

Strategic planning in order to reduce earthquake hazards (Case Study: Darreh Shahr County)Alireza Darban Astaneh¹, Mansour Jafarbeiglou², Ebrahim Moghimi³, Zainab Valizadeh⁴¹Department of geography, Assistant Professor of Geography and Rural Planning, Tehran University, Iran²Department of Physical Geography, Associate Professor, Tehran University, Iran³Department of Physical Geography, Professor, Tehran University, Iran⁴ a graduate student in Geography and Environmental Hazards, Tehran University, Iranz.valizadeh1@gmail.com

Abstract: Earthquake is of natural disasters and hazards which has immense destruction power in a very short time and in a very vast area that leads to a severe damage on the ground and structures that these damages cause casualties. In addition to direct damage, secondary damage such as fire and outbreaks and other losses such as damage to the economy, society and politics; are of the effects of the earthquake. Therefore, the strategic planning in order to reduce the earthquake hazards is of great importance. In this context, the present study was conducted with the aim of strategic planning to reduce the damage caused by the earthquake in Darreh Shahr City in Ilam Province. This study has been an applied research which its research method is descriptive- analytic. The research population included 15 individuals (experts) working in Darreh Shahr Municipality who were selected through the Snowball method and were questioned and in the following, regarding the comments received from the statistical population (experts), was conducted the strategic planning (SWOT) and finally were provided some policies through the SWOT model.

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Introduction and problem statement

Earthquake is the sudden release of large amount of energy at a too short time which occurs due to disturbance in the earth's crust. Earthquake may release the (tens, hundreds, or thousands of years) blocked energy in a few seconds (Gibson, 1997, 356). The earthquake in human settlements causes huge losses in terms of lives and property of human that destroys the results of long term investments and also endangers the country's development and progress. Such consequences occur due to the existence of vulnerabilities in various aspects of human life which assessing and identifying them help the crisis management in reducing the damage caused by the earthquake. Due to its geographical location, Iran is of disaster-prone countries in the world that earthquake is one of most important disasters (Bahraini, 2006, 104).

However, in the past decades with the development of human knowledge, scientists have scientifically discovered how this phenomenon occurs and examined the occurrence and consequences of it, but mankind is still unable to prevent and resist in face with such natural events, in many cases, does not have adequate knowledge to accurately and scientifically predict in terms of occurrence and the power of these events and only after the occurrence of such disasters, analyze them by using scientific methods (Ghanavati et al., 2009, 17). According to the International Institute of Seismology and Earthquake

Engineering, Darreh Shahr is among the cities that have a high relative risk of earthquakes. The study area is located in the Zagros Folded Zone and in its southwestern part, this region includes relatively high mountains with a general trend of North West - South East which tectonically this feature is located at the driven folded Zagros belt and on the South-East terminus of Ravari anticline and on its northern edge.

Darreh Shahr as a gathering place for the human population is not excluded from the occurrence of such natural disasters and it is necessary to take serious actions to relieve the vulnerability of these settlements against natural disasters, that's why today urban needs and demand for housing in urban and rural -urban migration have led to its growth and development in recent decades, in this regard, the present study has been conducted with the aim of identifying strategies to reduce damage caused by the earthquake in Darreh Shahr City (Ilam Province), therefore, in this context, are faced with these main questions:

What are the strategies to reduce the human hazards?

Theoretical literature

Earthquakes as a natural phenomenon becomes hazardous and creates crisis when the society is vulnerable to it and don't have the readiness to face with it (Farajzadeh Asl et al., 2010, 20). In fact, the 21st century began with a lot of earthquakes which

among its salient results, can be mentioned large economic losses and social distresses (Zhang et al, 2013, 2). In other words, the earthquake is sudden and quick movements and vibrations in the ground which are originated from a limited area and then spread in all directions (Omidvar, 2011, 17) in general, the earthquake word covers any vibration and earthquakes are often caused by breakage and movement of faults, similarly, volcanic activities, falling mountains, mine explosion and the nuclear tests which are the starting point of seismic gap or center (Savadkuhi Far, 2007, 232). Earthquake is known as the most destructive unexpected natural disaster which happens regardless location and time, but has sudden impact and occurs completely random and without any warning which may occur at any time of year and any time of the day (Basij Medical Society, 2006, 8). In fact, earthquake occurs when a great mass moves near the fault and this quake is known as a stage in the long term and referred to the period of active faults (Doglioni et al, 2011, 266). Since during the earthquake, the vertical component fall into the faults' smaller trays, so the normal fault is dominated by the gravitational potential (Doglioni et al, 2011, Dempsey et al, 2012).

In the midst, Iran because of locating in the Alps-Himalaya earthquake belt, has been one of permanent victims of the frequent earthquakes (doosti, 1992, 37), so that among natural disasters, the earthquake is the most common cause of death in Iran (Hosseini, 2008, 62).

Natural hazards

Hazard literally means falling in risk, "Mokhatereh": Risks (this is not singular), what is presented in terms of the definition of hazards, has been named more based on the two main axes of natural hazards, including: earthquake and floods with internal origin and storms, drought, hail, lightning, dust, cold, frost and ice, air pollution, fire and acid precipitation... and with external origin and human hazards including hard wars, disease, crime and population growth (Karimi and Ahmadi, 2013, 84).

Fault

Fault is a discontinuous surface that separates two sets of stone, it is the result of rupture and movement, in which the first two stone sets attached together get separated and then two parts slip and get away from each other; this causes earthquakes in various areas, including the cities (Moghaddam, 2002, 24).

The study area

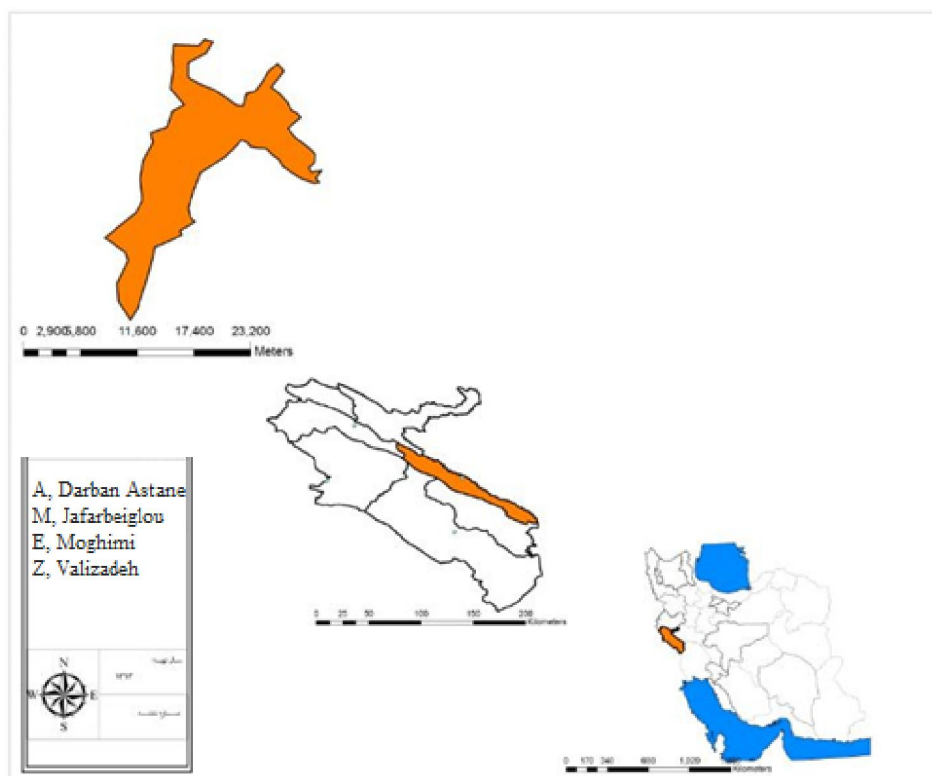


Figure 1: Map of the area under study

The city of Darreh that the fourth largest city in the province of Elam regarding population (Population and Housing Census 2011), it is located at longitude 47 ° and 22 minutes and latitude 33° and 8 minutes and it is located at a height of 650 meters above sea level. This city is 142 kilometers from the city of Ilam and in Ilam- Dokhtar bridge road. It has mild and dry weather, the maximum temperature is 42 degrees and the lowest degree is 6 degrees, and has average annual rainfall of 350 mm. Darreh city is the neighbor Shirvan and Chardavol, Kouhdasht and Dokhtar bridge(Lorestan province) from northwest, north and to southeast, respectively, and from south-east, south to northwest is neighbor with Abadan, Dehloran, Mehran, and Ilam, respectively (Maleki, 2013, 11).

Research Methodology

Research method of this study has been descriptive-analytical that the data collection has been

performed by survey and evidence method. In the present study that was to examine the strategic planning for reducing disaster risk, through getting help of experts, a questionnaire aiming at strategic planning (SWOT) was formulated and In fact, the study area (Dareh City) had 6 quarters (Farhangian, downtown,, Taleghani, Ordughah,, flower castle and Motahari) and 15 questionnaires in connection with each neighborhood was completed by experts, that 12 variables were prepared for all quarters and completed by experts and strategic planning model (Swot) were provided.

Research Findings

In connection with descriptive findings, descriptive characteristics of experts were investigated and their age, education, employment and gender features were evaluated, the results are expressed in Figure 2.

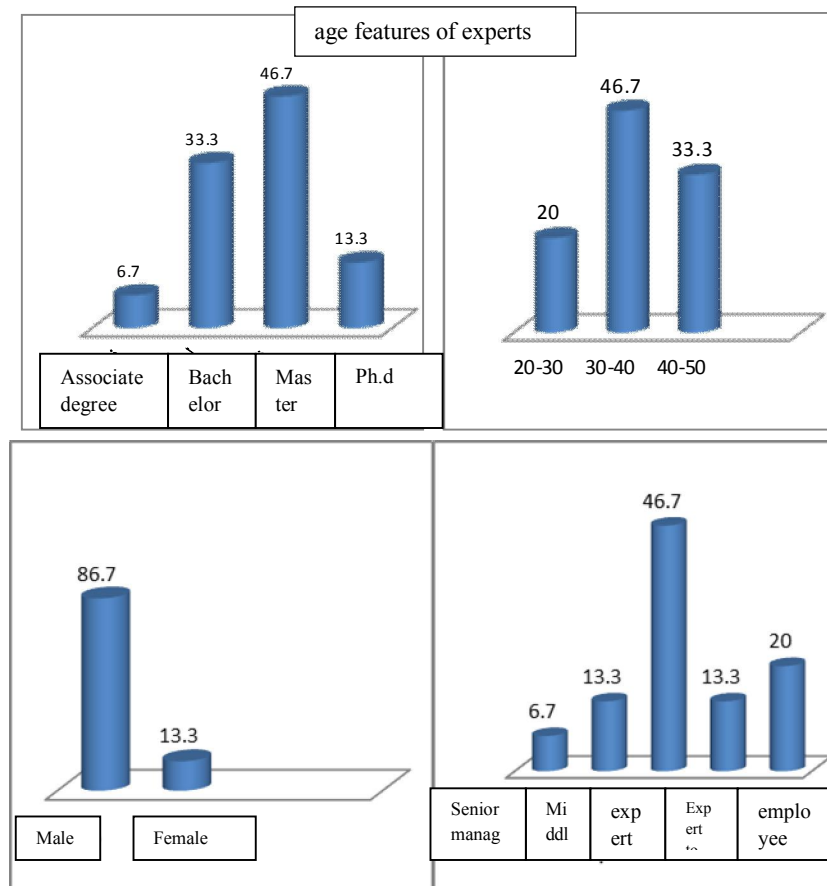


Figure 2: Investigation of Descriptive features of experts

Referential findings External Factor Evaluation Matrix(EFE)

External factors influencing the subject of study is evaluated in six steps using the evaluation matrix used to assess the external environment.

Step One: Determining the external factors

The aim of this stage is exploring the effects of the external environment in order to identify the opportunities and threats it faces in connection with the earthquake. Therefore, based on studies carried out set of opportunities and threats affecting decrease hazard s arising from earthquake have been

considered and examined. The number of external factors identified is 8 and among these, 4 factors are

considered an opportunity and 4 ones as threat (Table 1).

Table 1: External factors influencing the reduction of earthquake hazards

Opportunity	Threats
O1- national planning guidance in achieving the goals of crisis management	T1- lack of sufficient attention to crisis management
O2- enabling legislation for crisis	T2- lack of foresight and National look to Crisis
O3- possibility of using national resources and potentials	T3- weakness in national planning
O4- possibility of using foreign experience	T4- lack of unity of command of the crisis management at the national level

Step Two: Determining the total score of each of the external factors

At this stage, the total scores of each of the opportunities and threats are calculated based on the responses provided in Likert scale by respondents.

$$R_{ij} = \sum S_i F_i$$

score of factors (Equation 1).

Step Three: Determining (normalized coefficient) of each of the external factors

At this stage The normalized ratio of the external factors (opportunities and threats) are calculated by equation (2).

The normalized Coefficient of factors (Equation 2)

$$= \frac{R_{ij}}{\sum R_{ij}}$$

Step four: determining the score or rank each of the external factors

At this stage each of factors is given a score or rank from 1 to 4, based on the current response and the importance of that factor and using Delphi method. This score or rank indicates importance degree of each factor in success of the system.

Fifth step: determining the final score of the external factors and its evaluation

At this stage, coefficient of each factor is multiplied by related score or rank obtain the final score. Then, all the final scores of external and internal factors are added separately, so that total score of internal and external factors is obtain (Table 2).

Table 2: matrix of evaluating external factors influencing reduction of hazard arising from earthquakes

Factors	Score sum	Normalized score	Grade	Final score
O1 - national planning guidance in achieving the goals of crisis management	119	0/066038	3	0/198113
O2 - enabling legislation for crisis	130	0/072142	4	0/288568
O3- possibility of using national resources and potentials	125	0/069367	3	0/208102
O4 - possibility of using external expertise	115	0/063818	2	0/127636
O5- high morale for participation and sense of identification for residents of city	124	0/068812	3	0/206437
O6- building density in the city	125	0/069367	3	0/208102
-T1 Lack of sufficient attention of officials to crisis management.	120	0/066593	3	0/199778
T2- lack of foresight and National look to Crisis	132	0/073252	4	0/293008
T3- weakness in national planning.	135	0/074917	4	0/299667
T4- lack of unity of command of the crisis at the national level.	140	0/077691	4	0/310766
T5- lack of devoting necessary funds in the event of a crisis	145	0/080466	4	0/321865
-T6- Ugly and too horizontal spreading of city, non-recognition of accident black spots in disasters	115	0/063818	2	0/127636
-T7 Incorrect establishment and wrong distribution of services centers in times of crisis in the city	139	0/077137	4	0/308546
-T8 Poor cooperation between organizations and institutions with the private sector and voluntary organizations	138	0/076582	4	0/306326
Total	1802	1		40/3

Source: author's calculations and findings

Table 3: prioritization of external factors on the final score.

Opportunity and threat points	Final score	Prioritization of factors
T5	0/321865	1
T4	0/310766	2
T7	0/308546	3
T8	0/306326	4
T3	0/299667	5
T2	0/293008	6
O2	0/288568	7
O3	0/208102	8
O6	0/208102	8
O5	0/206437	9
-T1.	0/199778	10
O1	0/198113	11
O4-	0/127636	12
T6	0/127636	12

Step Six: prioritization of external factors influencing reduction of hazard arising from earthquakes

At this stage, external factors (opportunities and threats) in order of importance, that is considering the final score of are prioritized (Table 3).

Environmental factors internal evaluation matrix (IFE)

Step One: Determining the internal factors influencing reduction of hazard arising from earthquakes

The purpose of this stage is to evaluate internal environment of earthquake hazards in order to identify strengths and weaknesses. At this stage, after reviewing related information, internal factors identified in the evaluation matrix are evaluated. Accordingly, in order to reduce the Hazard caused by the earthquake 17 internal factors have been determined, that among these 7 factors are strength and 10 ones are weakness points (Table 4).

Table4: identified internal factors matrix

Strength	Weakness
1-distance from high voltage transmission network 2. Distance from the main gas transmission network 3. Establishment of bases crisis management centers in the study area 4. Presence of facilities and equipments of crisis management in the area 5. Ability of organizing and managing crisis in the region 6. Presence of expert and planning force in the region 7. Ability of providing part of crisis management needs from domestic sources	1. The risk of landslides in the area 2. Locating on fault 3. high percentage of Distressed tissues 4. lack of construction principles 5. lack of resistance of buildings in the area 6. Low-resistance strength of public uses 7. Low penetration coefficient 8. Lack of efficient organization components in crisis management 9. Lack of integrated management in crisis 10. lack of human resources (manpower, lack of education and training)

Step Two: Determining the total score of each of internal factors

At this stage, the total scores of each of the opportunities and threats based on the Likert scale responses provided by respondents, was calculated.

$$R_{ij} = \sum S_i F_i = \text{Factor scores (Equation 1)}$$

Step Three: Determining (the normalized coefficient) of each of internal factors

At this stage The normalized coefficient of each of internal factors (strengths and weaknesses) are calculated by equation (2).

$$Y_{ij} = \frac{R_{ij}}{\sum R_{ij}} = \text{The normal ratio of factors (Equation 2)}$$

Step four: determining the score or rank of each of internal factors

At this stage, each factor is given a degree from 1 to 4, based on current response and importance of that factor and using Delphi method. This score or rank indicated importance rate of each factor in success of system.

Step five: determining the final score of internal factors and its evaluation

at this stage coefficient of each factor is multiplied by the related score or rank to obtain the final score. The final scores of internal factors are then added separately to obtain total score of external factors (Table 5).

Table 5: internal factor evaluation matrix

Factors	Score sum	Normalized score	Grade	Final score
S1 - distance high voltage transmission network needs	115	0/032550241	2	0/065100481
S2 – distance from the main gas transmission network	116	0/032833286	2	0/065666572
S3 – establishment of bases of crisis management in the area	115	0/032550241	2	0/065100481
S4 - -presence of facilities and equipments for crisis management in the study area	118	0/033399377	2	0/066798755
S5 - ability to organize and manage the crisis in the study area	120	0/033965468	2	0/067930937
S6 - presence of expertise and planning power at the region	125	0/035380696	3	0/106142089
S7 - Power of supplying part of crisis management needs from domestic sources	114	0/032267195	2	0/06453439
S8 -High level of awareness of people about the dangers of earthquakes	110	0/031135013	2	0/062270025
S9 holding classes for earthquake emergency preparedness in schools, centers and Red Crescent	100	0/028304557	2	0/056609114
S10- low density building	135	0/038211152	4	0/152844608
S11- low number of Floors	130	0/036795924	4	0/147183697
S12 high spirit of partnership and cooperation among people	140	0/03962638	4	0/158505519
S13 presence of consecrated land and empty space in the context of city	125	0/035380696	3	0/106142089
W16 - risk of landslides in the area	115	0/032550241	2	0/065100481
W1 – being located on the fault	110	0/031135013	2	0/062270025
W2 - high percentage of Distressed tissues	118	0/033399377	2	0/066798755
W3 - lack of respecting construction principles	135	0/038211152	4	0/152844608
W4 – lack of resistance of buildings in the area	130	0/036795924	4	0/147183697
W5 - Low-resistance of public uses buildings	115	0/032550241	2	0/065100481
W6 - Low penetration coefficient	125	0/035380696	3	0/106142089
W7 - lack of efficient organization components in crisis management	125	0/035380696	3	0/106142089
W8 - lack of integrated management in times of crisis	115	0/032550241	2	0/065100481
- W9 lack of human resources (manpower, lack of education and training)	140	0/03962638	4	0/158505519
W 10 narrow side streets of the city	110	0/031135013	2	0/062270025
-W11 Weak Economic stamina of City	135	0/038211152	4	0/152844608
-W 12 Lack of awareness of citizens to react during an earthquake	132	0/037362015	4	0/149448061
-W13 Lack of studies of the Crisis in Urban context	125	0/035380696	3	0/106142089
W14- loss of land studies during the crisis	125	0/035380696	3	0/106142089
-W15 Limited entries of city	115	0/032550241	2	0/065100481
Total	3533	1		82/2

Step Six: prioritization of internal factors affecting reduction of hazards arising from earthquake

At this stage the internal factors (strengths and weaknesses) are prioritized in order of importance, that is according to the final score(table 6).

Second stage: Compliance phase

Compliance phase consists of two steps. First the stage of planning strategies through SWOT matrix is performed and then selecting the acceptable

strategies, through internal and external matrix will be done in the manner specified below.

Formation of Matrix of weaknesses, strengths, threats and opportunities (development strategies)

SWOT analysis is used to identify and evaluate internal factors (strengths and weaknesses) and external affecting factors (opportunities and threats) to reduce hazards of earthquakes. strategies of earthquake hazards reduction are developed in three steps.

Step one: determining the opportunities and threats

In this step, opportunities and threats identified in the field of earthquake hazards reduction in the external environment evaluation step is placed in rows of SWOT matrix.

Step Two: Determining the existing strengths and weaknesses

In this step, the strengths and weaknesses identified in the internal evaluation phase are placed in rows of weaknesses, strengths, weaknesses, opportunities and threats matrix.

Table 6: prioritization of internal factors based on the final score

Strength points and opportunities	Final score	Prioritization of factors
S12	0/158506	1
- W9	0/158506	1
S10-	0/152845	2
W3 -	0/152845	2
-W11	0/152845	2
-W12	0/149448	3
S11-	0/147184	4
W4 -	0/147184	4
S6 -	0/106142	5
-S13	0/106142	5
W6 -	0/106142	5
W7 -	0/106142	5
-W13	0/106142	5
W14-	0/106142	5
S5 -	0/067931	6
S4 - -	0/066799	7
W2 -	0/066799	7
S2 -	0/065667	8
1S	0/0651	9
S3 -	0/0651	10
w16 -	0/0651	10
W5 -	0/0651	10
W8 -	0/0651	10
-W15	0/0651	10
S7 -	0/064534	11
-S8	0/06227	12
W1 -	0/06227	12
W10	0/06227	12
-S9	0/056609	13

Step Three: Developing competitive / offensive (SO) strategies, strategies (WO), strategies (ST), and strategies (WT)

In this step, the internal strengths and external opportunities, internal weaknesses and external opportunities, internal strengths and external threats, internal weaknesses and external threats are compared with each other.

Competitive / offensive Strategies (SO)

Internal strengths and external opportunities are compared and this result is written in the box related to strength- opportunity strategies.

strategies (WO)

In this strategy, internal weaknesses and external opportunities are compared and result is

written in the box related to weakness - opportunity strategies. **strategies (ST)**

Internal and external threats and strengths are compared and the results are included in the box related to strength- threat strategies.

strategies (WT)

Internal weakness and external threats are compared and the results are written in the box related to weakness - threat strategies.

Formation of internal and external matrix(IE) (identifying more important strategies)

after formulating primary strategies from comparison of internal and external factors in matrix (SWOT), the optimal and acceptable strategies are chosen from the primary strategies.

Table 7: earthquake hazards reduction strategies

Strength	Weakness	
1-distance from high voltage transmission network 2. Distance from the main gas transmission network 3. Establishment of bases crisis management centers in the study area 4. Presence of facilities and equipments of crisis management in the area 5. Ability of organizing and managing crisis in the region 6. Presence of expert and planning force in the region 7. Ability of providing part of crisis management needs from domestic sources 8. high g public awareness of the dangers posed by earthquakes	1. The risk of landslides in the area 2. Locating on fault 3. high percentage of Distressed tissues 4. lack of construction principles 5. lack of resistance of buildings in the area 6. Low-resistance strength of public uses 7. Low penetration coefficient 8. Lack of efficient organization components in crisis management 9. Lack of integrated management in crisis 10. lack of human resources (manpower, lack of education and training)	
Opportunities (o)	Strategies (so)	weaknesses strategies
5 - ability to organize and manage the crisis in the study area 6 - presence of expertise and planning power at the region 7 - Power of supplying part of crisis management needs from domestic sources 8 -High level of awareness of people about the dangers of earthquakes	1. The development and deployment of local systems at the regional level. 2. Establishment of effective regulatory mechanisms 3. Using portion of the resources required to manage the crisis based on the local system 4. speedy return of normalcy in times of crisis 5. The use of international experience in the field of education and training specialists	1. The use of national and international resources to improve the strength of the local buildings and public uses 2. the use of external resources in order to eliminate possible shortcomings as mush as possible 3. The adoption of rules and principles in the safe construction 4. The conduct of a national program for the modernization and upgrading of Urban Distressed Areas
Threat		
1. lack of sufficient attention of authorities to disaster management 2. Lack of foresight and National look to Crisis 3. weaknesses in national planning 4. Lack of unity of command of the crisis at the national level 5. Ugly and too horizontal spread of city 6. Not detecting the accident black spots at the time of crisis	Using the power of unity of command specializing in crisis time attention to foresight to reinforce the strengths and prepare for future threats transferring part of national responsibilities to local sector	paying Special attention to overcome the dangers of the Distressed and increasing resistance of buildings Integrated management of disaster management at national and local level Fore sighting in education and training of qualified personnel

First step: formation of internal and external matrix

this matrix is used to determine the overall condition of the strategies. Preparation of internal and external matrix through previous investigations makes it possible to predict expected impacts of strategic decisions on reducing the risks of earthquake. Internal and external matrix has two main dimensions. The sum of final scores related to

evaluation matrix of internal factors in reducing the earthquakes hazards are shown on the X axis and the sum of final scores related to evaluation matrix of external factors reducing the earthquakes hazards is written on the Y axis. intersection point of the sum of external and internal factors of earthquakes hazards on the X and Y axis and define the position of this part in inner and outer matrix.

The inner and outer matrix places different of parts of the system in the box 9 and provides them as graphs. This matrix can be divided into three main regions and different strategies can be used for each of them. First, some strategies can be implemented for parts which are in boxes 1, 2, 4 (I, II IV) that can lead to "growth and recognition". second, for system

units that are in boxes 3, 5 or 7 (III, V, VII) some strategies should be implemented that their aim is to "maintain the current status". For units in boxes 6, 8 or 9 (VI, VIII, IX), strategies of "drop" should be implemented. figure (3) (Hekmatnia and Mousavi, 2011, 320).

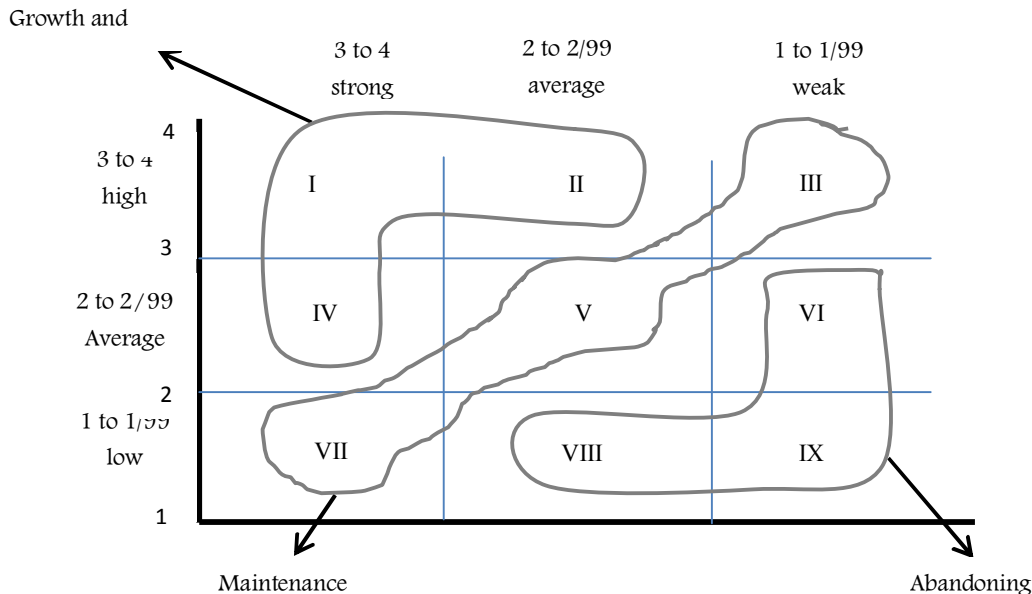


Figure 3: final score of internal and external factors evaluation matrix

Sum of The final score of internal evaluation matrix (IFE),Source: (Hekmatnia and Mousavi, 2011, 320).The scores obtained from sum of final scores related to of internal and external evaluation matrix, that are respectively 4/3 and 82/2, show that factors under study are in the fourth area and fourth box (IV), position of region indicate that earthquake hazards are moderate status and strategies should be used that lead to growth and recognition.

Conclusion

Earthquakes phenomenon, as a serious risk, reduces the ability of societies in maintaining lives of people and imposes great financial losses on society. In recent years, increasing deaths and economic losses caused by the earthquake has made many communities find effective strategies through which result of natural disasters such as earthquakes may be reduced to a minimum.

In connection with the results of research findings, first matrix of external factors were established, among these 4 factors were considered as opportunities and 4 as threats in relation to reducing earthquakes Hazard, table (1). And then the mentioned factors are scored and the final prioritization are

provided (see Table 3). Also, internal factors affecting the reduction of earthquake hazards were examined, that 7 factors are considered as strengths and 10 ones as weaknesses and the mentioned factors were prioritized and scored (Table 6). After the above steps, the obtained findings were implemented as presented as strategies for reducing the risks of earthquakes that included three factors of Staying away from the high voltage transmission network, staying away from the main gas transmission network, establishment of the bases for crisis management in the study area in order of importance in strength points, three factors of landslides in the area, being located on the fault, high percentage of the Distressed tissues in weakness points, three factors of development and deployment of indigenous strategies in the region, creating efficient regulatory mechanisms, using part of the resources needed to crisis management as the most important factors in SO strategies, and Three factors of using national and international resources to improve the strength of the local buildings and public uses, Using external resources to eliminate weaknesses in the extent possible, adoption of rules and principles in safe construction in WO strategies.

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