



An Evaluation of Disaster Preparedness in Four Major Earthquakes in Iran

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ABSTRACT

Iran is located in the Alpine-Himalayan seismic belt, as one of the most active tectonic regions of the world. Throughout history, the country has frequently suffered large and destructive earthquakes and experienced several major earthquakes in the past few decades. More than 70 percent of the big cities in Iran are located in the vicinity of seismic faults and in some cases, the active faults pass through the city. Therefore, earthquake preparedness can be regarded as one of the factors which can contribute to safety of various groups of citizens. In Iran, measures have been undertaken to improve the public knowledge about disasters. A review on the activities of recent two decades, reveal the gradual improvement on the trends of earthquake preparedness in the country. The aim of this paper is to evaluate the progress of disaster preparedness in four major earthquakes that has occurred in Iran including Manjil - Roudbar, 1990, Changureh-Avaj 2002, Bam 2003, and Darb-e-Astaneh-Silakhore 2006 earthquakes. At the end, recommended strategies towards promoting public awareness and education as well as professional training are presented.

Keywords:

Earthquake
Preparedness;
Manjil-Roudbar;
Changureh-Avaj;
Bam; Darb-e-Astaneh
Earthquakes; Iran

1. Introduction

Lack of preparedness usually results in significant material and other losses, both on the onset of the disaster and subsequently. The goal is therefore to shift from existing “reactive” approaches of the “disaster recovery” to “proactive” approaches of “disaster mitigation”. These “proactive” mitigation measures focus more on education, with the aim of improving community disaster preparedness [1]. In this respect, education and training are addressed as being among the most practical means of enhancing community preparedness and disaster mitigation. Education is the fundamental “bedrock” of disaster risk reduction [2].

Experiences exist in many developing as well as developed countries on how to promote earthquake preparedness. Disaster education has been effectively implemented in some areas for many years. For example, the American Red Cross in USA has a

long history of educating the public about natural and technological hazards and ways to reduce the effects of these hazards on people and their properties. However, evidence of developed public awareness materials from the 1950s onwards does exist with not many printed documents available. In the 1980s, the responsibility for developing and disseminating disaster safety information was spread. For example, those working in Federal Emergency Management Agency (FEMA) Earthquake Program in the 1980s wrote and disseminated earthquake-related materials for the people [3]. They have also published issues on preparedness, protection, emergency response, reconstruction and risk reduction, examples are: The book “Are You Ready?”: First published in 2004, the book “Reducing Risk of Non-structural Earthquakes Damages” regarding the important points related to security of non-structural components,

Earthquake Safety Checklist which was published in 2005, in which required implementations to be done for preparation before and during an event, were listed with very simple language along with images, and the book "Earthquake Safety Activities" which is produced for teachers and students. Some other agencies which have publications on disaster preparedness in USA include United States Geological Survey (USGS), Association of Bay Area Governments (ABAG), Red Cross in USA, Semi-private centers, etc. There is a section on issues in "Earthquake Education" in the technical report prepared by the Multi-disciplinary Center for Earthquake Engineering Research (MCEER) [4], covering articles and case studies relating to earthquake education in general and particularly in school curriculum. In Japan, experience of devastating earthquakes such as Kanto 1923 Tokyo earthquake, have led the Japanese government to allocate budget on earthquake risk reduction. Many national and international organizations are active in this regard, such as Disaster Reduction and Human Renovation Institute (DRI), Fire and Disaster Management Agency (FDMA), Japan Meteorological Agency, municipalities and urban centers, etc. In Turkey, part of measures taken by Kandili Research Center, University of Bogazici of Turkey (2001-2003), and Civil Defence organization, etc are also remarkable for disaster risk reduction issues [5].

Additionally, in recent years, the "Community-Based Disaster Preparedness (CBDP)" and training has been declared to be one of the most effective ways for successful disaster awareness-raising in various communities [6]. The process of CBDP aims to make the community well aware of the risk they are living with. The public must possess the necessary know-how to deal with impending disasters and communities must have a well laid down plan of action/list of activities, which they should follow to prevent the repercussions of a disaster. In addition, each one in the community should become aware of his/her responsibilities in an emergency situation/disaster [7]. As for the public, disaster preparedness activities should be based on participatory approaches involving local communities as much as possible, considering them as proactive stakeholders and not passive targets for intervention. It is evident that involvement and participation of communities can ensure a collective and coordinated action during emergencies.

Iran is located in the Alpine-Himalayan seismic belt, known as one of the most active tectonic regions of the world. Throughout history, the country has frequently suffered large and destructive earthquakes with considerable damage and casualties. In Iran, several measures have been undertaken to improve the public knowledge on risk and disaster mitigation and management. A review on the activities of recent two decades, reveal the gradual improvement on the trends of earthquake preparedness. Therefore, in the next section, firstly Iran experience and organizations involved in earthquake preparedness are introduced, and then an evaluation of earthquake preparedness and public awareness and its trend in four major earthquakes of Iran, Manjil-Roudbar 1990, Changureh-Avaj 2002, Bam 2003 and Silakhore 2006 is addressed. At the end, having a look on the issues observed in recent earthquakes of Iran, some strategies towards the improvement of existing programs in developing countries regarding earthquake public education and awareness as well as earthquake professional training will be presented.

2. Iran Experience and Involved Organizations

As mentioned earlier, Iran is considered as one of the earthquake prone countries in the world. In average, every 10 years, an earthquake with a magnitude greater than 7 occurs in the country which claims thousands of lives and substantial damage. Therefore, special attention is required to promote specialized knowledge related to earthquakes in areas such as structural, geotechnical engineering, and disaster management along with public awareness and preparedness. In this regard and especially after the June 1990 Manjil-Rudbar earthquake, the government agencies and NGOs in Iran paid special attention to the community education and training on earthquakes.

On education and training, many organizations have been involved which have used various methods and media to familiarize different groups of people with disasters. One of these organizations is Disaster Management Organization formerly called as National Disaster Task Force, (NDTF) which has been established recently and therefore, its activities have been carried out mostly by task forces before. NDTF activities include follow-up and holding seminars and workshops related to emergency and disaster management for members of the task forces

in the provinces or other cities; holding drills for general public to responsible authorities (task force members); publication of posters, brochures and journals, leaflets and books to increase public knowledge and expanding knowledge on disaster management and promoting safety culture as well as conducting several research projects on community training. Iran's Ministry of Education is also involved in holding national drills of earthquake safety in all schools under the guidance of "Drill Permanent Council" based in the International Institute of Seismology and Earthquake Engineering (*IIEES*); designing educational materials on earthquakes and related topics in the school textbooks; organizing courses and special drills for student's, teachers and educational personnel as well as holding exhibitions and competitions on "Earthquake and Safety"; and finally teaching earthquake preparedness to kindergarten children.

One of the other involved organizations is Tehran Municipality which has established a separate body for disaster management in the city is called "Tehran Disaster Mitigation and Management Organization" (*TDMMO*). One of the duties of this organization is in connection with community training to reduce the effects of natural disasters including earthquakes. Some of *TDMMO* activities include holding disaster management drills and emergency evacuation drills in various districts of Tehran such as 2 and 17; preparation and distribution of books, brochures, posters, and *CD's* among people including earthquake preparedness book distributed to Tehran citizens; providing face to face training in schools, religious centers, neighborhood units and so on in the form of two hour seminars; and holding training seminars to prepare related staff, agencies and organizations.

The Islamic Republic of Iran Red Crescent Society (*RCS*) as one of other active organizations achieves part of its educational objectives in connection with the earthquake relief operations, including preparation of educational materials on earthquake preparedness in the form of books, brochures, posters, training films, organizing public courses on rescue and relief-aid; holding drills for earthquake preparedness and search and rescue in different classes; and organizing training courses for students.

The International Institute of Earthquake Engineering and Seismology (*IIEES*) under the

Ministry of Research, Science and Technology has a specialized group on earthquake public education. Some of *IIEES* educational programs include research on developing educational methods in earthquake public awareness; conducting national earthquake safety school drills with the cooperation of the Ministry of Education; holding competitions at local to national and even international levels; organizing courses utilizing materials and educational media; offering training services for teachers and other related staff; holding conferences, workshops and scientific lectures on earthquake issues; organizing special annual workshops for students; developing disaster related materials for school textbooks with the cooperation of Iran Ministry of Education; preparation and production of educational materials and tools for promoting public knowledge of different age levels, including books, brochures, movies, posters, website training, games, etc.

Also other related organizations such as universities, fire fighting departments and media undertake research and assist in promotion of earthquake risk awareness in Iran. In addition, the role of some of existing *NGOs* can not be denied. For example, one of the *NGOs* active in this field is "Population of Earthquake Hazard Reduction of Iran" (*Ehrsi*) which has got a website presenting educational materials to the public. This organization also holds workshops, seminars and training courses and provides related disaster information to the public.

3. Evaluation of Public Preparedness in Iran

Although several efforts have been carried out to improve public education and training as well as awareness about earthquake risk mitigation during the recent years, but their impacts have not been clearly and remarkably observable in the recent earthquakes in Iran. However, the trend of activities shows some improvements which will be discussed in four major recent earthquakes of Iran, respectively, as follows:

3.1. Manjil-Roudbar Earthquake

Manjil-Roudbar earthquake occurred thirty minutes after midnight of June 20, 1990 in Gilan province ($M_w = 7.3$) [8]. According to the official reports, the earthquake claimed about 15,000 lives and more than 30,000 people were injured. The earthquake also made more than 500 thousand

people homeless and affected three cities of Roudbar, Manjil and Loshan. Almost 700 villages were damaged in the populated areas of the country on northern and western parts of the Alborz Mountains.

Before the earthquake, due to the internal conditions of country imposed by the war of Iraq against Iran, less attention was paid to earthquake preparedness. Therefore, the level of preparedness was not acceptable in all groups of society, from ordinary people to relevant authorities. Before this event, it was thought that the governmental organizations and institutions have the main role in disaster management, but the experience of Manjil earthquake showed that due to different reasons including, disabilities in management processes at national and regional levels, long distance to reach the affected sites, geographical situation, etc., this was not the case. It was also observed that the residents were among the first groups who provided the necessary assistance to the victims immediately after the disaster, while most of them were not familiar with first aid and emergency response. This showed the necessity for capacity building in the community levels for mitigation and response to the earthquake which could be mostly achieved by public education and awareness. In this line, in most of the laws and policies approved after that event, it was mentioned that the residents should know how to mitigate the impacts of a disaster and in case of an earthquake how to assist in rescue and relief and other emergency response activities. Thus, the relevant issues in earthquake risk preparedness in Manjil-Roudbar earthquake for the public can be classified into three categories as follows:

- ❖ Training people to promote public awareness for reducing risk and implementing preventive measures: Lack of training activities for residents may increase people's vulnerability. Unfortunately before the Manjil earthquake, no considerable efforts were carried out in this line in the affected areas for reducing the risk of earthquake as well as to make resistant buildings;
- ❖ Education of self-relief measures: After the Manjil earthquake, people in the region tried to help their family members or neighbors. Although these measures were important until the relief forces reached the area, but due to the lack of awareness on how to carry on these activities, people could not operate effectively. This caused

further injuries for the victims trapped under the debris in some areas. Moreover, since people were not familiar with the methods on how to perform first aid, such as ventilation or how to stop the bleeding, some lives have been lost at these stages;

- ❖ Training on how to participate in the process of reconstruction and emergency housing: Learning how to deal with emergency conditions need preparedness. Unfortunately, not many had the experience in the mentioned affected areas. Therefore, people were not aware about the prerequisites of living in these conditions and therefore, their behavior and interactions were not quite predictable.

Besides public awareness, the level of professional expertise is also important while reviewing preparedness in a society. This type of training is mainly important for workers in construction fields and those responsible in disaster management activities. Although at the time of earthquake, various institutions, such as universities, technical and professional organizations, technical schools, etc., were active in the country, no substantial efforts were implemented for promoting job skills in various areas related to risk management. In fact, the number of experienced engineers and technical staff were not sufficient especially in the field of construction. Thus, except for major urban areas, such as the cities of Rasht, Manjil and Roudbar, no considerable trained workers could be observed in the main affected areas. Therefore, this event showed the importance of developing training centers for local workers as well as university courses for promotion of the related education. Moreover, before the Manjil earthquake, only limited training short courses related to disaster management were organized in Iran. Thus, the level of employee's knowledge in disaster management was not good enough. This earthquake therefore, depicted the need for promotion of knowledge and awareness in these fields.

In general, the Manjil earthquake revealed the importance of promoting preparedness for risk reduction and improving disaster management according to the following reasons:

- ❖ Before the earthquake, the promotion of public awareness and education on earthquake risk reduction methods was not considered seriously by related authorities. This earthquake showed the

importance of these subjects. Several initiatives for promoting public knowledge and awareness were designed in the aftermath of the earthquake through using the capacities of related organizations, such as the media (i.e. *IRIB*);

- ❖ Buildings with the minimum required standards could resist well against this event. The residents noticed good performances of these buildings, and therefore tried to improve the construction quality considering the required standards in reconstruction stage;
- ❖ Damage to some residential units constructed on mountains showed the importance of site selection to make the construction safe against landslides and rockfalls. In fact, if such information could be provided before the event, it could be expected that less damage and casualties can happen as a result;
- ❖ Delay of relief and rescue forces caused these tasks to be implemented by the residents themselves. However, people's lack of knowledge about these activities caused some extra problems in saving survivors' lives in many aspects. Therefore, the importance of providing necessary training in emergency response in such conditions was revealed in this event;
- ❖ Lack of knowledge of the authorities and professionals on earthquake safety caused the construction of vulnerable buildings in some areas. This event revealed the importance of improving technical knowledge of different groups from workers to authorities in safe construction.

3.2. *Changureh-Avaj Earthquake*

After the Manjil earthquake, the urgent need for promoting the preparedness of people and officials for confronting the earthquake impacts were considered more seriously by relevant organizations, especially in issues such as training and capacity buildings. Of course, unfamiliarity with the issue of enhancing preparedness persuaded the officials to consider essential activities. Moreover, problems related to improve issues such as empowerment of staff and preparing necessary tools caused activities to be less effective, due to various reasons including the heavy cost of facilities, shortages of expertise, etc. Thus, in practice, limited actions were carried out before Avaj earthquake for enhancing

preparedness and the implemented activities were not efficient enough to improve risk reduction and emergency response. In such situation, the Changureh-Avaj earthquake occurred with magnitude of 6.4 at 07:28 (02:58 *GMT*) in July 22nd, 2002 in a region with high population distribution at 35.731*N* and 49.026*E*, located in Qazvin province, northwest of Iran [9]. Although the earthquake occurred in a region of low population density, it has led to widespread failure of thousands of housing units, killed 261 people, injured more than 1300 and destroyed hundreds of villages [10].

Considering the above-mentioned, the main issues on public awareness and education in this event can be classified as follows:

- A) Public awareness: The level of public awareness among the residents of the affected areas in Avaj earthquake was not satisfactory in many aspects based on research carried on [5] such as:
- ❖ Awareness about the significance of mitigation measures: The importance of reducing risk and implementing preventive measures and safe construction against earthquakes was highlighted after Manjil earthquake. Some activities for promoting public knowledge about living in safe buildings were also carried out by media and other related authorities. However, due to the lack of a proper information dissemination plan, only few people living in the region were aware about the importance of earthquake risk reduction and safe construction. It should be mentioned that the residents were sensitive to earthquakes due to experiencing large earthquakes (such as Boein-Zahra (1962) and Manjil-Roudbar (1990)), but this opportunity was not used for promoting safe construction in those areas seriously before this event. One reason for this could be the lack of necessary training of those responsible as well as the workers on how to construct safe buildings. Other reasons could be related to residents' financial problems as well as lack of necessary supporting measures [11];
 - ❖ Public awareness and education about self-relief and fellow-relief: Considering the extent of damaged areas in provinces of Qazvin, Hamedan and Zanjan, it was not possible to dispatch necessary number of rescue and relief teams to all affected villages.

Therefore, the first groups which started rescue activities were neighbors and the residents in the area. However, due to the lack of proper knowledge, experience and training regarding first aid and self-rescue activities, people could not act correctly and efficiently;

- ❖ Public awareness for understanding the earthquake hazard: In this part, relatively proper information was distributed among the residents through the media and textbooks of school students. A variety of educational materials that were prepared gradually after the Manjil earthquake, somehow were reflected in different school textbooks by the Ministry of Education; samples are shown in Figure (1).

Moreover, the “Earthquake and Safety” drills

started first in 1996 in Tehran and later implemented in all schools of the country from 1999 with partnership of *IIEES*, Ministry of Education, and Ministry of Interior as well as many other related organizations and have continued annually since then, see Figure (2). These drills had good effects on enhancing public preparedness at the time of the earthquake. Site visits and interviews conducted after the Avaj earthquake showed that fortunately, some students used their knowledge gained in such drills to protect themselves at the time of earthquake. Table (1) presents the number of schools and students participating in such drills before Avaj earthquake [12].

The most important objectives of holding such drills was to increase student’s awareness about earthquakes, creating preparation about accurate and on-time reactions in earthquakes, improving safety



Figure 1. Samples of school textbooks with sections on earthquakes.



Figure 2. “Earthquake and Safety” drills in schools.

Table 1. Drills on “Earthquake and Safety” carried out since 1996 until the Avaj earthquake.

	Year	Number of Schools	Number of Boys	Number of Girls	School level	Place
First Pilot Drill	1996	5	600	400	High School	Tehran
Second Pilot Drill	1997	3	-	-	High School	Tehran
Tehran Drill	1998	1059	266890	260480	High School	Tehran
The First Overall Drill	1999	15499	2,324,907	2,255,781	High School	All Over the Country
The Second Overall Drill	2000	45000	5,776,000	5,224,000	Secondary & High School	All Over the Country
The Third Overall Drill	2001	48000	6,176,000	5,624,000	Secondary & High School	All Over the Country

culture as well as making students familiar with natural disasters and how to deal with earthquakes. In addition to schools, since 2001 till present, *IIEES* with cooperation of the Welfare Organization have conducted a series of earthquake and safety drills in kindergartens of Tehran, see Figure (3).

B) Professional training: Besides the activities carried out for promoting public awareness on earthquakes, some professional training were also conducted by relevant organizations such as:

- ❖ General annual training courses of *RCS* on emergency response, first aid and self-assistance have been organized in different places, mostly in big cities. However, it should be mentioned that there were no standardized curriculum or educational toolbox available at that time. Volunteers were welcomed to participate in these courses in order to get familiar with hazards and safety issues in disaster management. However, it is not much clear what percent of residents in the Avaj earthquake affected areas have participated in such courses and in what extend these courses have been useful to them.
- ❖ Several public workshops on disaster manage-

ment were held by the International Institute of Earthquake Engineering and Seismology since 1993. Other centers such as Natural Disasters Research Institute (*NDRI*) and *RCS* had organized and held similar activities. In such workshops, different information about earthquakes and preparedness and what should be done before, during and after were taught to the participants through implementing various methods and tools;

- ❖ Specialized training courses were conducted by *IIEES* and *NDRI* including seismotectonic, static and dynamic analysis of buildings, earthquake engineering, retrofitting of existing buildings, improvements of non-structural components, risk management, operational emergency management, natural disasters, disaster preparedness, hazardous materials management, etc;

Although several specialized courses were organized before this earthquake, but the gained outcome was not completely satisfactory due to the following reasons:

- ❖ Training in all cities and villages was not possible due to the limitation of experts and lack of proper



Figure 3. “Earthquake and Safety” drills in kindergartens.

planning;

- ❖ Most trained engineers and technical staff were involved in major cities and there were no interest in them to work in rural areas and small towns;
- ❖ Construction of traditional buildings in villages was usually carried out by the local people and it was not easy to train them about the importance of improving the quality of construction;
- ❖ Graduate courses on earthquake engineering and seismology were growing in the country, but were not quite applicable for improving the existing conditions, due to different socio-economic and cultural conditions.

In addition to what was noted, the most important lessons of Changureh-Avaj earthquake for promoting the awareness and preparedness can be summarized in the following:

- ❖ Despite lessons learned from previous earthquakes, it seems that the necessary knowledge in the field of disaster management were not institutionalized for the related authorities before this event;
- ❖ Lack of specialized and trained staff active in the construction industry, especially in the rural areas was one of the main parameters for increasing vulnerability of the buildings. This shows the importance of training the local workers;
- ❖ Most of the residents were unfamiliar with the dangers of construction in the vicinity of geological hazards such as slopes and faults. Therefore, public awareness on these issues could led them to stop construction in such areas;
- ❖ Most residents were not aware about the methods of self-rescue and relief. It therefore showed the necessity of expanding training in these operations for the public at the local level;
- ❖ General knowledge of risk management and preparedness among the residents of the affected area has very little influence in saving their lives, since only a few percentages of students used such knowledge. This shows the urgent necessity of using the applied knowledge;
- ❖ The effectiveness of Iran's radio and TV (national and provincial) for promoting safety culture against earthquakes was very limited due to the lack of planning and sustainability;
- ❖ In spite of the scientific development, the research implemented in related fields of earthquake engineering and seismology at the universities did not lead to risk reduction, because they were mostly theoretical and were not conducted with regard to the local conditions.

3.3. Bam Earthquake

The 2003 Bam earthquake with a magnitude of 6.6 occurred at 5:26 local time (1:56 GMT) on December 26th, near Bam city and its surrounding villages in Kerman province, southeastern of Iran. The earthquake destroyed around 85 percent of Bam and Baravat cities and neighboring villages with a total population of approximately 143,000 people [13]. It also claimed 33,000 lives, about 10,000 injured and more than 75,000 homeless.

The awareness of the residents in the affected areas about earthquake risk and methods to deal with can be evaluated in three parts:

- ❖ Public awareness of earthquake hazards and risk reduction methods: Less people and authorities in Bam could believe that such destructive event can happen in the area, due to the existence of the Bam historical citadel being intact for many years as well as the lack of sufficient knowledge about seismicity of the area. This shows the high importance of information dissemination and awareness on earthquake risk among the local residents and authorities;
- ❖ Education of self-relief measures and fellow-relief: The first groups who started the rescue and relief activities were the ordinary residents of Bam, including families and neighbors, whom did not have previous training about search and rescue activities and therefore, their activities sometimes caused extra injuries to victims who were trapped under the debris. The most important problems that were observed due to improper activities of self-rescuers were spinal cord injury, lack of attention to broken bones, lack of information about how to stop the bleeding, etc. These problems mostly happened due to lack of people's training in relief and aid activities [14].
- ❖ Awareness about participation in activities after the earthquake: Unfortunately one of the issues after the Bam earthquake was lack of public participation in the region, especially those who had knowledge on the response and reconstruction issues. This was observed in the area, as there were no plans in advance to increase the awareness of residents about their specified role

in accelerating rehabilitation.

Description above show that measures carried out for promoting public awareness after previous devastating earthquakes such as Manjil and Avaj were not efficient enough for improving preparedness in different aspects. Moreover, it should be mentioned that holding local activities such as school safety drills had some minor effects in these lines, see Table (2).

Professional training conducted after Avaj earthquake was not satisfactory as well. Before Bam earthquake, some specialized courses for improving construction quality have been organized by different scientific and executive centers including Building and Housing Research Center (BHRC), IIEES, NDRI, related universities, technical and professional organizations, etc. [15]. Of course the effectiveness of these courses was limited in risk reduction and disaster management in Bam due to following reasons:

- ❖ Shortages of specialized training courses for all people working in the construction field due to capacity limitations of training centers;
- ❖ Organizing few specialized training courses in small cities such as Bam;
- ❖ Lack of professional competence control of the people working in construction fields by institutions such as the municipalities or the Iran Construction Engineering Organization;
- ❖ Unwillingness of most people working in construction (engineers and technical workers) to participate in such courses due to different reasons;
- ❖ Lack of coherent and standard programs to provide specialized training.

Except for specialized courses related to construction, some other training courses on disaster management and emergency response were also held before the occurrence of Bam earthquake by non-governmental and government organizations, such as RCS, NDRI, etc. Unfortunately, the effectiveness of such courses was also limited and most

of the disaster management task force personnel did not have the necessary knowledge about their tasks at the time of this event. Thus, the main lessons learned by Bam earthquake in the field of preparedness can be summarized in the following issues:

- ❖ Lack of a comprehensive plan for disaster prevention and management in the area: Developing and implementing such a plan could reduce the damage and casualties caused by this event and improve emergency response and reconstruction operations;
- ❖ Weak and improper coordination in disaster management activities among the relevant organizations: The emergency managers did not use the past experiences to promote earthquake preparedness due to the lack of enough documentation, quick change in management, etc;
- ❖ Lack of integrated, pre-designed and coordinated programs for implementing different tasks during the golden hours after the earthquake: This caused delay in starting activities and created further loss of life;
- ❖ Unclear commander-in-chief for conducting response operations: Different organizations worked in parallel without proper planning and duplication of responsibilities, as there were no unified and practiced systems of coordination. Also, some officials of the provincial headquarters conducted their activities based on their own individual decisions which could cause chaos and confusion for the survivors;
- ❖ Weakness in coordination between on-site managers and regional ones: The lack of emergency communication system and relevant protocols was obvious in the affected areas and caused some difficulties for implementing the correct and appropriate activities;
- ❖ Lack of proper and clear definition on interaction between organizations: Weak planning and management in terms of allocating responsibilities and tasks, designating personnel and equipment resulted in improper use of the armed forces,

Table 2. Conducted "Earthquake and Safety" drills in schools after Avaj earthquake till Bam earthquake.

	Year	Number of Schools	Number of Boys	Number of Girls	School Level	Place
The 4 th Earthquake and Safety Drill	2002	50000	6,500,000	5,500,000	Secondary and High Schools	All Over the Country
The 5 th Earthquake and Safety Drill	2003	110,000	8,297,000	7,730,000	All Grades	All Over the Country

- specialized teams, volunteers and *NGOs*;
- ❖ Improper mobilization of local residents in emergency response: Despite the proven key role of the residents in reducing the risk of major disasters, no activities were conducted to use these capabilities by the time of this event. As a result and as mentioned earlier, some of the conducted self-rescue activities caused extra injuries for the victims;
 - ❖ Weaknesses in media public awareness programs: The media role in promoting public awareness is important, but before this event, their programs were mostly related to announcing news of the natural disasters;
 - ❖ Lack of information on seismicity of the area: Most people and even officials did not expect such destructive event in the area and therefore, they had not arranged proper plans for improving seismic safety in the region.

3.4. *Darb-e-Astaneh-Silakhor Earthquake*

After the Bam earthquake, further activities were carried out to improve the public preparedness against earthquakes and mobilization of community residents and officials to face the effects of such events. Moreover, specialized courses for improving risk management in the country have been planned and organized. However, only considerable improvement could be observed in terms of public awareness up to the *Darb-e-Astaneh-Silakhor* earthquake. This event occurred on 31/3/2006 at 4:47:02 local time (1:17:02 *GMT*) with magnitude of $ML = 6.1$ within Southeast of Borujerd in Southwest of Iran, after the occurrence of several relatively strong foreshocks. Depth of the earthquake was about 14 km and the intensity at the epicenter is estimated equivalent to *VIII* (in Modified Mercalli Intensity Scale) [16]. According to the official reports, the

earthquake had 63 fatalities and 1418 injuries. Moreover, 330 villages were damaged in *Silakhor* plain.

The most important reasons of better public awareness in this event are:

- ❖ Most residents experienced some tremors during their lives and they were mostly sensitive and aware about the seismicity of their living places;
- ❖ After the Bam earthquake, actions by various cultural, social and technical institutions were done in order to promote awareness of earthquake risk. These initiatives such as television programs (national and regional), media and press reports, actions by local *NGOs* and organizations such as *RCS* as well as extracurricular programs had considerable effects on promoting public awareness of earthquake risk;
- ❖ Holding drills for earthquake preparedness in schools had also considerable effects to promote earthquake public awareness. Table (3) shows earthquake and safety drills in schools after Bam earthquake up to 2007.

It seems that due to the above-mentioned reasons, people were more sensitive in *Darb-e-Astaneh-Silakhor* earthquake and that is why they left their houses and could save their lives after feeling foreshocks just before the main earthquake did occur.

Although it appears that public awareness in this region was desirable in comparison to other parts of the country, but in other aspects of preparation such as precautions for self-relief and fellow-relief, improvement of construction quality, etc., still the situation was not very acceptable. In fact, only small number of people (mostly in Borujerd and Doroud cities) had passed training courses on rescue and relief. Due to the unfamiliarity of people in villages, problems were created for those trapped

Table 3. List of school drills carried out after the Bam earthquake up to 2007*.

	Year	Number of Schools	Number of Boys	Number of Girls	School Level	Place
Special Drill in Commemoration of the 40 th Day of Bam Earthquake	2004	110,000	8,300,000	7,700,000	All Grades	Nationwide
The 6 th National Earthquake and Safety Drill	2004	120,000	8,100,000	7,600,000	All Grades	Nationwide
The 7 th National Earthquake and Safety Drill	2005	110,000	7,872,610	7,391,739	All Grades	Nationwide
The 8 th National Earthquake and Safety Drill	2006	110,000	7,392,176	6,939,726	All Grades	Nationwide
The 9 th National Earthquake and Safety Drill	2007	146,213	6,364,991	7,443,162	All Grades	Nationwide

* For more update, refer to www.iiees.ac.ir website.

under debris, especially people suffering fractures or bleeding [17]. In addition, most people knew little about the importance of earthquake resistant construction. This issue shows that planning for public awareness should not be limited only to promote preparedness and response and can be extended for improving earthquake resistant construction as well. Regarding the professional skills among the relevant bodies, the following items can be mentioned:

- ❖ Academic and training courses were initiated on topics related to earthquake and other natural hazards as well as risk reduction methods, such as courses in Master and Phd. levels in earthquake engineering, disaster management, reconstruction and many other related fields;
- ❖ Training courses for professional engineers and other staff involved in construction or disaster management were developed. Some of these courses include improvement of resistance of building, disaster management, urban planning, etc. which were organized by professional organizations such as *IIEES*, *BHRC*, Institute of Applied Science, *RCS*, and other related centers;
- ❖ Training courses for technical people working in the construction industry were developed by various organizations such as technical training and professional organizations, department of labor and other related organizations;
- ❖ Several seminars and specialized workshops on various topics related to risks and disaster management were held by private and public sectors;
- ❖ Training courses on first aid, rescue and relief, and earthquake drills were organized by *RCS* in different provinces.

Despite these activities, the professional knowledge of workers and disaster management staff in the region was limited due to the reasons such as: lack of appropriate use of specialized workers; educational limitations; occupation of workers without checking their licenses and skills; lack of coherent programs to provide training and professional standards; insufficient specialized courses in small cities; lack of proper specialized courses for construction workers in rural areas; limited usage of academic research; and lack of attention to scientific research by executive officials.

Based on these issues, the most important lessons of Darb-e-Astaneh-Silakhore earthquake in preparedness aspects can be listed as follows:

- ❖ Although it appears that the public information in this region was more desirable relative to other parts of the country, still the status was not acceptable in issues such as reactions for self-relief and fellow-relief as well as improvement of construction. In fact, only few number of people, mostly in Borujerd and Doroud cities, had passed training in courses for self-relief and rescue [18];
- ❖ Preparation of disaster management institutions and regional authorities for confronting big seismic events was relatively limited. Items and equipment needed in the region for conducting emergency response were not sufficient and there were no command center in the region;
- ❖ Regarding technical training, the situation was not acceptable. Most people employed for construction, especially in rural areas or people working in risk management and crisis task forces, suffered from lack of enough information for carrying out specialized tasks properly.

4. Challenges and Consequences

The challenges and results of Manjil-Roudbar, Changureh-Avaj, Bam and Darb-e-Astaneh-Silakhore earthquakes in the field of earthquake preparedness are stated in Table (4).

5. Recommended Strategies Towards Promoting Public Awareness and Education and Professional Training

Considering the existing global experiences and based on lessons learned from the recent earthquakes in Iran in the field of public awareness and professional training, the following strategies can be proposed for promoting the present conditions in Iran and most of the similar developing countries.

5.1. Promoting Public Awareness and Education

Some of the issues that can be considered in promoting public awareness are as follows:

- ❖ A comprehensive plan should be prepared to address the necessary activities for promoting public awareness among different groups of people from ordinary residents to all related stakeholders. This plan should be developed somehow to answer three fundamental questions of: What, to whom, and how education should be? “What should be taught”, determines the exact

Table 4. Challenges and effects of four major earthquakes in the field of earthquake preparedness.

Earthquake	Issues	Challenges	Consequences
Manjil-Roudbar	Preparedness to Confront with the Effects of Large Scale Disasters	<ul style="list-style-type: none"> - Lack of sufficient infrastructures for DM - Lack of initial action plans - Lack of sufficient equipment, tools and materials 	<ul style="list-style-type: none"> - Implementation of tasks by establishment of local taskforce - Shortages of information - Difficulties in coordination - Inadequate response
	Public Education and Awareness	<ul style="list-style-type: none"> - Lack of public awareness about the earthquake risk and mitigation methods - Lack of awareness on self-rescue - Lack of awareness about living in chaotic situation 	<ul style="list-style-type: none"> - No serious effort for making safe structures - Improper activities during and after the earthquake - Lack of ability to assist others properly
	Professional Training	<ul style="list-style-type: none"> - Lack of skilled workers - Insufficient training courses related to DM - Insufficient knowledge of DM managers 	<ul style="list-style-type: none"> - Construction of vulnerable structures - Improper knowledge of new DM system - Impossibility of making proper plans for risk reduction
Changureh-Avaj	Preparedness to Confront with the Effects of Large Scale Disasters	<ul style="list-style-type: none"> - Lack of suitable commanding regarding the response activities - Lack of a local and provincial command center with the necessary facilities - Coordination difficulties in relief activities due to the vastness of damaged areas and lack of data - Lack of preparedness of the responsible organizations - Lack of needed equipment and tools 	<ul style="list-style-type: none"> - Importance of preparing a response plan in the country - Importance of building safe command centers with necessary facilities
	Public Education and Awareness	<ul style="list-style-type: none"> - Lack of public knowledge from earthquake risk - Low impacts of national and provincial radio and TV to raise awareness against earthquakes - Residents' lack of knowledge about self rescue and relief 	<ul style="list-style-type: none"> - Importance of promotion of public education according to social and economical condition - Importance of spreading earthquake safety culture - Importance of public exercises and drills - Necessity of media cooperation in information dissemination and education
	Professional training	<ul style="list-style-type: none"> - Lack of specialist forces for safe constructions - Limited specialist training workshops in the small towns and villages - Lack of knowledge among the local people in charge of disaster management and risk reduction 	<ul style="list-style-type: none"> - Importance of educating all construction agents - Importance of holding different courses in the field of risk and disaster management - Importance of updating data and knowledge of managers in the related fields
Bam	Preparedness to Confront with the Effects of Large Scale Disasters	<ul style="list-style-type: none"> - Lack of having a comprehensive plan of prevention and disaster management in all levels - Weakness in coordinating and programming for disaster management at local level - Lack of having regular, well-organized, pre-planned and practiced programs in some fields - Weakness of coordination and operation command in response to the disaster - Unfamiliarity of some of the headquarters with regional condition - Weakness in communication between local and dispatched managers - Weakness in inter-organizational relations in the region - Having parallel performance instead of joint activities - Lack of having equipped command room for disaster management in local to national levels - Lack of enough preparedness of rescue centers and staffs in the region to encounter huge disasters 	<ul style="list-style-type: none"> - Necessity of paying attention to prevention and preparedness issues as well as emergency response and reconstruction - Necessity of establishing local and regional disaster command centers - Necessity of developing required databanks of construction situation and population distribution - Necessity of establishing clarified codes and instructions for different organizations involved in disaster and their regular drills - Necessity of applying specialized managers in disaster management at local level
	Public Education and Awareness	<ul style="list-style-type: none"> - Lack of paying enough attention to safe construction against the earthquake - Lack of considerable implementations by affiliated organizations in order to improve people's preparedness to face earthquakes - Limited activity of media in disaster management for publishing reports - Lack of people's awareness about the possibility of earthquake occurrence in the city - Lack of people's awareness of search and rescue and relief methods 	<ul style="list-style-type: none"> - Necessity of informing people of the importance of improving buildings - Necessity of activating media in improving safety culture - Necessity of proper informing of earthquake hazard and preparedness approaches - Necessity of presenting self- and fellow-rescue to different people
	Professional Training	<ul style="list-style-type: none"> - Lack of skillful human resources for safe construction - Limited local capabilities for organizing related specialized training courses - Weakness in knowledge and skills of local authorities regarding risk mitigation and disaster management 	<ul style="list-style-type: none"> - Necessity of developing practical training courses - Necessity of optimum use of provincial and intra-provincial capabilities in providing specialized educations for different levels of the public

Table 4. Continued...

Earthquake	Issues	Challenges	Consequences
Darb-e- Astaneh-Silakhoore	Preparedness to Confront with the Effects of Large Scale Disasters	<ul style="list-style-type: none"> - Lack of Emergency Operations Centers (EOC) - Improper coordination between organizations and affiliated institutions - Absence of emergency operation systems - Absence of operation plans specifically prepared for the initial hours - Incapability of preparing and dispatching rescue forces to the region - Lack of needed information regarding the region's conditions - Lack of awareness of dispatched forces on region's situation - Lack of sufficient facilities and necessary equipment - Lack of cooperation between people and the authorities 	<ul style="list-style-type: none"> - Necessity for implementing the relief and rescue master plan in various dimensions - Necessity for creating emergency operation centers at local and provincial levels - Necessity for improving coordination and drills between relevant systems - Necessity for implementing disaster operation systems - Necessity for creating capacities and improving aid and facilities at local level - Importance of using regional aid for guiding operations and planning - Necessity for optimum usage of local residents for carrying out related affairs
	Public Education and Awareness	<ul style="list-style-type: none"> - Lack of considerable implementation by affiliated organizations in order to improve people's preparedness - Limited activity of media in disaster management - Lack of people's awareness about possibility of earthquake occurrence in the city - Lack of people's awareness of search and rescue and relief 	<ul style="list-style-type: none"> - Necessity for multilateral planning in order to improve awareness - Necessity for presenting self-relief & fellow-relief training to people through media or local centers - Necessity for disseminating information about the importance of living in safe places
	Professional Training	<ul style="list-style-type: none"> - Limitation on using skilled labors - Limitations on holding training courses especially in villages and small towns - Problems faced in retraining the employees - Weakness in planning and implementing training courses - Lack of practical work in university researches - Lack of attention of local authorities for human resource development 	<ul style="list-style-type: none"> - Necessity for planning and using technical courses in various levels across the country and motivating participation - Prohibiting the use of unspecialized staff in construction - Necessity for providing plan and timing schedule for participation in technical courses - Necessity for using all local and provincial facilities to develop training

materials that must be transferred to the target audience. "Who should be taught?" determines the audience or the target groups to be educated. And finally, "How the education should be?" depicts the educational channels and ways to approach it;

- ❖ The activities of different institutions in the field of public education and information dissemination should be coordinated and harmonized. The roles of media as well as the local community centers, such as mosques in Moslem countries, should be highlighted into such a comprehensive plan. Considering the differences between target groups, the materials should be different for each group. Topics should be presented in a way to be understandable for target groups. Moreover, proper channels for providing these materials should be selected from the existing alternatives, including written materials, photos and files, movies (short and long), animation, teasers, trailers, etc. Also, the media for providing these materials should be chosen from radio and television, newspapers, posters, brochures, internet, etc.;

- ❖ The activities necessary for promoting preparedness should not be concentrated in special time frames. However, in most of the developing countries, these activities are planned to be implemented in a specific time which have less effectiveness. In fact, the sustainability of the training programs is one of the important measures that can assure their effectiveness;
- ❖ The proper methods as well as means of training for providing different types of education and promoting culture of safety against earthquakes should be adopted based on the socio-economical and cultural situation of the local communities to cover most of the population at risk;
- ❖ Organizing regular drills and practices for different target groups have important impacts on enhancing preparedness to confront potential earthquakes. In addition, earthquake museums and national parks can play important roles in promoting knowledge and awareness on earthquake and mitigation measures among the residents;
- ❖ The necessary training for local residents should

not be limited to explaining the ways of sheltering or emergency response, as normally can be observed in developing countries. This training should cover the subjects related to risk mitigation and reduction as well.

5.2. Promoting Professional Training

In regard to promoting the professional training, the followings can be mentioned:

- ❖ Improving the skills of workers in construction has important impacts on earthquake risk reduction. Thus, necessary training courses should be implemented for local workers in urban and rural areas;
- ❖ Controlling the skill of these workers by municipal governments or local authorities may encourage them to participate in training courses and improve their skills on construction. In addition, by controlling the work license of the workers, it would be possible to reduce the vulnerability of new constructed buildings;
- ❖ Regular training for disaster management staff will improve their capacities in using the advanced knowledge and technologies in implementation;
- ❖ The proper criteria to control the skill and knowledge of those working in the related fields of risk reduction and management should be prepared and applied;
- ❖ Media has important role to promote the culture of safety in construction;
- ❖ Documentation on the impacts of previous events can play an important role in risk reduction, if used by relevant authorities.

6. Conclusion

This paper attempted to look at the role of disaster-related education and training in developing countries such as Iran. Four major earthquakes in Iran were investigated. Based on the global experiences and lessons learned from these earthquakes, recommended strategies towards promoting public awareness and professional training are addressed for expansion of disaster education towards sustainable development. A comprehensive plan needs to be prepared to address the necessary activities for promoting public awareness among different groups of people from ordinary residents to all related stakeholders. Also, the activities of different institutions in the field of public education and information

dissemination have to be coordinated and harmonized and should not be concentrated in special time frames. Proper methods as well as means of training for providing different types of education and promoting culture of safety against earthquakes should be adopted based on the socio-economic and cultural situation of the local communities. Regular drills and practices for different target groups have important impacts on enhancing preparedness to confront potential earthquakes. Last but not the least, necessary training for local residents and professionals should cover the subjects related to risk mitigation with the hope to result in disaster risk reduction in the country as well as similar developing countries.

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