



Knowledge Management for Disaster Scenario: An Exploratory Study

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Available online at: www.isca.in, www.isca.me

Received 19th March 2013, revised 30th April 2013, accepted 30th June 2013

Abstract

As a human being we all believe that natural disasters cannot be eliminated from the earth. But losses can be minimized by reducing response time to a disaster. In a couple of years natural disaster occurrence frequency is increased due to climate changes. When a disaster took place, it is necessary to start the relief work at affected site to save more and more lives. Effective communication, collaboration between different departments, NGO's and communities can reduce and minimize the losses of lives and property. Information Communication Technology (ICT) and Mobile Technology (MT) can play a vital role in DM. The aim of this research is to explore existing DM systems (DMS) and investigation of current technology contributing in development of DMS. Study of variety of DMS gives the opportunity to address the problems in existing DMS as well as discover the immediate needs to enhance the DMS. One of the objectives is to anticipate, collect and analyze the requirements to develop a model for disaster management on the basis of enterprise architecture (EA). Additional challenges are evolution of the proposed model with the help of prototype or simulation of latest technology.

Keywords: Knowledge management, natural disaster management, south asia vulnerability, ICT, disaster technology.

Introduction

Disasters is an unexpected and unfavorable event in nature when occurs brings great damages to lives and livelihoods. These unfortunate event either natural or man induced can exceed coping capacity of the affected region or country and resulting in terrible losses of lives, plants, animals and property. When a disaster occurs social and economical life of the affected region is paralyzed¹. Climate changes are frequently occurring all over the globe. These calamitous changes including destruction of forest, rapid urbanization, extraordinary growth of industry, population growth, changes in weather patterns and environmental demolition like pollution are associated with an increasing frequency of major disasters². United Nations Development Programme (UNDP) defines disaster as "a social crisis situation occurring when a physical phenomenon of natural, socio-natural or anthropogenic origin negatively impacts vulnerable populations ... causing intense, serious and widespread disruption of the normal functioning of the affected social unit."

Following is the table that demonstrates damages and estimated figures caused by three recent disasters (table 1).

Now a days global warming is the warmest issue in the world, global warming is one of the key factors in changing weather patterns. Due to global warming more and more hot days and fewer cool days are observed over the land. Different kind of adverse natural events like heat waves, storms, floods, and droughts are now more severe as compare to last decade. Ocean surface temperature increases due to warmer and hurricanes may appear with more intense power. Global warming is

effecting in rising sea levels, more frequent coastal flooding. The problem is serious because up to 10 percent of the world's population lives in vulnerable areas which are less than 10 meters (about 30 feet) above sea level³

Table-1
Comparison of Damage Caused by Three Recent Disasters

Incident	Considered Area	No of deaths	Estimated Financial Loss
Indian Ocean Tsunami (Dec 2004)	Sri Lanka	30,920 or 38,195 (Two different official estimate)	US \$ 1 billion Damage and US \$ 1.8 billion recovery cost
Northern Pakistan Earthquake (Oct 2005)	Pakistan	87,350 (Official) Over 100,000 (unofficial)	US \$ 5 billion
Hurricane Katrina (Aug 2005)	New Orleans, USA	1,604 accounted for both (direct and indirect) 2000 missing	US \$ 25 billion – US \$ 100 billion US \$ 75 Billion (According to the US National Hurricane Center)

Sources: BBC: <http://news.bbc.co.uk>; Central Bank of Sri Lanka: <http://www.cbsl.lk>; <http://www.pakquake.com>; US National Hurricane Center: <http://www.nhc.noaa.gov>

Natural Disaster: People referred natural disaster as an act of God. The International Federation of Red Cross and Red Crescent Societies (IFRC) defines natural disaster as an event of nature that resulting in effecting the Earth and devastate the social and economic development of people of that region. Natural disaster can include injury, loss of life, economic loss

and environmental loss etc.

Natural disaster can be classified into followings. i. Geophysical (Tsunamis, landslides, earthquakes and volcanic activity), ii. hydrological (flood and avalanches), iii. Climatological (wildfires, extreme and droughts, iv. Meteorological (storms and cyclones), v. Biological (disease epidemics and insect/animal plagues).

Man-Made or Technological Disaster: In contrast with the natural disaster man made or technological disaster is the event caused by human. According to The International Federation of Red Cross and Red Crescent Societies (IFRC) Environmental degradation, industrial accidents, transport accidents, displaced population, food crisis, bomb blasts and fire emergency are the common examples of man made disasters.

Disaster Management: Disasters are massive in nature, paralyzed human life activities, need great strength and coordination of the different departments who are responsible for coping them. Responding and management of such kind of adverse events like natural disaster or man made disaster is not an easy task, its required enormous activities or chain of systematic activities with efficient resource utilization, effective management of responsibilities in accordance with all humanitarian aspects of emergencies in all the phases of disaster management⁴. No standardized rule can be defined in different phases of disaster management cycle. Disaster management activities can be carried out according to the nature of disaster and the objectives set by the different coping agencies, in a particular phase of disaster management. One thing is common and it is agreed that activities should be carried out in a cycle⁵.

Disaster Management Cycle: Disaster management is not such an easy task; it is a massive work and required collaboration of different agencies and department of public sector, private sector and community level. Disaster management is a cyclic process, normally in a cyclic process ending of one process or phase is the starting of second process or phase, but not in disaster management case, more than one phases can execute simultaneously. The essence of disaster management cycle is the collaboration and coordination of different departments and organized efforts to respond against disaster, prepare for unexpected adverse event and recover from the hilarious destruction of the disaster.

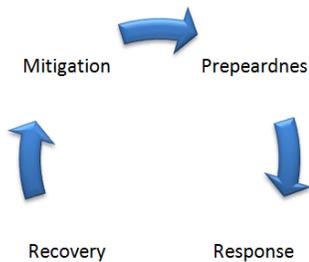


Figure-1
 Disaster Management Cycle

Generally there are three stages of disaster management named as pre disaster stage, disaster stage and post disaster stage. Each stage contains different phases of disaster management cycle. Following figure shows disaster management stages and disaster management phases.

Pre Disaster Stage	Disaster Stage	Post Disaster Stage
<ul style="list-style-type: none"> • Mitigation: Activities that reduce the effect of disaster events like public education, awareness. • Preparedness: Pre disaster activities like training, early warning systems. 	<ul style="list-style-type: none"> • Response: Activities like search, evacuation, rescue and relief during a disaster situation. 	<ul style="list-style-type: none"> • Recovery: Post disaster activities including medical care, temporary housing⁶

Figure-2
 Disaster Management Stages and Phases

Natural Disaster in South Asia: As natural disaster occurrence frequency is raised in the last decade all over the globe. Developed and developing countries trying to prevent and better response to natural disaster and strengthen their local agencies and departments, which are responsible for managing these inauspicious event, with the help of latest research in the domain of natural disaster management. The geographical location of south Asia makes this region's countries more vulnerable to natural disasters. According to the United Nations International Strategy for Disaster Reduction (UNISDR) and the World Bank, South Asia Disaster Risk Management Program, disaster risk at country and regional levels with focus on earthquake, flood, drought, landslide, cyclone and volcano hazards. The SAR countries like Pakistan, Bangladesh, Maldives, Afghanistan, Nepal, Bhutan, Sri Lanka and India exhibit a high level of vulnerability as demonstrated by their lack of coping capacities. South Asian's region experiences a lot of disasters and most of the recent disasters are due to the climate changes and their frequency, unpredictability and severity of the disasters increases in last couple of years. Vulnerabilities are aggravating from stresses on water availability, agriculture and environment. It has been well recognized that developing countries are rather prone to disasters than the developed countries because developed countries have well planed strategies to coping up with disasters⁷. Natural disasters are the big threat for the whole world. In the south Asian region, unfortunately Pakistan is one of the most disaster vulnerable countries due to its poor awareness to disasters, lacking of training and exercises, insufficient preparedness to manage disasters and inadequate coping capacity with them. 8 October 2005 Kashmir Earthquake and floods of 2010 exposed its unpreparedness and weak management resulting in extraordinary losses of lives and damages of livelihood.

Disaster Management in Pakistan Scenario: Like other developing countries, Pakistan is very poor in managing natural disasters. There is no disaster management system, recommendation of development of a very strong and effective disaster management system is an urgent need of Pakistan⁸. Due to geographical location, Pakistan is seriously under attack of various kind of geological hazards like earthquake, Pakistan is located in a seismically active zone and more prone to earthquakes. 8 October, 2005 Kashmir Earthquake is the most devastating earthquake in her history. In this hilarious event, around 30,000 sq. km land was affected and 73,000 peoples killed in this earthquake⁹. In last couple of years Pakistani community continuously was suffering from both type of disasters that is natural disaster and man induced disasters. Natural disasters including earthquakes, , landslides, floods, cyclones, and drought while human induced disasters such as fires, civil unrest and terrorism, refugees and internally displaced people, health epidemics, transport accidents, industrial accidents and war. The losses of lives and livelihood in both are unbearable and the impact of this kind of events on social and economical life of Pakistani community is overburden¹⁰. There are two main factors of natural hazards in Pakistan. one is its geographical location and other is geomorphic structure of Pakistan. Himalaya Mountain possess heavy shower during summer season and Karakomm, Hindukush and Himalaya Mountain added a huge amount of water from their melting glaciers. Due to these two major reasons Pakistan average increases more than 1000 mm per annum¹¹. Like other developing countries, Pakistan faces the destruction and devastation due to natural hazards. Pakistan

demonstrated his coping deficiencies many times against natural disaster events. In disasters situation early response is very much important to minimize the casualties and the damages to human lives caused¹².

According to World Disaster Report 2012, following is a table that demonstrates number of people killed and effected by disasters in Pakistan from 1992 to 2011 (table 2).

The ongoing disaster management system and policies demonstrates great deficiencies in all the phases of disaster management cycle. This lacking shows poor institutional arrangement in order to address disaster related issues, as it seems that there is no central organization to cope with disaster scenario, no collaboration and communication found between different departments of public sector, deficiency of concrete policy of reconstruction and rehabilitation. Whenever there is emergency situation response time is too longer and result is in form of great damages of lives and property. In October 2005, a massive earthquake was experienced in the northern areas of Pakistan; there were many affected places which remained unaddressed even after five days. There are many disaster events, natural or man made, in which people of Pakistan suffered from large amount of losses of lives and property. One simplest examples is that fire brigade department was not informed in time when buildings caught fire after bomb blasts⁸. Following is a table that demonstrates the date, Disaster type, no. of people killed and no. of people affected by the natural disasters in Pakistan (table 3).

Table-2
Total number of people reported killed and affected by disasters in Pakistan

Total number of people reported killed (1992–2001)	Total number of people reported affected (1992–2001)	Total number of people reported killed (2002–2011)	Total number of people reported affected (2002–2011)	Total number of people reported killed (2011)	Total number of people reported affected (2011)
8,121	26,623,552	81,287	46,404,621	646	5,401,830

Table-3
Top 10 Natural Disaster in Pakistan

Date	Disaster	Killed	Date	Disaster	Affected
31-may-1935	Earthquake	60,000	Sept 1992	Flood	12,324,024
15-Dec-1965	Wind Strom	10,000	9-Aug-1992	Flood	6,184,418
28-Dec-1974	Earthquake	4,700	2-Aug-1976	Flood	5,566,000
1950	Flood	2,900	Aug-1973	Flood	4,800,000
Sept-1992	Flood	1,334	July -1978	Flood	2,246,000
3-March-1988	Flood	1,000	Mar-2000	Drought	2,200,000
June-1977	Flood	848	22-July-1995	Flood	1,255,000
14-Nov-1993	Wind Strom	609	24-Aug-1996	Flood	1,186,131
11-June-1991	Exterem Temp	523	June-1977	Flood	1,022,000
27-Nov-1945	Earthquake	4000	Aug-1988	Flood	1,000,000

Source: "EM-DAT: The OFDA/CRED International Disaster Database, Université catholique de Louvain, Brussels, Belgium"
<http://www.cred.be/emdat/intro.htm> Access time: 05/01/2003

Technological Aspects

In this section, we present a few related efforts on Disaster Management, Disaster managements Systems (DMS), DM communication systems (DMCS), existing and forthcoming technologies used in disaster management phases, software applications that facilitate the volunteers and victims to communicate and inform with the current situation of the affected area. As a human being we all believe that Natural disaster cannot be eliminated from the earth and can not stopped when they begun. Therefore the only thing a human can for minimizing loess of lives and property is coping strategies in advance. As a matter of fact, disaster divesting lives and disturbs all social and economical activities of human beings. There are numerous activities, which should be performed before and after disaster. Pre-disaster activities such as disaster management technique's training, exercise, data gathering and data analysis for prediction and development of early warning alarm systems are the healthy activities which can be reduced or minimize the loss when a disaster take place. Historical data analysis and developing a forecasting system for early warning is indeed a need for saving thousands of lives as well as economic and social life of human beings.

Technology may play a vital role in all the phases of disaster i.e. pre-disaster, disaster and post-disaster. Effective early warning system can save thousands of lives and livelihood and assets also early warning is most important than later treatment and repair. An early warning system¹³ based on information chain, included a GIS managed and supported data level system is proposed. This proposed system consists of five different links; each link is responsible for different task such as gathering information about past disaster, identifying abnormal activities, process collected data and make proper decision making for disaster early warning. To get the true picture of affected area a mobile technology based system is presented for Android platform¹⁴. This system consists of a desktop web application, a mobile web application and a standalone application for Android platform. By using this application either (Desktop, Mobile or Android based) any one can submit an event with event headline, reporter name, location and type of event, theses reports can viewed by users of that application. Trustworthy issues about submitted report also discussed in this paper and three schemes are applied for trust level. Trustworthy scheme named as Trust Association with group membership, Trust development by crowd sourcing and trust determined by machine learning. Future expansion of the application, timeline tool, color coding and numerical identifiers on Google's map¹⁴. Many researchers doing great efforts in the field of monitoring and forecasting earth phenomena to avoid a disasters and response to a disaster in short time. Different technologies and heterogeneous devices and sensors are used in continuous monitoring of calamitous variations and earth phenomena. These devices and sensors connected to different type of machines with different operating environment and different user interfaces, as well as heterogeneous protocols are followed

for data communication. Data processing may be doing using various types of algorithms. Means there is a distributed and heterogeneous environment for monitoring the earth. All the above discussed scenario, integrated with in a single platform, where all the heterogeneous resources worked together in same fashion is an obstacle.

Grid computing has the potential to cross this obstacle. The main concept of grid computing is viewing computing as a utility. Grid computing enables resource sharing and dynamic allocation of distributed heterogeneous computational resources. Theses resources may be geographically distributed and follows different protocols and made by different vendors¹⁵. When a disaster occur different public sector department, agencies, volunteers and NGO's worked together for the relief of affected people at disaster site. All the people belonging to different entities, worked together at different locations, they want to communicate with each other to informed others and be informed with the current state of disaster site and victims. When the communicate effectively they can request for help, services, goods, medicines and what ever the stuff they need at that time, for better response and relief for the victims. So at disaster affected area communication and collaboration between the volunteers and victims as well as volunteers and different department like police, fire department, medical personal is most important to communicate real time information and better decision making. Technological support has been directed towards communication systems development. Computer Augmented Communication¹⁶ (CAC), a communication system for disaster affected area is presented. CAC have three different technological flavors, a client server application, a web based application and a mobile based application. Consisting of multiple mobile personal display and three mobile applications named as Mobiphos, Mobile Dance Revolution (MDR) and a mobile version of poker also discussed for the development of effective and real time communication and sharing of applications on multiple mobile devices, which helps the interaction of personal in a relief effort. Another mobile¹⁷ based prototype for collaboration and support between different entities during emergency response is presented. This prototype application uses mobile phone as a main platform for capturing, transmitting and receiving information. MVC patterns are used for the sake of mobility and low cost implementation of mobile device. The Geo Information Technology (GIT) includes Remote Sensing (RS) Geographical Information Systems (GIS), Global Positioning System (GPS), Information and Communication Technology (ICT) are also the core of comprehensive Natural Disaster Management System that covers disaster monitoring, modeling, mitigation rescue operation management, and rehabilitation strategies development¹⁸. GIS provides information on the static locations, they do not provide dynamically changing locations of things and people on the move while Radio Frequency Identification (RFID) wireless network technology can automatically tracks and identify the moving objects like fire engines, ambulances, volunteers and victims and providing real time information to

the related departments and volunteers for better decision making at the time of disaster¹⁹. During the disaster rescue and recovery efforts are usually hindered by weakness of communication system or mechanism as the existing communication system of the affected region may be collapsed or damaged due to disaster. An ad-hoc communication network²⁰ combination of wireless networks technology (WiFi, WiMax and GEO satellite) and multimedia software applications (Voice-over-IP) is presented to meet the requirements of disaster rescue communication scenario. A Digital Ecosystems⁸ idea is proposed in order to improve the working of existing disaster management system of Pakistan. Such a system would prove to be beneficial in terms of saving lives, property and resources. The personalized E-Learning platform²¹ can be used in disaster situation for communication between volunteers and can be helpful in delivering voice, videos and images etc, to aware the current situation of disaster stricken region. For the transportation and supply chain management in the affected area the drivers of the vehicles can be used navigation systems to make their journey save and sound. Vehicular Communication Infrastructure²² (VCI) can be used by the divers of the logistic support team in disaster area for traffics monitoring, location awareness, as well as the tracking of the vehicles is another benefit of this system.

ICT Assistance for Disaster Situation

This Research study is exploratory in nature and it aims to use Mobile or Information Communication Technology to improve disaster response time or enhance existing disaster management system. Review the literature of disaster management system, investigation of existing disaster management practice and issues in developing countries like Pakistan, also identify relevant practices in developed countries. Classify the good and bad practices in the domain of disaster management; pinpoint the gaps and issues in existing disaster management systems and its immediate needs to enhance DMS. One of the goals is to investigate latest Technology with its limitations which can support DMS, also probe the forthcoming technologies that may play an important role in developing effective DMS. To accomplish the requirement for better DMS the study employed a variety of methods, including literature and website searches and review, document analysis, questionnaire surveys and analysis, visits to select organizations like National Disaster Management Authority (NDMA), and interviews with key individuals/groups. To acquire the practical information field work is also in consideration. This research found significant gap for technological application in disaster situation and emphasis for a Model for improvement of DMS by exploiting latest technology; especially integration of mobile technology in disaster procedures through enterprise architecture approach. Evaluation of the proposed enterprise architecture model for improving DMS with the help of prototype (full functionality with limited elements) / simulation of latest technology and the take the expert opinion (from the field of disaster management) to evaluate the prototype or simulation of the model.

Conclusion

It is understood that disaster cannot be eliminated from the earth but effective management and response can saves thousands of lives and property. As natural disaster occurrence frequency increasing in last decade, research community getting more attention in the domain of disaster management. As per literature, nature of disaster management research is highly interdisciplinary so there is a need of collaboration of different domain researchers to contribute in furthering in disaster management research. Latest and forthcoming technologies can play a vital role in almost all the phases of natural disaster management. Choosing the appropriate technology among the hottest technologies for each stage of disaster management is one of the main concerns in the research of disaster management.

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