Original Article

A comparative study on the Earthquake Information Management Systems (EIMS) in India, Afghanistan and Iran

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ABSTRACT

Context: Damages and loss of life sustained during an earthquake results from falling structures and flying glass and objects. To address these and other problems, new information technology and systems as a means can improve crisis management and crisis response. The most important factor for managing the crisis depends on our readiness before disasters by useful data. **Aims:** This study aimed to determine the Earthquake Information Management System (EIMS) in India, Afghanistan and Iran, and describe how we can reduce destruction by EIMS in crisis management. **Materials and Methods:** This study was an analytical comparison in which data were collected by questionnaire, observation and checklist. The population was EIMS in selected countries. Sources of information were staff in related organizations, scientific documentations and Internet. For data analysis, Criteria Rating Technique, Delphi Technique and descriptive methods were used. **Results:** Findings showed that EIMS in India (Disaster Information Management System), Afghanistan (Management Information for Natural Disasters) and Iran are decentralized. The Indian state has organized an expert group to inspect issues about disaster decreasing strategy. In Iran, there was no useful and efficient EIMS to evaluate earthquake information. **Conclusions:** According to outcomes, it is clear that an information system can only influence decisions if it is relevant, reliable and available for the decision-makers in a timely fashion. Therefore, it is necessary to reform and design a model. The model contains responsible organizations and their functions.

Key words: Crisis management, destruction, earthquake, information systems, natural disaster

INTRODUCTION

Iran, because of extent, geographical situation and climatic variety, is one of the damageable countries of the world.[1] Natural disasters, for example earthquake, are an unexpected event that cause damage and destruction to human life and health, and the injured persons without others assistance are not able to meet their need. Earthquakes in Iran and neighboring regions (e.g., India, Turkey and Afghanistan) are closely connected to their position within the geologically active Alpine-Himalayan belt[2-5] [Table 1]. This crisis happens in an especial situation that changes all of the daily affairs of disastrous society, such as people earning, city services, communication system and community public needs and people health.[6] Earthquake Information Management System (EIMS) is a system that records, collects, keeps, retrieves and analyzes inputs and alters the reports and required earthquake information (EI) and renders it to the right people and organization to manage earthquake outcomes.[7]

Information is not an end in itself, but a means to better

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Access this article online	
Quick Response Code:	Website: www.jehp.net
	DOI: 10.4103/2277-9531.99963

This article may be cited as:
Ajami S. A comparative study on the Earthquake Information Management Systems (EIMS) in India, Afghanistan and Iran. J Edu Health Promot 2012;1:27.

decisions in policy design, planning, management, monitoring and evaluation of programs and services, including damage of disasters reduction.[8] Unfortunately, information systems in most countries are inadequate in providing the needed management support. Earthquake loss estimates are forecasts of damage and human and economics impacts that may result from future earthquakes. These estimates are based on current scientific and engineering knowledge.[9] The "earthquake loss estimation methodology" is a system that uses mathematical formulas and information about building stock, local geology and the location and size of potential earthquakes, economic data and other information to estimate losses from a potential earthquake. EIMS uses Arc GIS (Geographical Information System) to map and display ground shaking, the pattern of building damage and demographic information about a community. Once the location and size of a hypothetical earthquake is identified, EIMS will estimate the violence of the following: ground shaking, the number of buildings damaged, the number of injured persons, the amount of damage to transportation systems, disruption to the electrical and water utilities, the number of people displaced from their homes and estimated cost of repairing projected damage and other effects.[10-13] An estimate of losses from future earthquakes is essential to preparing for a disaster and facilitating good decision making at the local, regional, province and national levels of government. An EIMS can estimate earthquake losses, providing vital tools for the following:

1) Land-use planning and facility site decisions (e.g., a map-based analysis of the potential intensity of ground shaking from a postulated earthquake that identifies those parts of the community that will experience the most violent shaking and the buildings at greatest risk of damage).
2) Prioritization of retrofit or abatement programs (e.g., an estimate of building damage that provides the basis for establishing programs to mitigate or strengthen buildings that may collapse in earthquakes by providing estimates of damages and casualties).
3) Regional, province and local emergency response and contingency planning (e.g., estimates of casualties and of damage to buildings and utilities).
4) Medical and relief agency preparedness and response (e.g., estimates of casualties and homelessness).
5) Assistance planning.[11]

In this research, our important questions were:

1- When can EIMS be useful?
2- What are the essential substructures in EIMS?
3- What is the usage of EIMS?
4- What are the stages for formulating EIMS?
5- How do we use EIMS to prepare for earthquakes?

In this study, the management network for information related to earthquake in India and Afghanistan was compared with Iran to determine the total score of EIMS in them. Then, weaknesses and strengths points were determined. At last, several recommendations and a model were proposed to decrease weaknesses, improve the efficiency of EIMS process and, therefore, reduce damages and loss and expedite relief to victims after earthquakes.

MATERIALS AND METHODS

This research was practical and the study was an analytical comparison. The statistical population consisted of the EIMS on network in India, Afghanistan and Iran. Countries such as Iran, India and Afghanistan were chosen because these countries have high rate of disasters, especially earthquakes.

To perform this study, the researcher made forms and questionnaires. The method of collecting information was interview and observation. The forms contained items to define standard characteristics of the Information Management System that was extracted from JCAHO; Joint Commission on Accreditation of Healthcare Organization, AHIMA; American Health Information Management Association and CCHSA; Canadian Council on Health Services Accreditation,[14] and then made synthetic forms. The questionnaire was designed to determine viewpoints and opinions of experts to set weights for every characteristic of the EIMS. In the first phase of data collection, validity of forms and questionnaire was approved too. The source of information contained Internet, personnel, documentations, journals and books. Data included EI sources, method of recording, storing, retrieving, analyzing, interpreting, distributing of EI, national and international levels usage, and so on.

Data were gathered from the Internet, personnel, journals and books. Criteria Rating Technique[15] and descriptive method were used to analyze findings.

Standard characteristics of the Information Management System were selected as criteria. In the second stage, for comparing characteristics of EIMS, experts' opinions were selected to set weights (the relative importance of each criterion from 1 was low until 10 was high) by brainstorm decision criteria and measured mean of experts' opinions to set weights for each of them in Table 1. Rating was established (ratio = weight of each criteria divided by sum). Then, scales (positive = 4, moderate = 3, not access = 2, negative = 1) and scores (score = ratio*scale) for selected countries were calculated.

RESULTS

Findings showed follow answers for our questions.

When can EIMS be useful?

1) Information users and addressers specified,
2) Time, form and mechanism of information distributed specified,
3) EI must be valid and reliable,
4) Fast access to EI.

Furthermore, the data received are often not helpful for

Table 1: Deadliest earthquakes by year, 1995–2005

Deadliest earthquake				
Year	Date	Magnitude	Fatalities	Region
2005	03/28	8.7	1313	Northern Sumatra, Indonesia
2004	12/26	9.0	283,106	Off the west coast of Northern Sumatra
2003	12/26	6.6	31,000	Southeastern Iran
2002	03/25	6.1	1000	Hindu Kush region, Afghanistan
2001	01/26	7.7	20,023	India
2000	06/04	7.9	103	Southern Sumatera, Indonesia
1999	08/17	7.6	17,118	Turkey
1998	05/30	6.6	4000	Afghanistan–Tajikistan border region
1997	05/10	7.3	1572	Northern Iran
1996	02/03	6.6	322	Yunnan, China
1995	01/16	6.9	5530	Kobe, Japan

management decision making because they are incomplete, inaccurate, untimely and unrelated to priority tasks and functions of crisis management.

Essential sub-structures in EIMS:
1) Science of Crisis Management,
2) Information Technology,
3) Geographic Information System,
4) Information System,
5) Mass media,
6) Cell phone,
7) Capital,
8) Human resources.

Usage of EIMS:
1) Impossibility of fast and easy retrieval, extract and access of information for managers and all related users;
2) Extract integrated data from different resources;
3) Prevent to implement parallel and repeated activities by various organizations;
4) Decrease cost and time;
5) Assessing and monitoring function and plans before and after earthquakes;
6) Recognizing training needs functional forces;
7) Formulate prevention, action and rehabilitation according to outcomes of EIMS evaluating.

Formulating EIMS's stages:
1) Institute joint commission from related governmental and non-governmental sectors and organizations;
2) Determine elementary sources;
3) Determine and formulate general concepts and purposes;
4) Recognize necessary data items;
5) Recognize and determine informatics resources;
6) Recognize and determine registration, collection and storage methods and administrators;
7) Recognize and determine retrieval and analyze methods and administrators;
8) Recognize and determine, distribute and issue of information methods and administrators;
9) Create methods to connect systematically among these administrators;
10) Notice to render feedback process in EIMS to ensure continuous improvement system;
11) Dynamic and flexible plans and functions must be design.

How do we use EIMS to prepare for earthquakes?
The first step in preparing for a disaster is estimating its potential impact. Loss estimates can provide the basis for developing mitigation policy, for developing and testing emergency preparedness and response plans and for planning for post-disaster relief and recovery.[16]

- Before an earthquake:

A reducing earthquake loss begins before the earthquake. Loss estimates provide public and private sector agencies with a basis for planning, zoning, building codes and development regulations, and policy that would reduce the risk posed by violent ground shaking and ground failure. Loss estimates can also be used to evaluate the cost-effectiveness of alternative approaches to strengthening potentially hazardous structures.

- Before an earthquake:

Preparing to respond, understanding the scope and complexity of earthquake damage is essential to effective preparedness. EIMS can forecast damage to buildings, casualties and disruption of utilities. These estimates can serve as the basis for developing emergency response plans and for organizing tests and exercises of response capability.

About EIMS: In India, findings showed that the Disaster Information Management System (DIMS) was launched by SRISTI "SRISTI"; http://www.sristi.org Society for Research and Initiatives for Sustainable Technologies and Institutions on the 18th of January 2002 at the Indian Institute of Management, Ahmedabad, Gujarat, India. SRISTI participated in the relief and rehabilitation work in Kutch. However, the relief work suffered immensely due to lack of information and proper planning. When we tried to get answers to important questions that were cropping up – for instance, whether there is a database on the distribution of available resources and expertise with individuals, institutions and corporations – all we got in response was a blank. This pointed to the urgent necessity of building a system for disaster mitigation and for documenting experiences of individuals and organizations, which might act as a knowledge resource and help in better coordination in case of future disasters. Thus, SRISTI initiated an effort to build a "Disaster Management Information System." Through this initiative, we are trying to develop a database-driven information system for Disaster Management Authorities (DMA) in various states, NGOs and other organizations. We appealed to NGOs, relief workers, DMAs and individuals to share their experiences and volunteer services and resources to the online database maintained at our website. The database currently contains more than a thousand volunteers who have offered to volunteer their

services and resources in time of emergency. About 700 organizations and institutions indexed on the site, besides other resources and web links. The DMIS is a voluntary activity run with contributions in terms of time and services by SRISTI volunteers, NGOs and, above all, civil society institutions across the world. All the information shared with us is accessible to all, except where the volunteer has chosen to limit accessibility only to the relevant authorities.[17]

About EIMS: In Afghanistan, findings showed that Afghanistan is in danger of many natural disasters. Therefore, it needs to have a DIMS, especially EIMS. Disaster management is a legal attempt that needs miscellaneous information, different locations and tenses, and this information must have a true format to be in access of key staff in deciding. The temporary project of "Management Information for Natural Disasters" in Kabul province and Kunduz province in Afghanistan has been doing well for 8 months. Aims of this temporary project were expanding a crisis information management system. Also, it updates and gives information to governments. This project has increased Afghanistan's ability in crisis management nationally, supporting educated people and city renewing services by building governmental organizations in management information for natural disasters. Natural disaster management in these two provinces is mostly based on estimating the amount of damages and concentrated rescue operations, and there is no system to avoid or decrease the amount of damages by natural disasters. Before or after disaster, management is very weak in these countries and they are dependent on UN or NGO. Information source in the process of collecting EIMS includes human forces and geographical informative systems that are a dangerous area and shows locations with high potential danger. In this system, the satellite has an important part in recognizing crisis locations distance.[18] To record collected information, a team of Information System Unit is educated to record in puts portions, information and management of stations of informative system of disaster management, and they will record the information. Structure of DIMS special earthquake is not useful in many parts of the country. The most important problem is lack of exact information (not in time).

In Iran, the EIMS showed absence of timely reporting of most of the data before, during and after earthquakes, Defective, insufficient and inaccurate registration of data, declaration and publishing different and contradictory population statistical reports by related organizations and weakness to use reliable information to support the prevention systemic planning. In order to make suitable EI in Iran, we need to provide and support managers. To improve current situation of EIMS, we need to design a midified model of EIMS.[1] The modified model contains; responsible organizations, their functions, and flow-work that were approved by the Delphi Technique.

Table 2 denotes the highest sum of score relative to India and the lowest relative to Iran. The weakness issues are respectively concluded: EI stores systematically, no parallel and repeated activities by various organizations and accessibility of EI easy and fast in EIMS' criteria in Iran. In the range of ranks, Afghanistan and India were classified in the very good range and Iran in the moderate range.

DISCUSSION

Mass media is imperative in communicating news and information to the public. Responsible journalism can also help clear inaccurate rumors and influence public's attitude toward preparing for disasters. Moreover, press coverage of old disasters may be a good source of data where official records do not exist. However, the present study has revealed that the press has largely failed in terms of disaster mitigation and preparedness guidance. It seems that media is more interested in giving disastrous news than informing the public. Turkish media had been more influential in urging

Table 2: EIMS characteristics evaluating in selected countries

Criteria/country	Weight	Ratio	India		Afghanistan		Iran	
			Scale	Score	Scale	Score	Scale	Score
1) Information sources are existed	8	0.11	4	0.44	4	0.44	3	0.33
2) Users of EI are specified	6	0.08	4	0.32	3	0.24	3	0.24
3) System has security process	6	0.08	4	0.32	2	0.16	2	0.16
4) EI is recorded and stored systematically	7	0.09	4	0.36	4	0.36	1	0.09
5) EI is retrieved, analyzed and interpreted systematically	9	0.12	4	0.48	2	0.24	3	0.36
6) Administrators are specified in various functions	9	0.12	4	0.48	4	0.48	3	0.36
7) No parallel and repeated activities by various organizations	5	0.07	4	0.28	4	0.28	1	0.07
8) EI is distributed and used in national and international levels	6	0.08	4	0.32	4	0.32	3	0.24
9) EIMS has feedback	9	0.12	4	0.48	4	0.48	3	0.36
10) Accessibility of EI is easy and fast	8	0.11	4	0.44	3	0.33	1	0.11
Sum	73	1		4		3.3		2.32

Earthquake Information= EI, Scales: Positive = 4, moderate = 3, negative = 1, not access = 2, Ratio = weight of each criteria/sum Score = ratio*scale

Range of ranks:	
1–1.6	Very weak
1.7–2.2	Weak
2.3–2.8	Moderate
2.9–3.4	Good
3.5–4	Very good

both the public and the officials in getting ready for the coming earthquakes. Television appears to be a better tool for this purpose.[19]

The Japan Meteorological Agency (JMA) as a governmental organization responsible for issuing EI and tsunami forecasts had developed an early earthquake notification system in Japan. At present, JMA issues the following kinds of information successively when a large earthquake occurs: (1) prompt report of occurrence of a large earthquake and major seismic intensities caused by the earthquake in about 2 min after the earthquake occurrence, (2) tsunami forecast in around 3 min, (3) information on expected arrival times and maximum heights of tsunami waves in around 5 min and (4) information on a hypocenter and a magnitude of the earthquake, the seismic intensity at each observation station, the times of high tides in addition to the expected tsunami arrival times in 5–7 minutes. To issue the above information, JMA has established an advanced nationwide seismic network with about 180 stations for seismic wave observation and about 3400 stations for instrumental seismic intensity observation, including about 2800 seismic intensity stations maintained by local governments.[20]

Beginning in the late 1950s in the world, planners started to develop and use computerized models, planning information systems and decision-support systems to improve performance. They have found tools to enhance their analytical, geospatial technologies that differ from one country to another. The industrialized information societies are well adapted to this technology. They use it in many fields; the governments apply urban information systems in all aspects of the planning process, including data collection, storage, data analysis and presentation, planning and policymaking, communication with the public, policy implementation and administration. The United States is the pioneer in this field; they began working with urban information systems in the 1970s. Canada and Australia have developed systems; also European countries like France, Germany and Holland have been successful in applying these technologies. Turkey is a latecomer in this field because of financial problems, the other priorities and the lack of technical expertise and different mentalities of the administrators. But today, urban information system is a popular magic word in the local governments. The first initiative of local governments like Bursa and Ayden cities began to use urban information systems in the mid-1990s, and then the other three metropolitan municipalities, Istanbul, Ankara and Izmir, made studies about digitizing the maps, plans and creating inventories about their cities. In this section, first, Turkey examples and their studies about urban information systems are explained, then the other world examples are described for their different uses and applications. In the earthquake management section, there is a disaster management cycle showing the actions and preparedness. The phases are based in this cycle. The preparedness and mitigation phases have more emphasis. Because it is believed that besides advice and instructions given to the public, raising awareness for the earthquake risk is necessary for the management levels and the residents, the technological tools help in this process. But, the management, including protection and recovery, is completed with the interrelated system.[21]

CONCLUSION

The first effort to systematically collect and analyze data in developing countries should be undertaken by national program managers. Based on the investigation of the current situation in India, Afghanistan and Iran, we need to have EIMS because of the following reasons:

1) Relevance of the information must be gathered;
2) Continuous improvement of data must be concerned;
3) Control and manage natural disasters (rapid availability and retrieval EI);
4) Timely reporting and feedback must be rendered;
5) Analyze information and render reports and define strengths, weaknesses, threats and opportunities;
6) Monitoring healthcare services status and services needs;
7) Coordinating activities between government and non-government sectors and other related sectors to use EI;
8) Determining causes of deaths and health priorities and planning to decrease mortality after earthquake in the future;
9) Using outcomes for determining cause of earthquake mortalities and other related problems to prevention in the future;
10) Formulating strategies to diseases incidence prevention and decrease of controllable deaths after earthquakes on wards.

After an earthquake, a rapid response to a damaging earthquake will reduce loss of life, lessen complications from injuries and secondary damage and loss and expedite relief to victims.

Reliable and up-to-date information can have an impact on the destruction factors and prevent them. Because of the financial and human damages of disasters, establishing a general, scientific and practical management network is necessary.

Figure 1 demonstrates a proposed model that shows the process of relationships between organizations related to EIMS in Iran. In this model, duty and function of every organization is determined. These duties are classified according to registering and collecting earthquake data, storing and processing, analyzing and distributing and using issued EI.

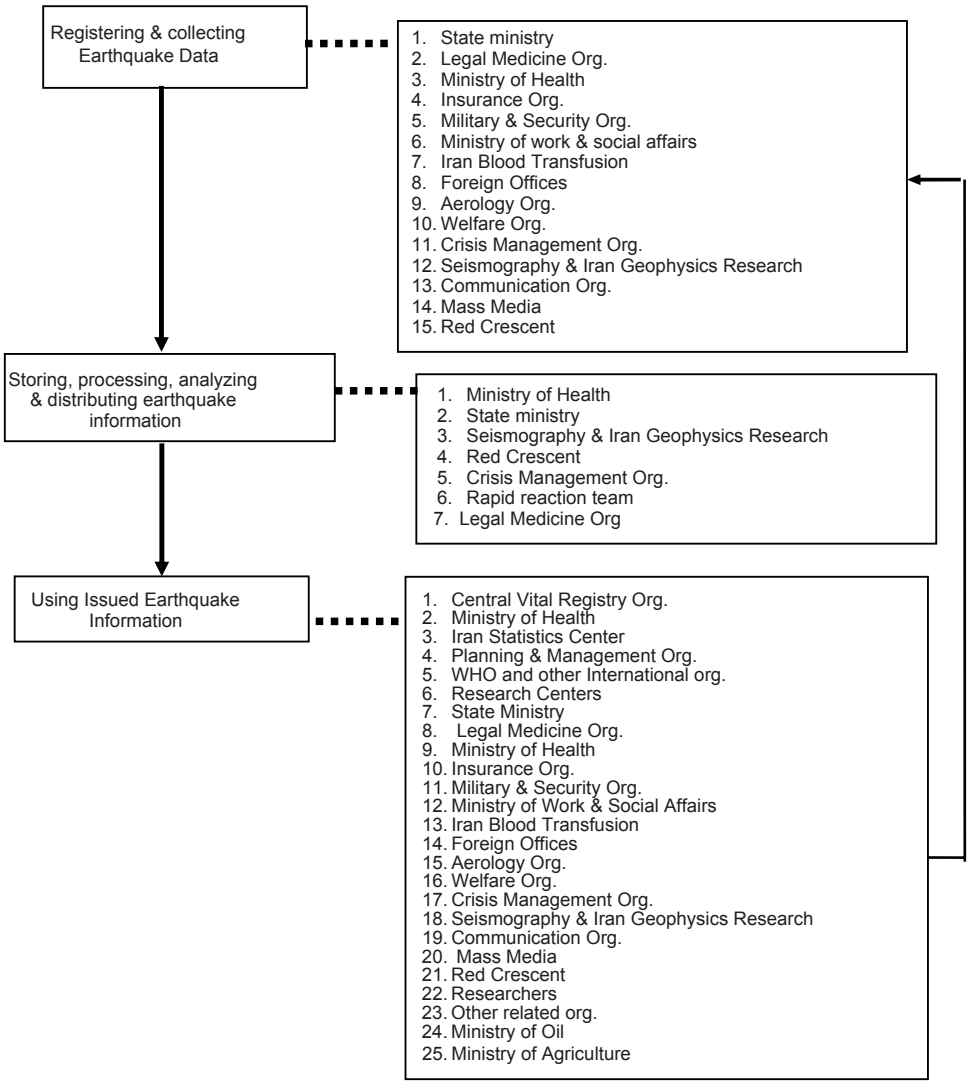

Figure 1: The proposed model that shows process of relationships between organizations related to EIMS in Iran

ACKNOWLEDGMENT

The author would like to thank Misses Z. Moradi, Mahshid Fattahi and N. Nematolahi for helping to fulfill this research.

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Source of Support: Nil, **Conflict of Interest:** None declared