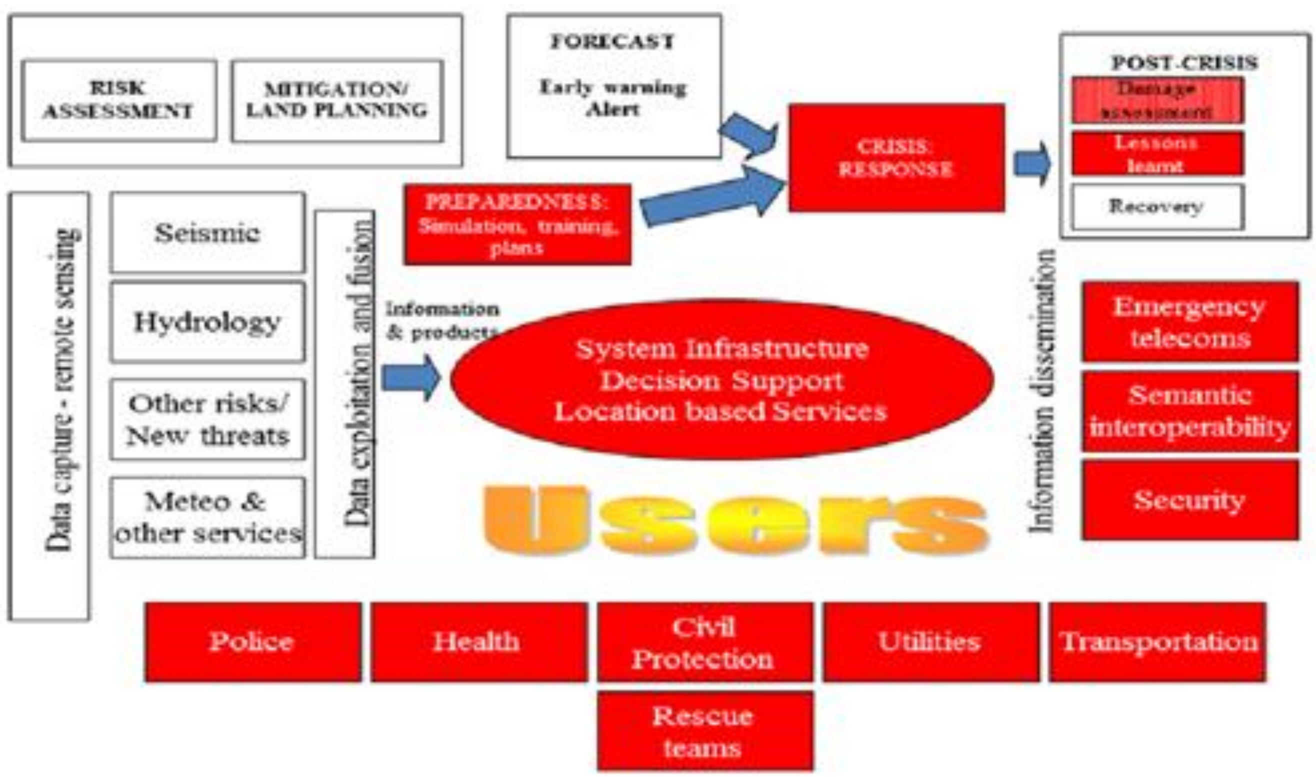


Figure 10: OASIS Scope

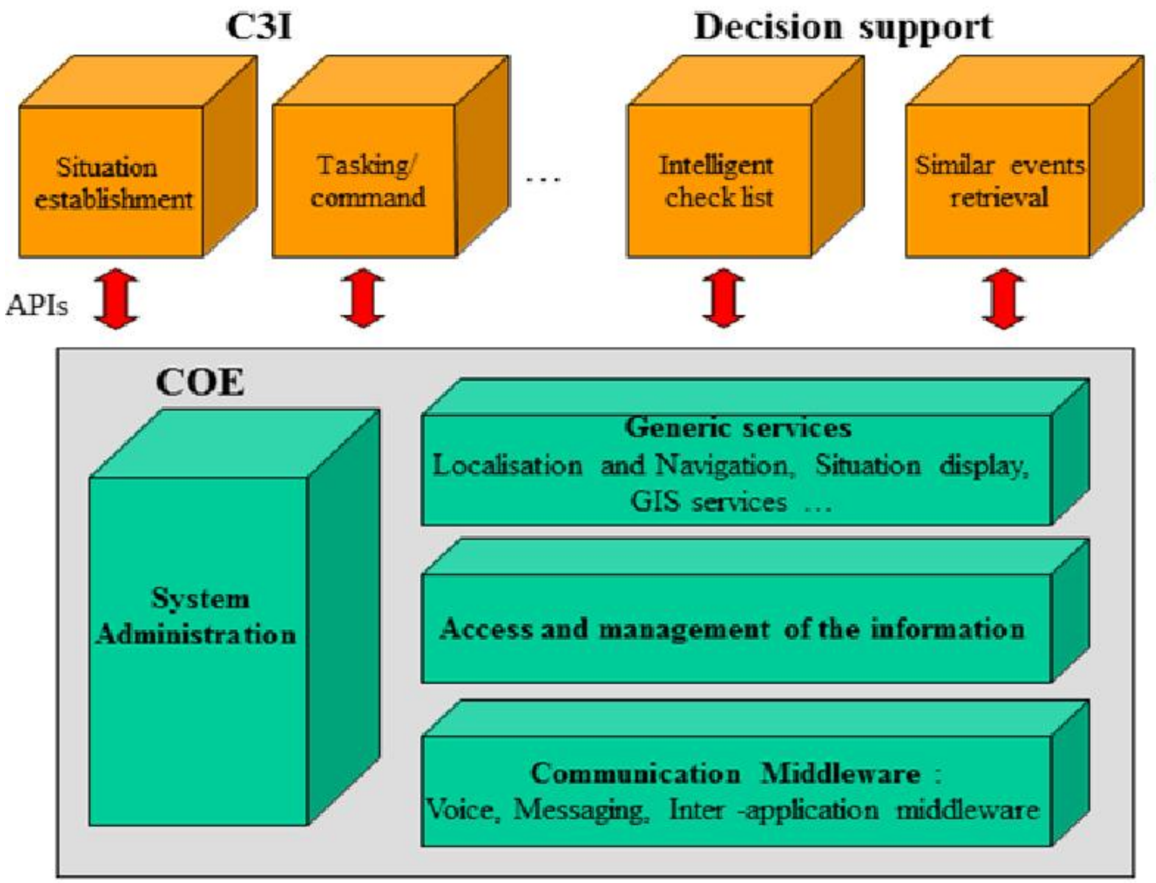


Figure 11: OASIS Architecture

OASIS project aims to address crisis management as explained in below

- OASIS is targeting the operations during the crisis
  - Crisis environment (low speed and unreliable communication, stress, …)
  - Set-up time must be reduced
  - Changing organization according to the events
  - We want to break the language barrier

Why Integrated Crisis Management Support System

The need for a crisis management support system is important due to time and stress constraints when decisions have to be made within short notice during a crisis. Technically, a structured knowledge based decision support system for crisis handling is needed to assist in restoring functions back to a normal level, and evaluate the response work for the future (Andrienko, 2005). The information systems to be developed should be relatively easy to use by crisis management experts (Li, 2009).

The expert system will be designed in a way that will enhance the collection of information from various expert users. For example there will be data collected from geographical organizations that together with other relevant information such as the location where a crisis has happened will be amalgamated into an information pool. Once collected, information will be integrated and presented to crisis management decision makers. Information to be presented will be prioritized based on which Management personnel will receive the go ahead to perform an action on the crisis. Also this selective availing of information will be important in terms of security towards availing sensitive information only to the required recipients.

Situation Picture

A common understanding picture that shows the dynamics of the changes during a crisis might be missing in the crisis management support tools currently in use. At the same time, there is an information over-flow. A suitable system would be able to show how well the different existing systems are contributing to an already established crisis management process. It should be designed to enhance the collection of information from various expert users. This type of data will be collected from tools that cover a wide range of fields. (Andrienko, 2007).The most important fact through all this representation of information is that; the represented information should provide a common picture across multiple users so that a shared understanding of the intended information is easy to visualize. For effective communication and quick predictions in a crisis situation it is imperative that the common picture aspect of the model is readily understood by the various actors in position to handle a crisis.

Part 3

Thesis Concept

The concept of the thesis research should aim at developing software that addresses the following aspects of the crisis management process.

Assist Decision Makers in performing their roles and duties

The Crisis Management personnel's roles and responsibilities must be clearly documented. An example of these actors in the Swedish commune system would include the following institutions.

- The Municipality Administrative Office (MAO),
- The County Administrative Board (CAB),
- The County Council/Medical Service,
- The Police Force,
- The Fire Department, and
- SOS Alarm.

Communication Support

Communication support within the organizations should be accorded to the public and the media. Quality information should be processed and updated to maintain a common operational picture.

Crisis management actors need to collaborate with almost every actor in the local community, and some actors on regional and national level. On local level, working methods and systems should have shared concepts to enable easy support of collaborations.

Risk and Vulnerability Support

Risk- and vulnerability support should be accorded to actors to help with the analysis of action plans geared towards solving specific tasks to help achieve return to normalcy.

Training and review of actions, collaboration with others and information management should be carried out to support practices and efforts that assist the sustenance of learned positive experiences with consideration for privacy laws, usage rights, availability, safety levels and security of information management processes

Vision for the concept of the decision support system

The concept should aim to develop a decision support tool designed to merge the latest techniques and processes of effective crisis management with the most recent commercially available technological software and application solutions. It should support the following typical steps in a crisis management decision making process. (Johnston et. al, 1997)

Step one: Information gathering

> Screens should be provided for the recording of all information pertinent to the incident. Prompts should be designed to guide the user in collecting relevant information pertinent to the crisis decision making process. Drop-down menus speed the process of entering data and minimizing typographical errors.

Step two: Analysis

> The user should be led through a process of developing probable worst case scenarios. This allows the user to take what is known about an incident and extrapolation into the future. Using this approach the user may be pro active in his or her decisions on strategy. The data might be stored in a relational database that allows for trend analysis.

Step three: Decision Making

> During time for action the expert software should display a preloaded screen with typical issues and appropriate actions that have been already stored in an archived database. The decision maker can browse through this list and select the appropriate issues and actions for the specific circumstances involved. Once selected the relevant actions should be automatically displayed to the decision maker through a friendly Graphical User Interface.

Step four: Monitoring

As the crisis plays out, the crisis management decision support system should have a knowledge base that is able to update an archive of stored prioritized actions that reflect the progress of assigned actions to respective events. The user should be able to review this information periodically and make adjustments as circumstances that update the Knowledge base as additional facts about the crisis become known.

Objective

The thesis's objective is to provide a concept that will aid in the development of a reliable software model for evaluating a crisis and developing an efficient plan for tackling it. An integrated model for crisis management's implementation consists of several software packages, a knowledge base, and set of expert rules. During the formulation of this integration, existing rules and regulations designed specifically to tackle a crisis scenario will be formalized. (Belkhouche, 2009)

Support System flow diagram

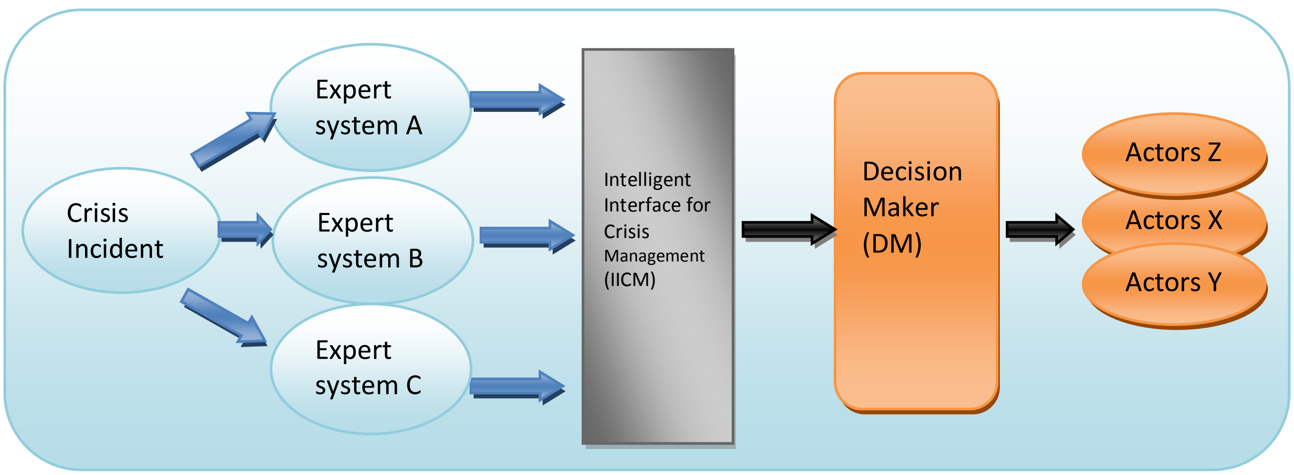


Figure 12:

Vision for a decision support system

The goal of the planned support system's intelligent visualization is to provide a user with the information that is necessary for rapid perception and proper understanding of a task to be undertaken (Andrienko 2008). An Actor Figure 11 refers to the crisis management personnel who are responsible for the implementation of directives of the Decision Maker (DM) in the crisis management process. In Sweden, an example of an actor would be the municipality and county council administrative staff, the police force or the fire department.

The expert systems A, B, or C will collect scenario information from a crisis incident and provide input data (Asplaugh and Anton, 2008) for the Integrated Interface for Crisis Management (IICM).The support system then generates a report based on the information requested by the User. If the system meets specific user requirements as expected, then it will be able to help crisis management decision makers to obtain and send the correct messages to the various actors. The structure we plan to develop aims to improve the coordination of information collected from the expert systems and the information presented to the User. (Mackinlay, 1986)

A description for each behavior expected from an individual concept will be developed and modeled into a use case. Quality scenario and use cases development will communicate clear user needs from the system to be developed. The design process will gain a clear understanding of what is required (Asplaugh and Anton, 2008) by the users of the system. It will be necessary to develop a scenario structure that will show mutual relations of the parts that determine the whole meta-model. During the design phase there will be the construction of a shared event diagram to show the extent to which specific events are shared. The scenario context diagrams will make explicit the temporal relationships between scenarios. Initially inadequate scenarios will have their quality improved to the level where satisfactory software could be developed (Asplaugh and Anton, 2008). A demonstration of how the expert system would handle a given scenario will be shown though a schematic diagram.

Intelligent visualization

The objective of intelligent visualization is to give everybody the right information at the right time and in the right way. A decision maker should be timely supplied with relevant information that is effectively supplied in a user friendly GUI. (Andrienko, 2007)
In this regard the development of an intelligent visualization should aim to achieve some of the following aspects of information gathering and processing:-

- Reduction of the information load on the recipient by presenting relevant aggregated information with focus on techniques and design whose display ensure quick and accurate recognition of the meaning.
- Consider the characteristics of the medium used for viewing the presentation. Intelligent visualization supposes that both the selection of the relevant information and the subsequent processing, organization, and representation of the selected information are automated.
- Incorporate expert knowledge in the visualization software development using the knowledge base technology in visual displays for data analysis, decision support, and information communication; the process will be similar to the notion of decision-centered visualization. (Andrienko, 2007).

Visualization guide

The intelligent visualization should be used for the purposes of building an interactive display to support the work of an analyst, planner, or decision maker, and build an information presentation for a specific recipient.

The first type of use supposes that the information is presented directly to the user of the system through a screen of the same computer where the system runs. The second type of information is intended for another person or group of people as a standalone application to enable its mounting on various platforms. Such would include fax, cell phones and TV.

User and System Requirements

Soft System Methodology (SSM) was used to identify the system requirements for the ICMS. SSM helps to understand different actor's interactions with each other's perspectives. It focuses on creating human activity systems for organizations or user groups that could achieve a common purpose. The methodology is based on seven-results of an improved user system interaction. The decision to use SSM in this requirement eliciting process would also allow for an opportunity to provide clear and simple action plans in the conceptual model.

Based on literature survey the generic user requirements for an integrated crisis management system were identified. Some existing systems that are currently used in different countries were selected. The evaluation of each existing system's capabilities against the requirements that were identified was then carried out. An assumption that a partially met user requirement was to be considered as completely not met for tabulation convenience was made.

Through research, existing crisis management support systems that have been described earlier in this paper were reviewed and key user requirements that these tools are missing were noted. A significant point of this research was to stress the importance of developing a decision support system that would improve the way an ideal support system would collect, analyze and disseminate necessary information to a crisis management decision maker. We also note the importance of ensuring that such a tool presents information to its user over a user friendly interface. The structure thus developed should be a standalone application that could be incorporated into existing platforms such as cell phones, PDAs and laptops.

System evaluation

The outcome of the evaluation of the crisis management support systems against user requirements (Bautavicius and Lee, 2007) in the crisis management circle are shown in Table 1. The software tools were reviewed based on their ability to:-

- Support smooth collection and recording of incident information by the users.
- Use stored information to generate probable scenarios that would result from a crisis situation.
- Pre load typical crisis issues and corresponding appropriate actions used to handle crisis situations of similar nature.
- Support the tracking of event progress.

User Requirements	Geo conference	WIS	Microsof t Vine	CATS Aims	Geo Chat
1. Can the system be used with other portable devices and support communication between users? 2. Is the system designed for use in a distributed environment? 3. Is training on using features, description of fields and how each function works readily available to users? 4. Does the system have predefined facilities and interfaces to allow input of data by users?	1,3	1,3,4	1,2	2,3	1,2,3
User Requirements	**Geo conference**	**WIS**	**Microsof t Vine**	**CATS Aims**	**Geo Chat**
1. Can the system generate suggestions for the user to develop based on a user query? 2. Does the product use a widely recognized information collecting source? 3. Does the system provide instructions on how to generate queries of different scenarios? 4. Does the system provide a pre defined interface to allow addition of custom routines by the user?	2,3	2	2,3	1,2,3	2,3,4
1. Can the product visualize data according to actor roles and provide correct information. 2. Does the system summarize procedures according to various scenarios described by user? 3. Are tools to create custom reports available on the system? 4. Can the product be used with common Operating Systems, networks, disk storage, cell phones etc?	1,3	3,4	3,4,6	1,2	2,4
1. Can a user record work progress in the system? 2. Does the system track actor actions and produce reports for review.	3,4	1,3,4	3	4	3,4

3.Does the system provide automatic information source update 4. Is there a consistent user interface amongst a wide range of users for the product?					

Table 1 system evaluation against defined user requirements
Key:

- The values 1, 2, 3, 4. Represent a specific system requirement a systems should meet.

Since all of the systems that were evaluated met the listed user requirements partially, a clear need exists for the development of a better crisis management support system that would incorporate more user requirements to assist crisis management personnel in their decision making duties when a crisis occurs.

Summary of Review findings

From our study we see the need of developing a structure for a completely new crisis management software tool. An integrated, intelligent system that is modeled to address specific user requirements will greatly improve the crisis management process. A stand alone prototype that could be incorporated into already existing and widely used applications such as cell phones, PDAs and laptops would improve the response of civilian population when a crisis occurs. Currently most crisis management tools are only available to government authorities or local community administration personnel. A tool providing a user friendly graphical interface that ordinary civilians can access would improve response to a crisis in terms of communication from the decision maker to the Actors. Figure 16 shows the basic transactions of crisis management process which we used to develop our concept.

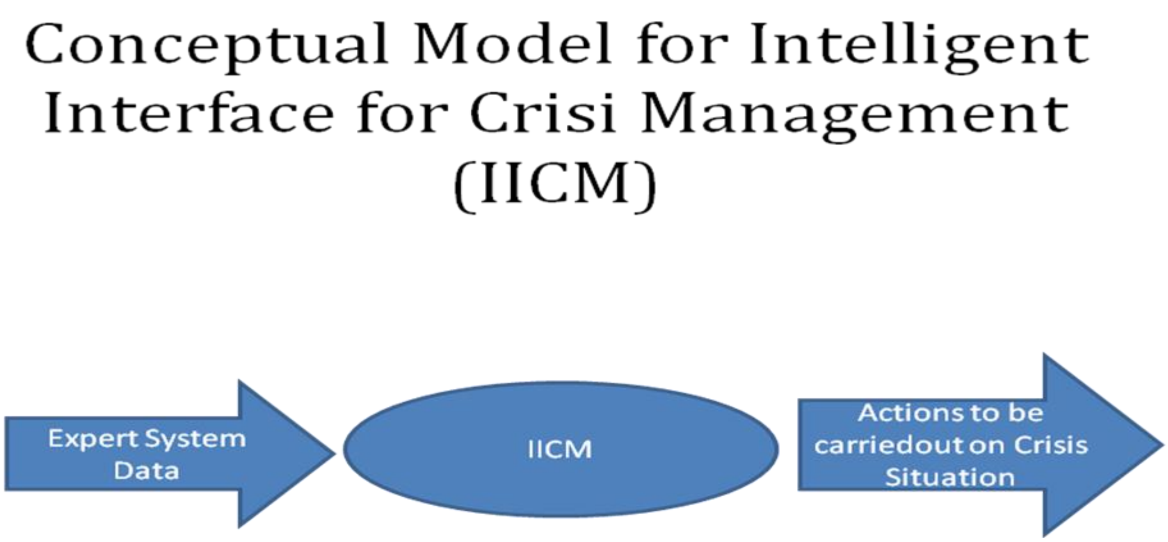


Figure 12 : Base for the conceptual model

The user of IICM

The general users of the ICMS are categorized in to four main user groups. The Blue Light (BL), Public Service and Utility (PSU), Crisis Management Authority (CMA) and the Housing Companies and Industrial representatives (HCIR) see Figure 12.

User Group	Users
BL	Local Police, Ambulance, Hospitals and Fire Department
PSU	Local Public transport authorities, Energy suppliers, Water supplier, Meteorological and Hydrological Institutes, Weather experts, Radio and TV, Telecommunication suppliers,
LCMC	Local Crisis Management Center
LHIR	Local housing companies and Industrial representatives

Table 2: User of the IICM.

Member of these groups contribute to the crisis management process holding different roles, such as Analyzers, Decision makers, Planers, Performers, Suffers and Observers [7]. Each of these roles is equally important with whatever crisis management plan exists to execute. Figure 13 shows that how the data flow through system entities of crisis management process. The data flow starts with a crisis situation; which create enormous amount of data related the specific crisis event. The expert systems collect these data. IICM collect data from the expert systems and generate effective outcomes from them. The Human team who is responsible for decision making considers the IICM data analysis and takes their actions to naturalize the crisis situation

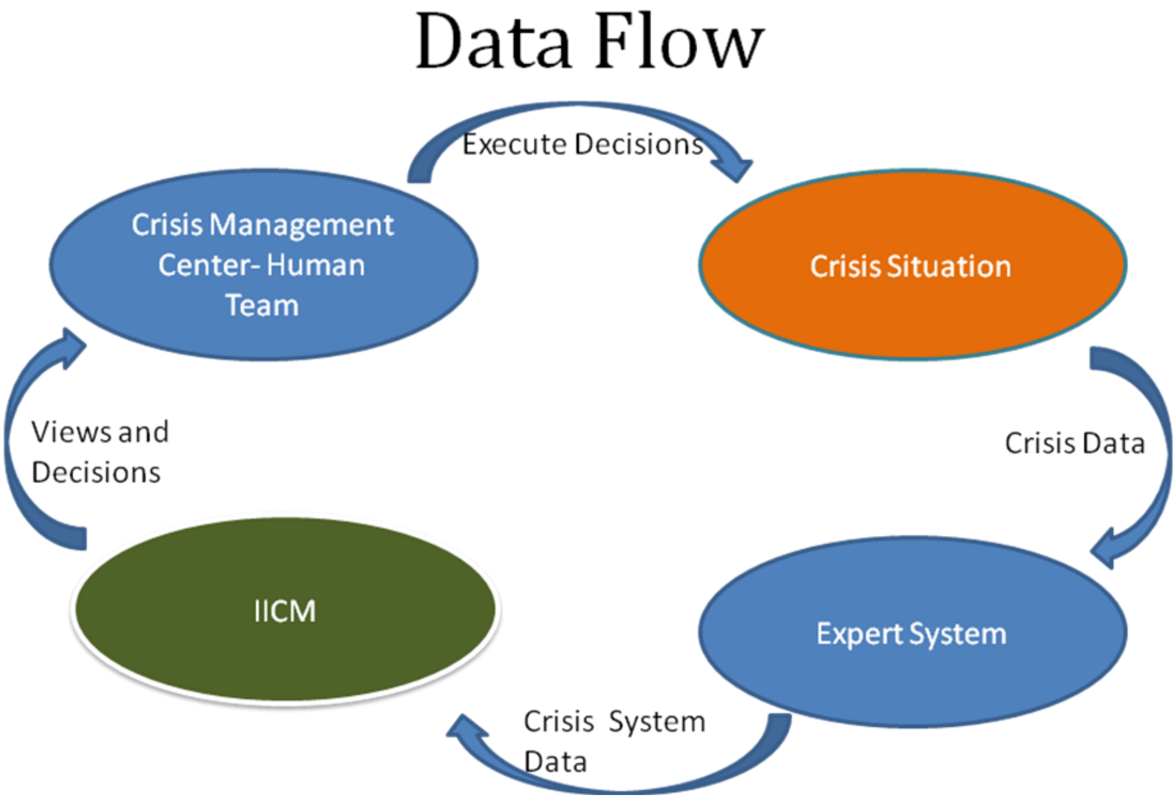


Figure 13: Data flow in the proposed system

When we analysis the current crisis management process we can clearly identify the Crisis Situation, Expert systems and the Crisis Management Human team. Integrating a IICM in between the expert systems and the human team, it will fetch most up-to-date different expert system's data in a common picture with intelligent suggestions focusing to handle the crisis effectively and efficiently.

Basically the IICM will contain a knowledgebase which is capable of creating different views of crisis situation utilizing its capabilities and dynamic expert system data. Figure 14 shows how the interactions happened between different system entities. Each view is differs from each other due the consideration of its potential user profile such as BL, PSU, LCMC and LHIR. Each view will belong to a unique priority category depending on the effects of the crisis situation. The view will contain rich information (text reports, instructions, warnings, maps, graphs, videos and audios) about the crisis and set of actions to be carried out. Furthermore the views will contains information on expected crisis scenarios and anticipated results, this information will present to the user through an interactive web interface which will be platform independent and high usability.

Depending on the crisis data that flow in to IICM the views will generate and update the system itself. There will be a structured data base in charge of manipulating the crisis data. Each view generating iteration will contain comments and updates from the human table. This information also flows back to the knowledge base to update the archives. At the sometime the knowledge base will work as a general platform for all expert systems to share information.

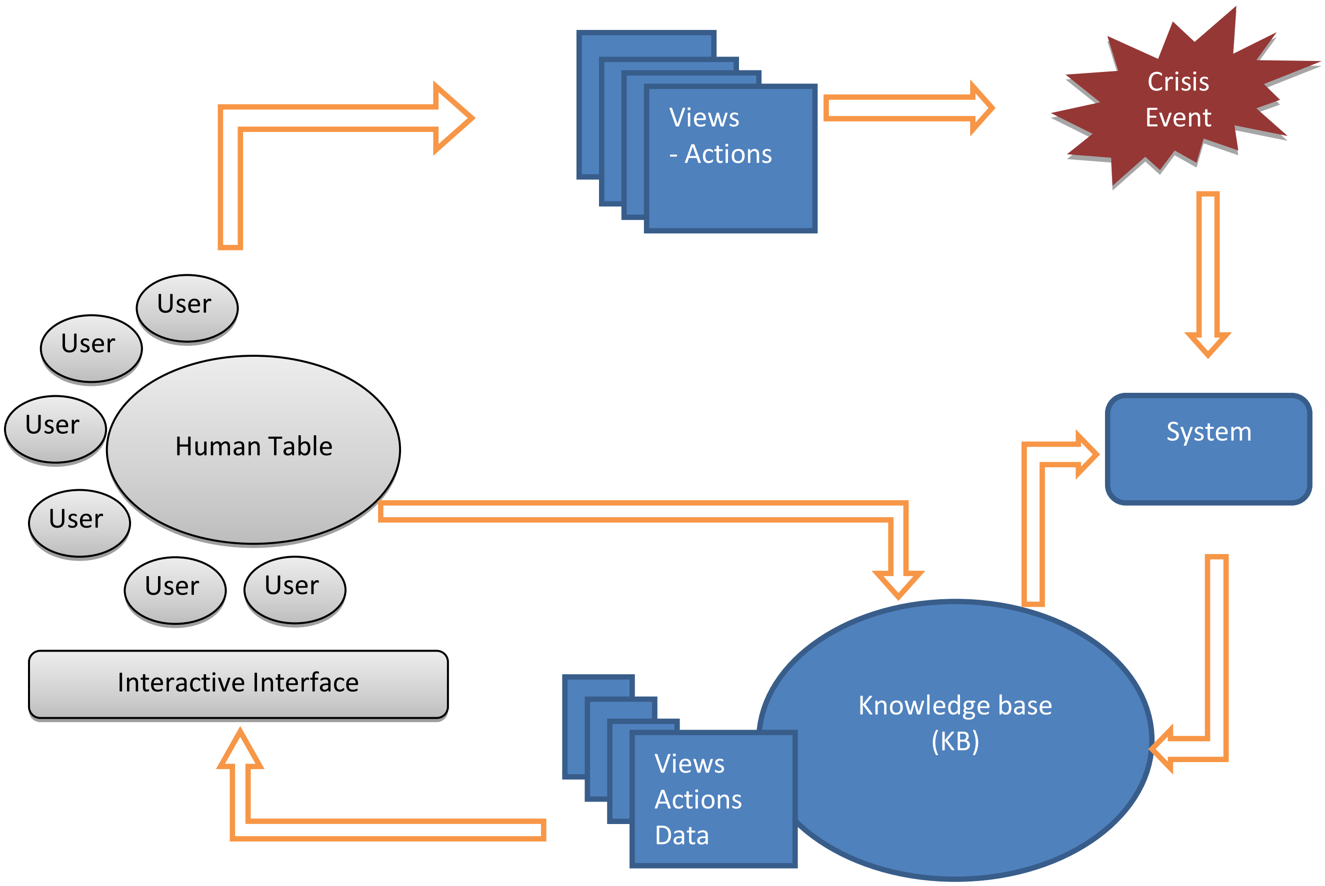


Figure 14: System entity interactions

The Knowledgebase

The knowledgebase (KB) will contain methods to priorities the crisis data and generate views with important contents. KB will start its rule base and stage base data reasoning process with the percepts come from different expert systems belongs to Police, Ambulance, Fire services, Housing companies Public media and other may more systems which provide information for the Crisis management decision making process . Not only form the existing expert systems, KB will be comfortable with capturing data that comes from future expert systems which build to facilitate crisis management. Each expert system will contain information with different formats, different entities and characteristics such as web pages, standalone applications and specific reports containing sensitive information. It can be different file types, languages and encryptions.

Figure 15 shows that how the different strategic layers positioned in the KB. The "Perceptual Knowledge" (PK) is the first level of information in the KB and it contains a description about what happens in the crisis event, what action executed and what is the present development on the crisis. It can be geographical data, detail descriptions of destructions occurred by the crisis event. Furthermore it can be information on list of decisions, actions executed by the expert systems. Sometimes it can be immediate actions taken by the specific actor outside the concern of the other organs in crisis management process. Once PK is gathered, it has to be satisfying the rules of KB. Then the next level actions will be trigger. Mainly the next steps are Conceptual Knowledge analysis (CK) and Archive Data Analysis (ADA).

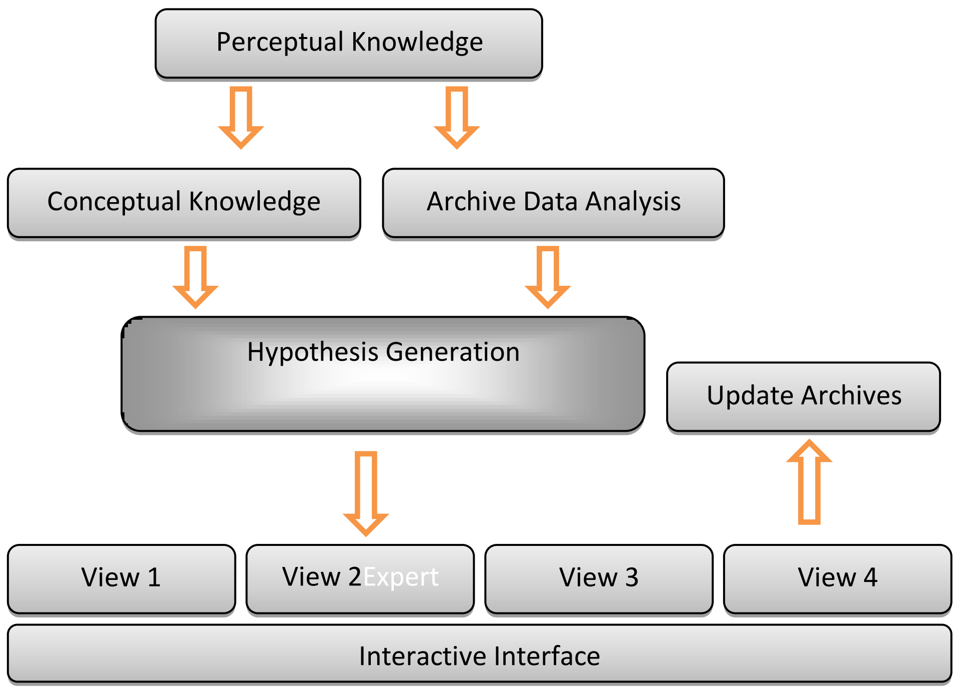


Figure 15: Layers of the Knowledgebase

The CK's definitions are based on some factors such as crisis destruction level, crisis elevation speed, the effects on the life hood and the environment. CK contains number of rules for specific crisis data and this is called the rule based priority assessment. As an example the level of crisis elevation is measured on the number of casualties per a significant time consideration. This information is compared against a certain standard level and determines the priority levels of the each action to be carried out on the crisis situation. Same way we can determine the level of resource destruction level and the level of public disturbances. The next assessment method is the stage based priority evaluation. Here it examines which stage the crisis belongs and determines is it a Prodomal, Acute or Chronic stage crisis considering the time factor on each stage and the crisis type.

Analyzing the PK against the CK rules the final CK decisions are made and passed them to the next level the KB. The ADA analysis the PK against the available archive data and generate its results and passed them to the next level of the KB. In the next level at Hypothesis Generation HG both CK and ADA will analysis against each other and create final hypothesis on the crisis situation. The next level is the view generation considering different user profiles against the created hypothesis. The last level of the KB is the Interactive Interface and it will consist with presentations of different views of crisis situation. Mainly in CK, ADA and HG will operate with suitable algorithms that capable of creating results in optimal time considerations.

Example IICM in Action

In Sweden WIS is used by Swedish Police, Fire services and Public utility services. Once a crisis situation happened the very first attendees for the event are these actors. Using their communication capabilities they will take their initial actions and then communicate with the higher authorizes for the further actions. The Figure 16 shows how their communication happens today. Using WIS actors communicate each other and they contact the Decision Makers and execute actions until it beocme nutraized.

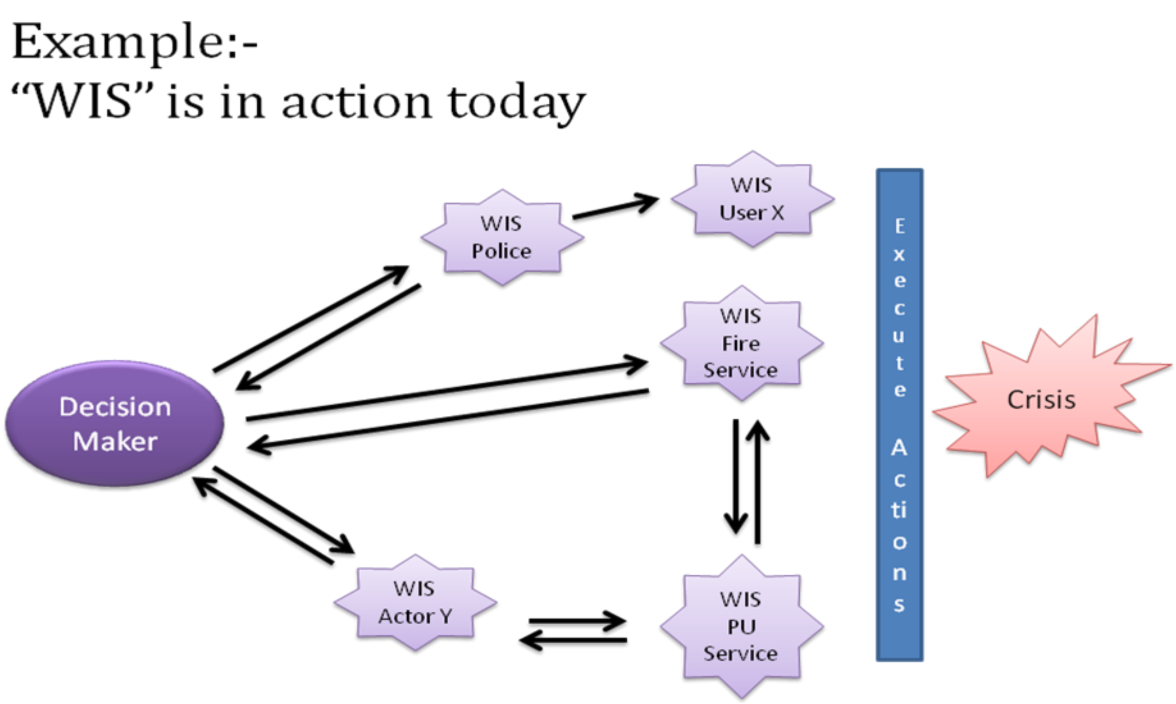


Figure 16 Commnunication between different actors using WIS

Once the IICM is in place the communication will be direct as explained in Figure 17. Mainly the WIS will act as the communication platform and the IICM will facilitate the decision making table. All the actors will send their data to the IICM and it will analyze the data and produce different views for different users. These views will present in the interactive interface which will contain list of actions and graphical presentation of crisis data. These interactions will continue until the crisis brings in to normal and the archive data will in KB will update to prepare for future events.

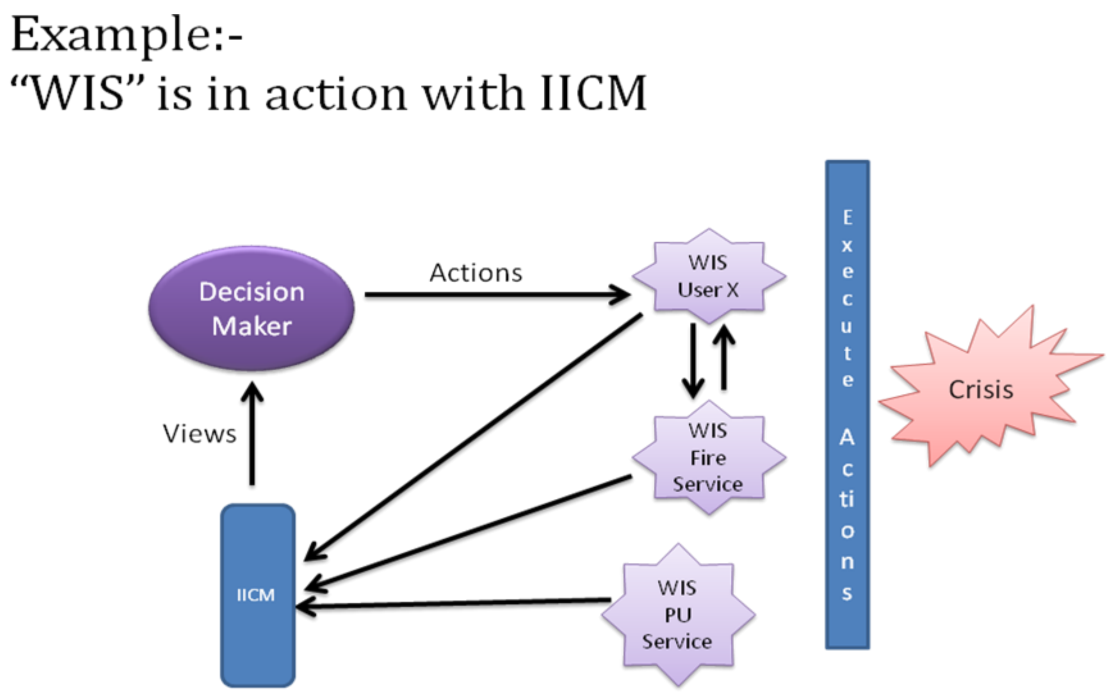


Figure 17: IICM is in action

FUTURE WORKS

Usability is very important factor in a stressful crisis management environment. Therefore further studies are needed to improve the usability IICM. Simulate the system with prototypes are the most effective way to achieve that. Simulated scenarios can be use with real users to observe and interview the users.

The workshops for the real users are other form useful data gathering method that can observer the user feedbacks.

Suitable algorithms have to develop considering number of dependencies in each levels of the KB. Time optimization and Learning capabilities are most important aspects of these algorithms to be considered.

Bibliography

REFERENCES

1. Anton, A. I. and Asplaugh, A.T. (2008) Scenario support for effective requirements, *Information and Software Technology,* 50, 3, 198-220.

2. Andrienko, G. and Andrienko, N. (2007) Intelligent Visualization and Information Presentation for Civil Crisis Management, *Proceedings of the 9th AGILE Conference on Geographic Information Science,* Visegrad, Hungary, 291-298.

3. Bautavicius, A. M. and Lee M. D. (2007) An empirical evaluation of four data visualization techniques for displaying short news text similarities, *International Journal for Human Computer Studies,* 65,11, 931 – 944.

4. Fink, S. (1984) Crisis Management: Planning for the Inevitable. *America Management Association*, New York, NY.

5. Hallberg, N. and Jungert, E. (2009) Capabilities of C2 Systems for Crisis Management, *Proceedings of the 6th International ISCRAM Conference,* Gothenburg, Sweden.

6. Kevany, M.J. (2003) GIS in the World Trade Center attack – trial by fire, *Computers, Environment and Urban Systems*, 27, 571-583.

7. Li, Z. and Wang, H. (2009) Research on the Enterprise Management System Basic on Knowledge Demand, *Proceedings of the 2009 International Symposium on Web Information Systems and Applications (WISA'09),*Nanchang, China, 5-9.

8. Mackinlay, J. (1986) Automating the design of graphical presentations of relational information, *ACM Transactions on Graphics (TOG)* 5, 2, 110 – 141.

9. Rinkineva, K. (2004) the role of Information Technology in Crisis Management, *ProceedFings of the 14th EINIRAS conference*, Helsinki, Finland.

10. Adams, John G. J. Z., Granger, M., Indira M. N. (2006). Risk Analysis 15(3): *313-318.*

11. *Alexander, D. A., Wells, A. (199*1). "Reactions of police officers to body handling after a major disaster: a before and after comparison" *British Journal of Psychiatry* 159 517-55.

12. Birch, J. (1994). "New factors in crisis planning and response." Public Relations Quarterly 39 (1): 31-4.

13. Brown, J. K. (1979). "The Business of Issue: Coping with the Company's environments." conference board New York.

14. Blaikie, P., Cannon, T., Davis, I., Wisner, B. (1994). "*At Risk: Natural Hazards, People's Vulnerability and Disasters* ".

15. Carver, J. (1989). "Monitoring-relaxing about the pres*ent ... so we can get on with the future."*

16. *Darlin, J., Hannu,* O., Raimo, N. (1996). "Crisis management in international bussiness: a case situation in decision making concerning trade with Russia." The Finnish Journal of Bussiness Economic 4.

17. *Driskell, J. E., &* Salas, E. (Eds) (1996). "Stress and human performance."

18. Douglas Paton, L. S., John Violanti (2000). "Disaster response: risk, vulnerability and resilience." Disaster prevention and management 9(3): 173-180.

19. Donoho, R. (1994). "Managing crisis at US Air." Sales 146(11).

20. Earle, T. C. (2004). "Thinking Aloud about Trust: A Protocol Analysis of Trust in Risk Management." Risk Analysis 24(1): 169-183

21. Eng, E., Parker, E. (1994). "Measuring community competence in the Mississippi Delta: the interface between program evaluation and empowerment." *Health Education Quarterly* 21 199-220.

22. Gonzales-Herrero, A., Pratt, (1995). "How to manage a crisis before - or whenever - it hits." Public Relations Quarterly, 40 (1): 25-9

23. Haywood, R. (1994). "*Managing your Reputation*."

24. Hardin, C. D., Higgins, E.T. (1996). "Shared reality: how social verification makes the subjective objective." *The Interpersonal Context,* 3.

25. Jackson, J. E., Schantz, W.T. (1993). "Crisis management lessons: when Push shoved Nike (boycott of Nike by People United to Serve Humanity." Business Horizons 36 (1): 27-35.

26. Johnston, D. P., G. L. Crawford, K. Ronan, B. Houghton and P. Bürgelt "Measuring Tsunami Preparedness in Coastal Washington, United States ": 173-184

27. Johnson-George, C., Swap, W.C. (1982). "Measurement of specific interpersonal trust: construction and validation of a scale to assess trust in a specific other " *Journal of Personality and Social Psychology* 43 1306-17.

28. Knox., H. W. K. a. R. E. (1970). "Conceptual and methodological considerations in the study of trust and suspicion. ." *Journal of Conflict Resolution,* 14(3): 357-366.

29. Lion, R., Meertens, R.M., Bot. I. (2002). "Priorities in information desire about unknown risks." Risk Analysis 22(765-76).

30. Leonard, G., Johnston, D., Paton, D. (2005). "Developing effective lahar warning systems for Ruapehu" *Planning Quarterly* 158 6-9. .
31. Loppacher, Laura J., Van Vliet W. A. K.,. (2004). "The BSE Crisis in Canada: A Trade Perspective on Sanitary Barriers ".

32. Mayer, R. C., Davis, J.H., Schoorman, F.D. (1995). "An integrative model of organizational trust" Academy of Management Review 20: 709-34 –

33. Marris, C., Langford, I.H., O'Riordan, T. (1998). "A quantitative test of the cultural theory of risk perceptions: comparisons with the psychometric paradigm." *Risk Analysis* 18: 635-47.

34. Michael Siegrist, G. C. (2002). "Perception of Hazards: The Role of Social Trust and Knowledge." Risk Analysis 20(5).

35. Maynard, R. (1993). "Handling a crisis effectively." Nation's Business, 81 (12): 54-5.

36. Mitrof, I., Harrington, L., Eric, K., G. (1996). "Thinking about the unthinkable." Across The Board: 44-48.

37. McClure, J., Walkey, F., Allen, M. (1999). "When earthquake damage is seen as preventable: attributions, locus of control and attitudes to risk " *Applied Psychology: An International Review* Vol. 48 (239-56).

38. Paton, D. (2007). "Preparing for natural hazards: the role of community trust "Disaster Prevention and Management "16(3): 370-37

39. Paton, D., Bishop, B. (1996). ""Disasters and communities: promoting psychosocial well-being"." *Psychological Aspects of Disaster: Impact, Coping, and Intervention*,.

40. Paton, D., McClure, J., Bürgelt, P.T. ((2006),). "Natural hazard resilience: the role of individual and household preparedness."

41. Paton, D., Smith, L.M., Johnston, D. (2005). "When good intentions turn bad: promoting natural hazard preparedness." *Australian Journal of Emergency Management* 20: 25-30

42. Paton, D. (1999). "Disaster business continuity: Promoting staff capability." Disaster prevention and management 8(2): 127-133.

43. Poortinga, W., Pidgeon, N. (2003). "Exploring the dimensionality of trust in risk regulation" *Risk Analysis* 23 (No. October): 961.

44. Rippl, S. (2002). "Cultural theory and risk perception: a proposal for a better measurement." *Journal of Risk Research* 5 147-65.
45. Toby J. Kash, J. R. D. (1998). "Crisis management: prevention, diagnosis and intervention" Leadership & Organization Development Journal.

46. Speer, P. W., Peterson, N.A. (2000). "Psychometric properties of an empowerment scale: testing cognitive, emotional and behavioral domains" _Social Work Research_ 24 (109-118).