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ASSESSMENT AND ANALYSIS OF THE PHYSICAL VULNERABILITY OF ABPAKHSH CITY AGAINST SEISMIC HAZARDS

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Abstract

The natural hazards, especially the earthquake, cause serious damage to skeletal and physical infrastructure as well as to human communities in cities. Therefore, assessing the vulnerability of cities against these hazards will have a significant impact in reducing the damage caused by these hazards. Therefore, this study assessed the physical vulnerability of Abpakhsh city to seismic hazard using Dematel, AHP and GIS models. The results show that, according to the AHP model, seismicity and earthquake strength parameters were 0.259 and 0.251, respectively, for the seismicity index and seismic parameters and materials for physical vulnerability with the highest rank of 0.35 and 022, respectively. In the Dematel method, the fault seismic power parameter and the severity of the earthquake with J- R is as follows: (0.086 and 0.063) for the seismic sub-index and seismicity and building materials are as follows with J-R, respectively: (0.070 and 0.055) for physical vulnerability, the most influential maternal agents and soil depths with J + R (0.110) and slope with J + R (0.103) for seismicity and building materials with J + R (0.085) and seismicity With J + R (0.079) for Physical Vulnerability. These factors are the most interconnected parameters in terms of seismicity and physical vulnerability of Abpakhsh city. In general, the results show that as the northwest of the city progresses, the amount of seismicity and damage will increase.

Keywords: *vulnerability, physical, seismicity, Abpakhsh city.*

1. INTRODUCTION

The confrontation of human activities with the environment and natural trends that govern it creates various risks, which is one of the most important earthquakes. Earthquakes are one of the natural and unpredictable hazards that impose multiple risks to one society in the same way. This risk potentially causes loss of economy, assets and population (Adrian Fredrick et al, 2015; Gayen et al. 2019). In the twentieth century, more than 1,100 earthquakes occurred in different parts of the world, in which more than 1,500,000 were killed (Lantada et al, 2008). The number of casualties caused by the earthquake is directly related to the vulnerability of local buildings, population density and earthquake severity. The vulnerability of all construction facilities (residential buildings, commercial, industrial, schools, hospitals, roads, bridges, pipelines, power plants and communication networks) indicates that there is a probable seismic hazard in them and they are at risk of earthquakes (Nath et al, 2015). In general, when exposed to hazards such as earthquakes, the main task is to choose an integrated and flexible approach to vulnerability assessment according to available indicators. Therefore, before assessing the seismic vulnerability in residential areas, it is necessary to take the precautionary measures necessary to meet the vulnerability identification spatial patterns as part of a flexible approach (Banica et al., 2017). In a collaborative approach, vulnerability is the degree to which a system or part of a system may respond badly during or after a dangerous event (Proag, 2014). These losses vary geographically, over time and among different social groups, which cause changes in vulnerability in time and place (Cutter et al., 2003). The various dimensions of vulnerability reflecting the sensitivities of different systems are as follows: (1) Physical vulnerability related to the impact on infrastructure on the basis of geological and human characteristics (buildings and infrastructure) (2) social vulnerability, including barriers to flexibility related to the ability to deal with people's weaknesses, (3) Economic vulnerability, including assets and commercial infrastructure, (4) environmental vulnerability that takes into account the potential impact of hazards on natural and beneficial systems and (5) Systemic vulnerability that includes access to support services (Sinha et al, 2016). Generally, the seismic vulnerability of the city actually represents the degree of resistance or sensitivity of physical structures and socio-economic systems to earthquake impact (Wei et al, 2016). Knowing and measuring the vulnerability are key factors in disaster risk management. Accordingly, many researchers have tried to provide solutions to measure vulnerabilities and reduce damage. Including the study by Inqualabi et al. (2017) regarding the assessment of urban bridges vulnerability, The Sarraz et al. (2015) study on the seismic vulnerability of buildings in Chittagong, Bangladesh, Also, the evaluation of the seismic vulnerability of residential buildings in the cities of Srinagar, Jammu and Kashmir by Muntaha Anees and Sultan Bhat (2015), Providing simulation model to predict urban vulnerability to earthquake hazards in Lima, Peru city by Kaji et al. (2014), Evaluation of Seismic Vulnerability in Schools in Tehran by Panahi et al. (2014), Also, the assessment of the seismic vulnerability of residential buildings in Indonesia's Jakarta by Saputra et al. (2017). Due to the Alpine-Himalayas earthquake belt, Iran is considered as a very active and seismic region of the world (Hamzehloo, 2005, Martini et al 1998), with 950 seismic events occurring annually, which only in the last century was 144 earthquake with a magnitude of over 5 Richter has been recorded (khatam, 2006). Being on the boundary of convergence of lithospheric plates, the existence of more than 20 active faults of more than 500 km in length, as well as the existence of dense population points, has made it a highly vulnerable country against earthquakes. The excessive population growth, urban construction and its expansion to the margin of the cities, without proper planning and taking into account the necessary measures and regulations, have doubled the situation (Pourkhosravani et al, 2016). Accordingly, this research has tried to evaluate and analyze the physical vulnerability of Abpakhsh city in southern Iran against seismic hazards.

Location of study area:

The study area is located in the folded Zagros region and geographically in the geographical range of "58.70'8 ° 51 'to' 11.96'45" 50 (E) and "14.73'26 ° 29 'to 34.20'22 ° 29 north (N) is located. This area is bounded north to Genaveh, westward to the Shapur-Dalaki basin and south to the Ahrom (Fig. 1).

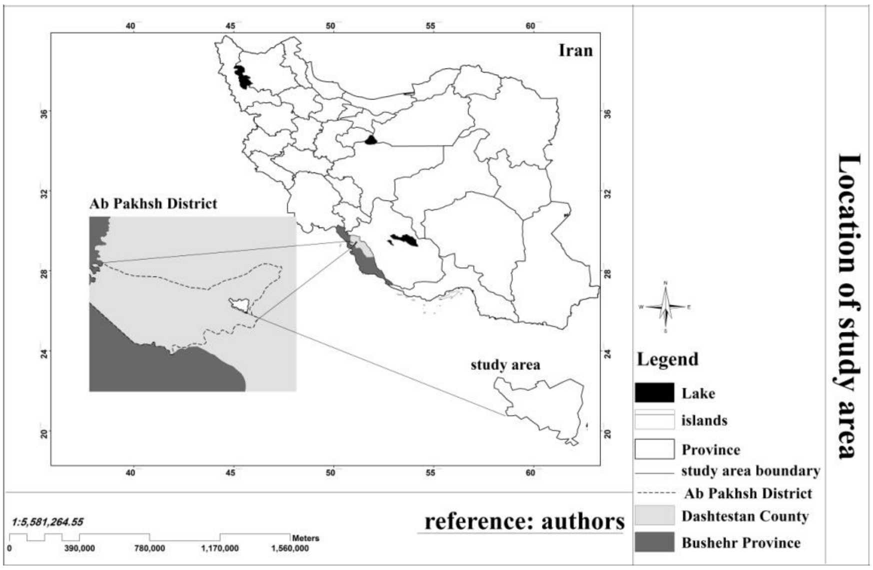

Figure 1. Location of the studied area

2. RESEARCH METHODOLOGY

The method of research in this study is descriptive-analytic, and is a practical nature. In this research, using field and library methods, we compiled the required information and then analyzed the subject using Excel, AutoCad, ARC GiS and GOOGLE Earth, and AHP and Dematel methods. In the first step, using maps of 1: 100,000 geology and maps of 1: 50000 topography - K753 series, 6248IV leaves and K753 series, 6148 I leaf, digital elevation model (DEM), satellite imagery, collecting 1112 seismicity centers registered in the 600 km radius of the study area were provided with baseline maps. Then, in the second phase, using the AHP method, weighing the sub criteria and using DEMATEL and AHP methods weighted the main criteria of the research and eventually plotted the final map of seismic zonation and physical vulnerability of the city of Abpakhsh against earthquake was prepared.

3. RESEARCH FINDINGS

3.1 Geology

Bushehr province, located in the southern part of the Tango-Sangria Oblast, is composed of evaporative and destructive sedimentary lithology (Fakhri et al., 1394). Most of Bushehr province has High Mountain and mountain morphology. However, in the coastal areas, the physiographic image of the province is plain. In this regard, the province has two distinct poles. The Kuhsar morphological unit, like other parts of Zagros, has a northwest trend in the south-east, which includes a periodicity of asymmetric anticlines and compressed ramps to the south. The coastal plain of this province has eroded births that cover the mountainous areas to the shores of the sea. The northwestern part of the province, from Borazjan to Genaveh, is part of the Khuzestan pit, the oldest rock outcrop is part of the Fars group, that the facies of the sequences coincide with the cove, and their sedimentary structures represent the accumulation in a retrograde sedimentary basin to the south (Aqanabati, 2010), which is a major part of the city of Dashtestan, and in particular the city of Abpakhsh. In general, the structure of this area is of the type of terraced reserves and low-lying foothill heath cones (Fig. 2).

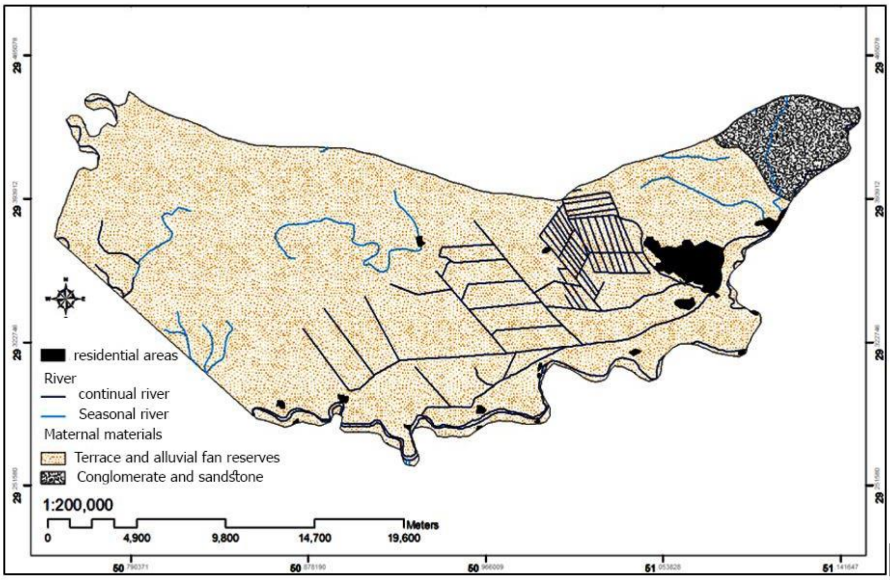

Figure 2. Maternal materials Map

3.2 Seismicity history of the study area:

According to 1112 seismicity centers recorded at 600 km radius of the study area, the oldest seismicity in this area related to the 357-year-old Hijri Shams earthquake in the Siraf port with a magnitude of 5.3 on the surface of the Ms and the latest earthquake related to the magnitude of the earthquake of 1396 3.4 is 6 km north of Saadabad. Also, other events of historical seismicity in this area are based on aggregated data and earthquake reports of the International Institute of Seismology and Earthquake Engineering on 20/1/1392, respectively: In 387 Hijri Shamsi in Syraf with magnitudes 6.5 Ms and Dec. 30, 1241 Hijri Shamsi in Shiraz with magnitude 6.2 Ms.

The city of Abpakhsh, the center of the Abpakhsh section, is one of the most voluminous parts of the Bushehr province. Due to the presence of numerous and active Qatari-Kazeroon, Borazjan, Rag sefid and Zagros faults, this region has been exposed to numerous and sometimes severe earthquakes with a maximum magnitude of 5 magnitudes. Since the magnitude of earthquakes has long been measured in this area at most on different scales of ML, MS, MW, Mb, it is essential that all relationships be identical. Therefore, in the present study, using Alizadeh, Chenari and Pourzinli's proposed magnitudes conversion method, we first transformed the magnitudes in Iran to Ms. Then, to prepare the seismic zoning map and physical vulnerability of the city of Abpakhsh against earthquake in the study area, the relationships between 1 and 8 were used.

A. Determination of the maximum seismic capacity of the fault in the studied area (A):

At this stage, using the following equations, maximum seismic power in faults in the study area was calculated. Accordingly, the ability to generate seismicity in all faults does not differ significantly in the scope of the study. However, according to Borazjan fault calculations with the length of 188 km and seismic capacity equal to 5 have the highest seismic and MJ faults (74.40 km) and the 4.73 seismic potential of the least seismic capacity. In accordance with relations 1 to 4 and calculations (Table 2) there is a direct relationship between the length of the fault and the power of the seismicity. So that the length of the fault in the studied area is less, its seismicity can be reduced as well.

Relationship (1): Migratory Equation, Nowruzi and Ashjaei 5.4 M = logL +
Relation (2): Ambers and Melville equation 3.24 - M 0.7 = logLR

Relationship (3): Nowruzi equation Ms 0.675 + 0.126 - logL =
Equation (4): Salmones equation LogL 1.169 +1.404 Ms =

Description: In these relationships (M) represents the magnitude of the earthquake on the Richter scale and in relations 1 and 2L represents the length of the fault per kilometer. Also, in relations 3 and 4, L represents half the total length of the fault per meter.

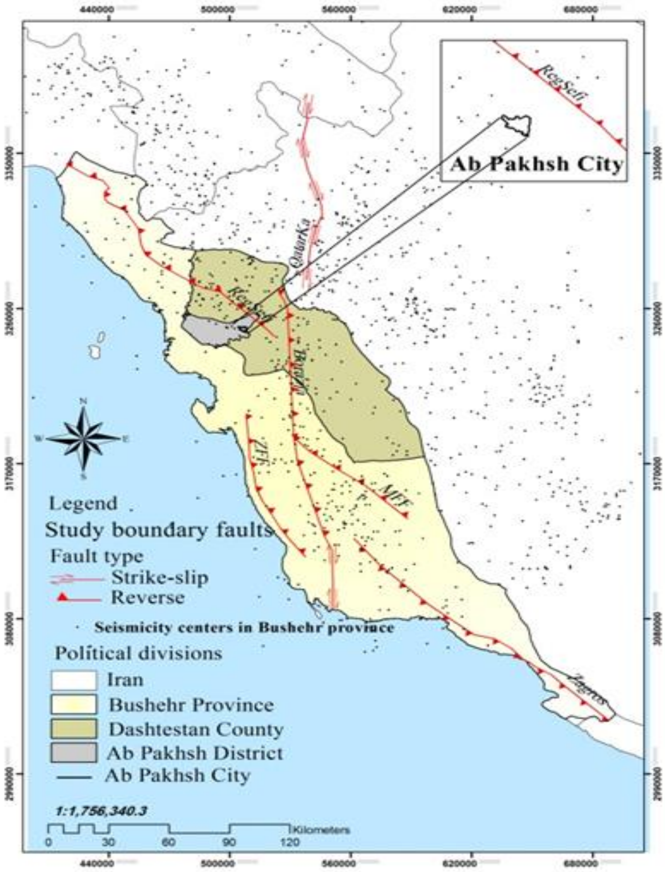

Figure 3. Seismic focal points relative to the city of Abpakhsh

Table 1 . The method of converting a variety of magnets to the proposed Ms for Iran

Magnitude	M ≤ 5	5 < M < 7
ML	0.671ML + 0.879	0.272ML 2 -1.641ML + 5.711
Mb	MS = 1.14mb -1.136	MS = 0.334mb 2 -1.93mb + 5.831
MW	1.136MW - 2.403	

Table 2. Maximum power of seismicity in effective faults in the studied area (A)

Average (A)	LogL	Ms	LogLR	M	Fault length to km	Fault name
4.9	2.08	3.26	4	10.46	157.46	Rag sefid
5	2.09	3.28	4	10.64	188	Borazjan
4.7	2.03	3.20	4	9.90	90	Zagros pit fault (ZFF)
4.9	2.08	3.27	4	10.51	165.4	Zagros fault
4.8	2.05	3.22	4	10.06	106	Kazeron fault
4.7	2.02	3.18	4	9.71	74.40	Mountain Front Fault (MFF)

B- Determine the maximum intensity of earthquakes created in earthquake centers:

At this stage, using the relationships of table (1), the types of the magnitude of earthquakes was first converted to Ms Magnitudes, and then, using relations 5 and 6, the level of the earthquake intensity for each center was calculated. According to the calculations, the maximum earthquake intensity in the seismic centers of the study area is 5, at least 3.9 and is average 4.6.

Relationship (5): Nowruzi - Ashjaei (B) 2.8 - Ms 1.7 I =
Relationship (6): Ambers and Melville (C) 0.09 - Ms 1.3 I =
In these formulas (I) shows the earthquake intensity in the Mercalli scale and (Ms) indicates the magnitude of the earthquake on the Richter scale.

C) Determination of maximum acceleration of earthquakes caused by faults in the studied area:

At this stage, using the Multi Ring Buffer tool, ArcGis software designed the fault interval map according to the potential for earthquake generation. Then, using the 7th equation, the maximum acceleration for each fault was calculated in the study area.

Relationship (7): Donovan

$$a = \frac{1080e^{0.5\,M}}{(R+25)^{1.32}}$$

Note: In this case, (a) represents the maximum acceleration in the scale of the gall, (e) indicates a constant coefficient equal to 2.718, (M) indicates the magnitude of the earthquake on the Richter scale and (R) represents the distance to fault in terms of kilometers. Accordingly, with the increase in the distance from the study area faults, the acceleration rate in this range is reduced (Figures 4-7).

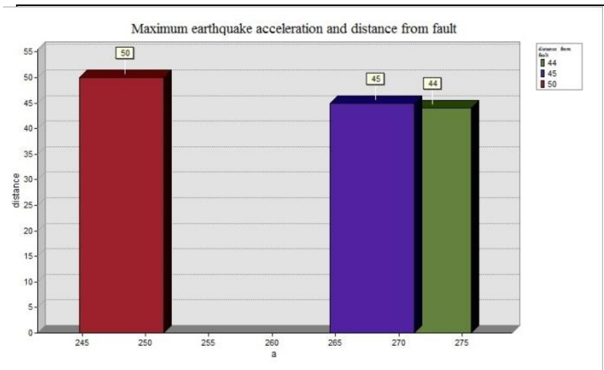

Figure 4. Maximum Seismic Capacity 4.8

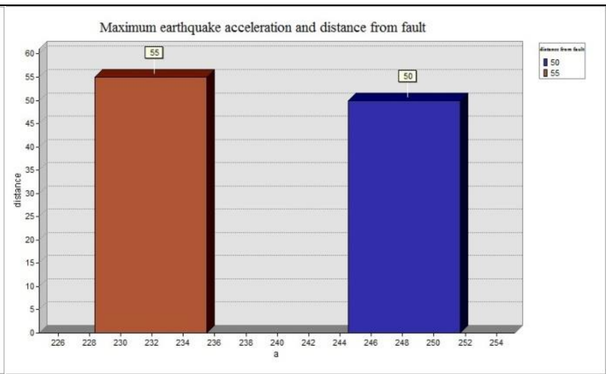

Figure 5. Maximum Seismic Capacity 4.7

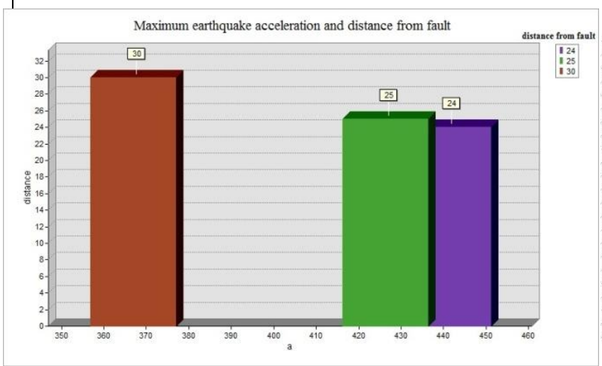

Figure 6. Maximum Seismic Capacity 5

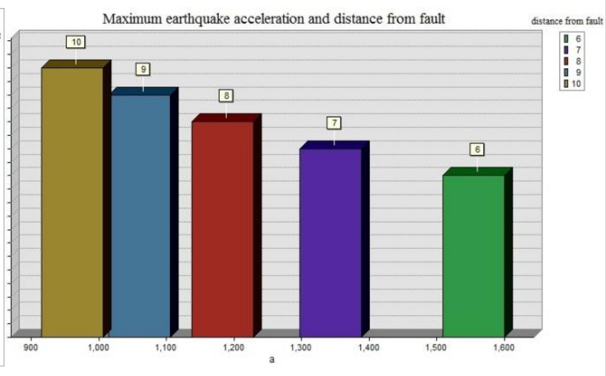

Figure 7. Maximum Seismic Capacity 4.9

Table 3. The severity of the earthquake in the historical and instrumental seismic centers

I	C	B	Magnify to MS	data type	Date of occurrence	Width	Length
4.59	5.24	3.94	3.9	instrumental	2017	29.6	50.91
3.98	4.72	3.25	3.5	instrumental	2016	29.48	50.58
5	5.81	4.68	4.4	historical	2003	29.53	50.93
3.38	4.19	2.57	3.4	historical	1905	29.43	51.15
6.59	6.98	6.21	5.3	historical	978	27.7	5.03

AHP technique:
Stage One: Formation of Hierarchical Structure

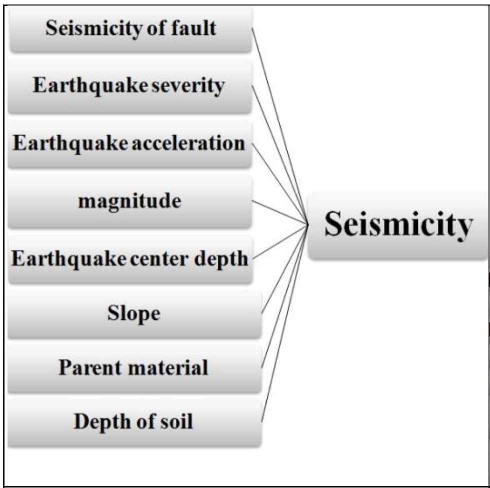

Figure 8 Hierarchical structure of seismic zonation map

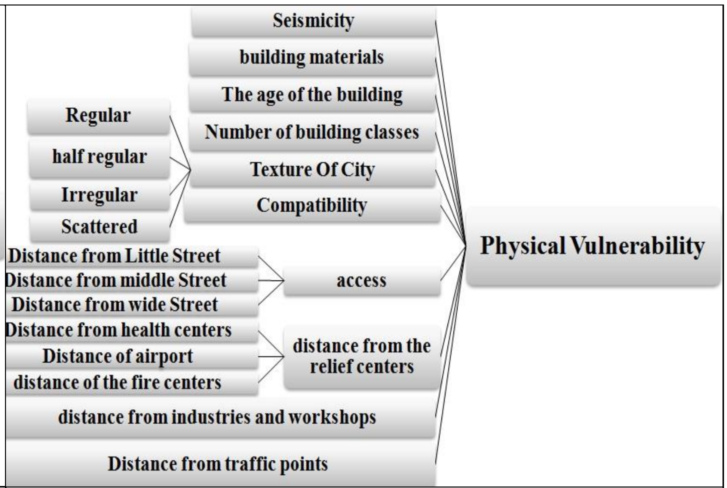

Figure 9. hierarchical structure of physical vulnerability in Abpakhsh seismic zoning map

Second step: preparing a questionnaire and a matrix of paired comparisons: This step involves preparing a questionnaire based on the hierarchical structure (forms 8 and 9) and the table of importance for the paired comparison (Table 4) (Saaty, 1980).

Table 4. Degree of importance of paired comparisons

numerical value	Preferences
9	Quite preferable
7	Very strong preference
5	strong preference
3	Low preference
1	same preference
8,6,4,2	Preference between the above intervals

Third step (weight calculation): To calculate the weight of the factors, the average of each row is calculated, which is the number that represents the weight of each agent (Azimi Hosseini et al., 2011).

Table 5. Data matrix (Abpakhsh city's physical vulnerability to earthquakes)

Distance from traffic points	Distance from industries	Distance from relief centers	access	Compatibility	Urban texture	Number of floors	Antiquity	Materials	Seismicity	Index
9	9	9	9	9	9	9	9	9	1	Seismicity
9	9	9	9	9	9	9	9	1	0.11	Materials
6	6	5	4	5	5	5	1	0.11	0.11	Antiquity
0.17	5	0.20	0.25	0.20	0.20	1	0.20	0.11	0.11	Number of floors
6	6	5	4	5	1	5	0.20	0.11	0.11	Urban texture
5	7	5	0.20	1	0.20	5	0.20	0.11	0.11	Compatibility
6	7	5	1	5	0.25	4	0.25	0.11	0.11	access
7	8	1	0.20	0.20	0.20	5	0.20	0.11	0.11	Distance from relief centers
0.14	1	0.13	0.14	0.14	0.17	0.20	0.17	0.11	0.11	Distance from industries
1	7	0.14	0.17	0.20	0.17	6	0.17	0.11	0.11	Distance from traffic points

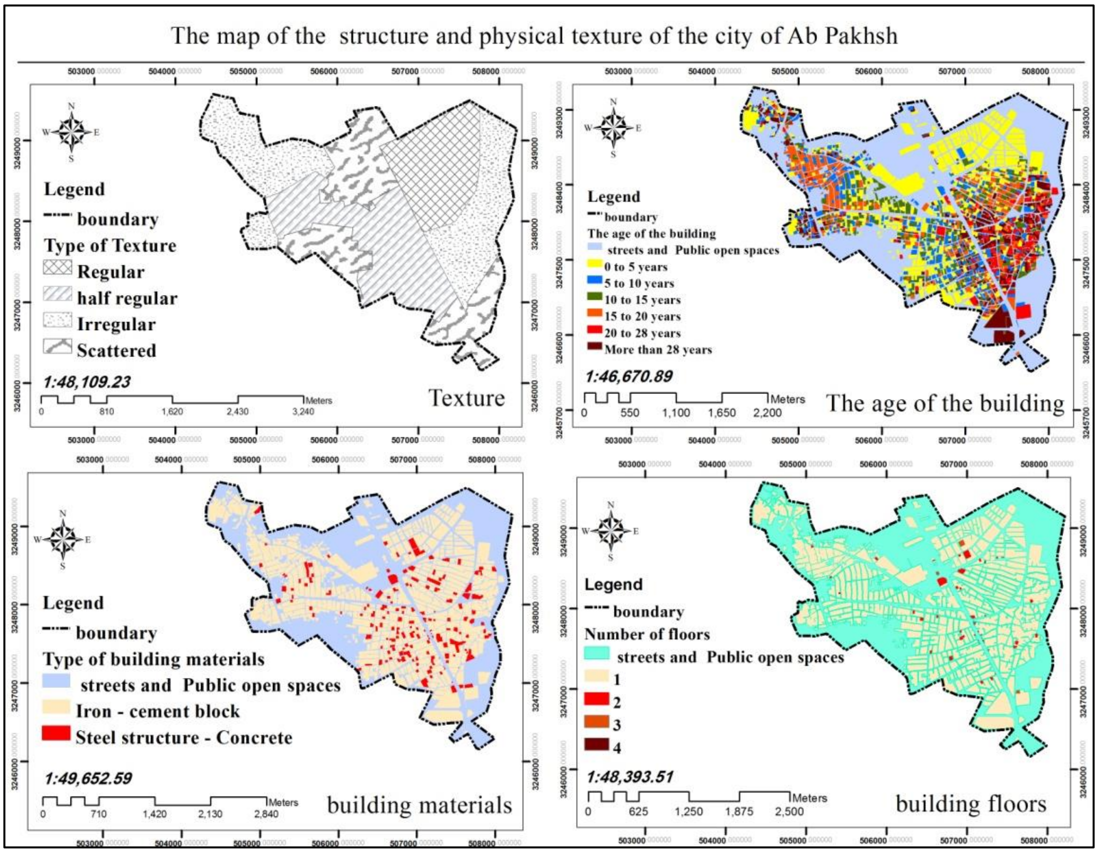

Figure 10. Texture and physical map of Abbakhsh city

Step Four: Calculate the incompatibility rate:
This stage consists of three steps;

A. Special vector (λmax):
B: Calculate the amount of incompatibility index (I.I): This step is calculated according to the following formula:

$$I.I. = \frac{\lambda max - N}{N-1} \text{:(1) Relation}$$

C: Calculating Inconsistency Rate (RI): This step of dividing the incompatibility index into the randomly matrix incompatibility index is calculated according to the following formula.
Formula

$$\mathrm{I.I.} = \frac{\mathrm{I.I}}{\mathrm{R.I}} \text{:(2)}$$

Table 6. Randomness index

10	9	8	7	6	5	4	3	2	*n*
1.49	1.45	1.41	1.32	1.24	1.12	0.9	3.58	0	*RI*

Source: Hekmat Nia, 1392

Table 7. The weight of the parameters based on the AHP method

Rank	Weight	Vulnerability indicators	Weight	Seismicity indicators
1	0.35	Seismicity	0.259	ability to create earthquakes in fault
2	0.22	Materials	0.251	Earthquake severity
3	0.10	Antiquity	0.155	Magnitude of earthquake
4	0.08	Urban texture	0.154	Earthquake acceleration
5	0.07	Access	0.116	Earthquake focal depth
6	0.06	Compatibility	0.024	Maternal materials
7	0.05	Distance from relief centers	0.020	Depth of soil
8	0.03	Distance from traffic points	0.017	Slope
9	0.02	Number of floors	-	-
10	0.01	The distance from small industries and workshops	-	-

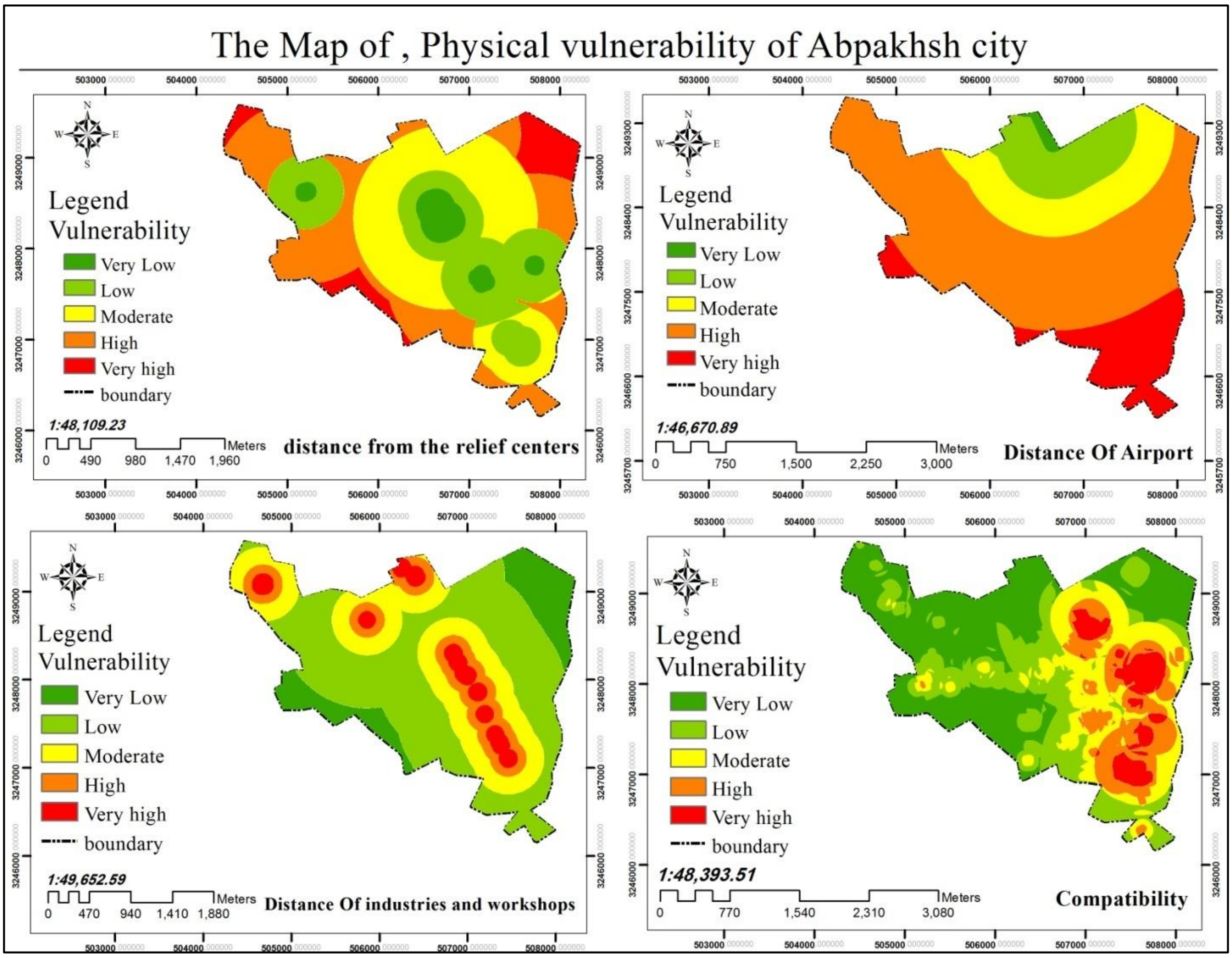

Figure 11 Map of Vulnerability sub-criteria of Abpakhsh City against Earthquake

3.3 Dematel Method

The effects of the decision-making process (Dematel) have been proven in the understanding and solving of complex problems (Bacudio, 2016). This method is based on the theory of graphs in creating the structure of the system in the form of directional graphs and its constituent elements, according to experts, hierarchical structure and the relations of effective and influential relationships factors.

First stage (forming a direct communication matrix): At this stage, the judgment of the experts is used (Celik, 2015) and experts are asked to prioritize the parameters in accordance with the following table.

Table 8. Degree of importance comparisons based on the Dematel method. (Bacudio, 2016)

Very high impact	high impact	Little impact	Very little impact	Effectless	Preferences
4	3	2	1	0	numerical value

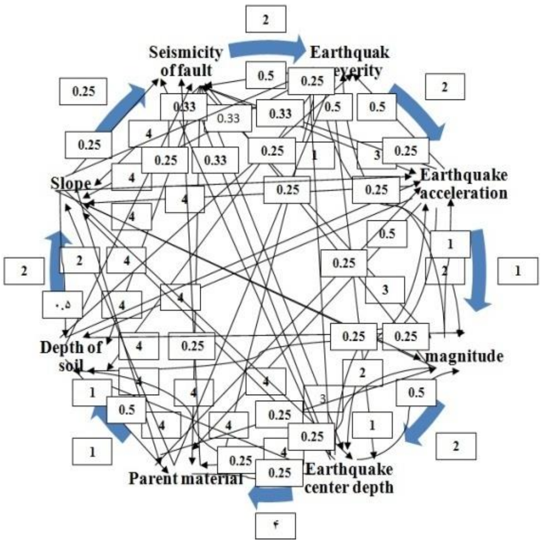

Figure 12 Primary directional damage diagram of Seismicity

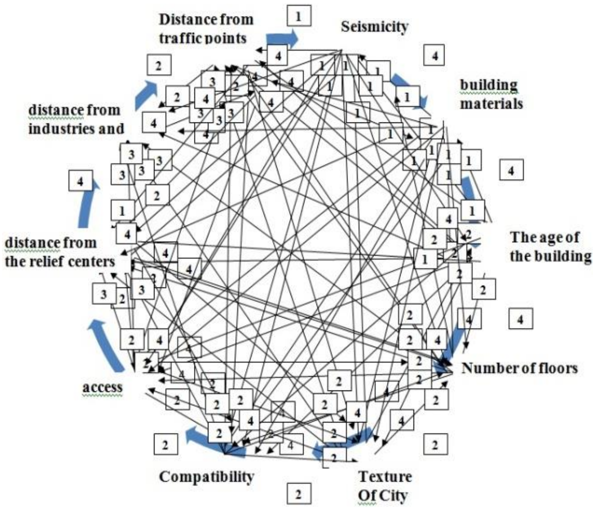

Figure 13 Primary directional damage diagram of Vulnerability

Second step: Calculate the relative intensity matrix governing the direct relations: At this stage, first we multiply each variable in the inverse of the highest sum of rows (k). Also k is calculated by the following formula. According to calculations k, for seismicity 0.04 and for damage it is equal to 0.028.

Relationship (3):

$$k=\frac{1}{\max\sum_{j=1}^{n} a_{ij}}$$

Step 3: Calculate the possible relative severity matrix of all direct and indirect relationships: This step is calculated by the following formula. In this formula, I is the unit matrix. In the matrix of unit (I), all of the elements of the original diameter are given 1.

Relation (4):

$$\mathrm{M}\times(\mathrm{I}-M)^{-1}$$

Table 9. Relative Intensity Matrix Governing Direct Relationships of Abpakhsh's Physical Vulnerability against Earthquake

Distance from traffic points	Distance from micro-industry and workshop	The distance from the relief centers	access	Compatibility	Urban texture	Number of floors	Old building	Materials	Seismicity	Indicators
4	4	4	4	4	4	4	4	4	0	Seismicity
4	4	4	4	4	4	4	4	0	1	building materials
4	4	4	3	3	3	2	0	1	1	Old building
2	3	2	2	2	2	0	2	1	1	Number of floors
3	3	2	2	2	0	2	2	1	1	Urban texture
3	3	3	2	0	2	2	2	1	1	Compatibility
3	3	3	0	2	2	2	2	1	1	access
3	4	0	2	2	2	2	1	1	1	The distance from the relief centers
2	0	1	2	2	2	2	1	1	1	Distance from micro-industry and workshop
0	2	2	2	2	2	2	1	1	1	Distance from traffic points

Table 10. The possible relative severity matrix of all direct and indirect relationships of seismic

R	Depth of soil	Maternal materials	Slope	Earthquake focal depth	Magnitude of earthquake	Earthquake acceleration	Earthquake severity	The ability to create an earthquake in fault	Indicators
0.0869	0.0152	0.0152	0.0136	0.0118	0.0128	0.0128	0.0056	0	The ability to create an earthquake in fault
0.0707	0.0200	0.0200	0.0150	0.0009	0.0058	0.0058	0	0.0003	Earthquake severity
0.0694	0.0214	0.0214	0.0192	0.0058	0.0013	0	0.0002	0.0001	Earthquake acceleration
0.0694	0.0214	0.0214	0.0192	0.0058	0	0.0013	0.0002	0.0001	Magnitude of earthquake
0.0680	0.0228	0.0228	0.0205	0	0.0002	0.0002	0.0014	0.0001	Earthquake focal depth
0.0009	0.0003	0.0003	0	0.0001	0.0001	0.0001	0.0001	0.0001	Slope

0.0075	0.0013	0	0.0058	0.0001	0.0001	0.0001	0.0001	0.0001	Maternal materials
0.0075	0	0.0013	0.0058	0.0001	0.0001	0.0001	0.0001	0.0001	Depth of soil
0.3803	0.1023	0.1023	0.102	0.0246	0.0203	0.0203	0.0077	0.0009	J

Table 11. The possible relative severity matrix of all direct and indirect relationships of physical vulnerability of the city of Abpakhsh in earthquake

Distance from traffic points	Distance from micro-industry and workshop	The distance from the relief centers	access	Compatibility	Urban texture	Number of floors	Old building	Materials	Seismicity	Indicators
0.007	0.006	0.007	0.008	0.008	0.008	0.008	0.009	0.001	0	Seismicity
0.007	0.007	0.008	0.009	0.009	0.009	0.009	0.010	0	0.0003	building materials
0.009	0.007	0.010	0.005	0.005	0.005	0.001	0	0.0004	0.0004	Old building
0.001	0.0005	0.002	0.002	0.002	0.002	0.002	0.002	0.0005	0.0006	Number of floors
0.0005	0.0005	0.002	0.002	0.002	0	0.002	0.002	0.0005	0.0005	Urban texture
0.0005	0.0004	0.0005	0.002	0	0.002	0.002	0.002	0.0005	0.0005	Compatibility
0.0005	0.0004	0.0005	0	0.002	0.002	0.002	0.002	0.0005	0.0005	Access
0.0005	0.010	0	0.002	0.002	0.002	0.002	0.0003	0.0005	0.0005	The distance from the relief centers
0.002	0	0.002	0.002	0.002	0.002	0.002	0.0004	0.0005	0.0006	Distance from micro-industry and workshop
0	0.001	0.002	0.002	0.002	0.002	0.002	0.0004	0.0005	0.0006	Distance from traffic points

Step Four: Create causal Chart:

1. (R): The sum of the elements in each row and indicates the effect of the factor on the other operators of the system.
2. (J): The sum of the elements of each column and indicates the extent of its effect on other factors of the system.
3. (J + R): The extent and impact of the factors and the indicator of the interaction of each factor with other factors. In other words, the greater the (J + R) of each parameter, the greater its interaction with other factors.
4. (J-R): The final value of the effect of each agent on other factors

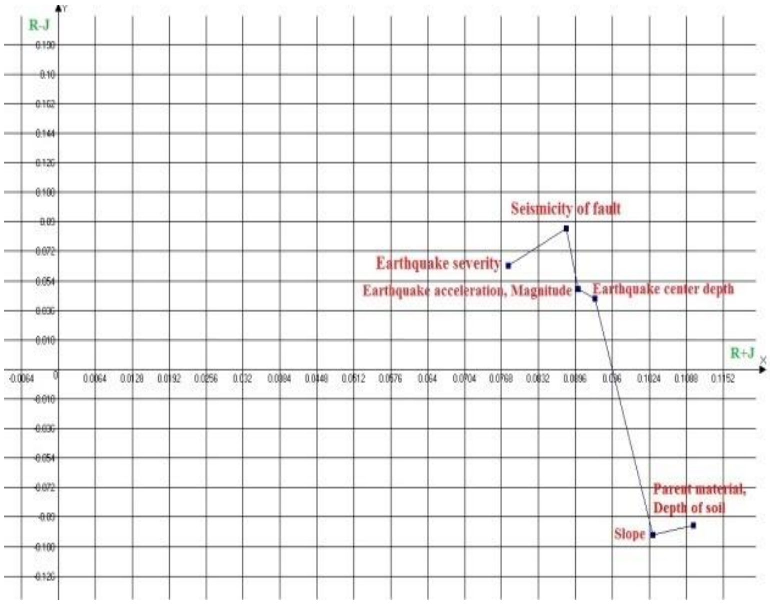

Figure 14 Final graph (causal diagram) Seismicity

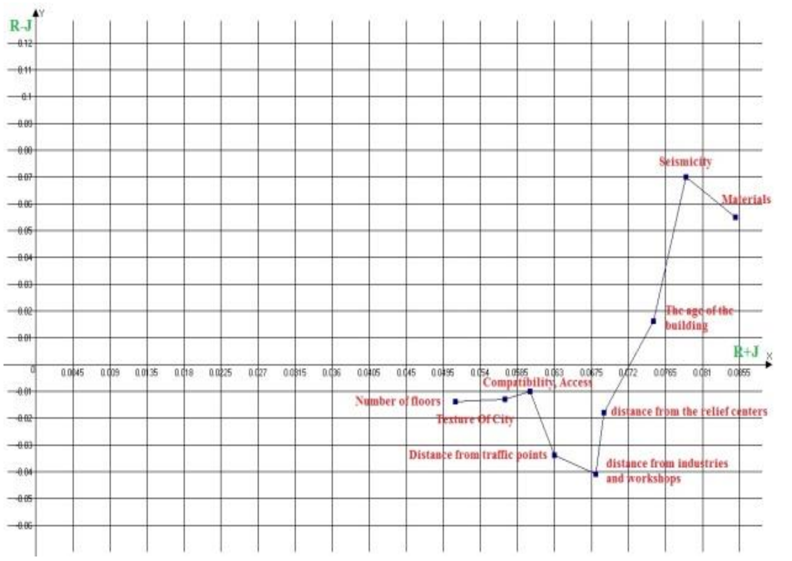

Figure 15. Final graph (causal diagram) Physical vulnerability

Table 12. Weight of Seismic Parameters Based on Dematel Method

Rank	R-J	R+J	J	R	Indicators
1	0.09	0.088	0.001	0.087	The ability to create an earthquake in fault
2	0.06	0.78	0.008	0.071	Earthquake severity
3	0.05	0.09	0.020	0.069	Earthquake acceleration
4	0.05	0.090	0.020	0.069	Magnitude of earthquake
5	0.04	0.093	0.025	0.068	Earthquake focal depth
8	-0.09	0.103	0.102	0.001	Slope
6	-0.09	0.110	0.102	0.007	Maternal materials
7	-0.10	0.110	0.102	0.007	Depth of soil

Table 13. Weight of physical vulnerability parameters based on Dematel method

Rank	R-J	R+J	J	R	Vulnerability Indicators
1	0.070	0.079	0.005	0.074	Seismicity
2	0.055	0.085	0.015	0.070	building materials
3	0.016	0.075	0.030	0.046	Old building
7	-0.014	0.051	0.032	0.019	Number of floors
6	-0.013	0.057	0.035	0.022	Urban texture
4	-0.010	0.060	0.035	0.025	Compatibility
5	-0.010	0.060	0.035	0.025	Access
8	-0.018	0.069	0.043	0.025	The distance from the relief centers
9	-0.041	0.068	0.055	0.013	Distance from micro-industry and workshop
10	-0.034	0.063	0.049	0.007	Distance from traffic points

Final stage (Integration of maps and final map production): This is achieved by overlapping weighted maps using Dematel and AHP methods. As a result of the combination of weighted layers, in each method, the physical vulnerability map and seismic power generation capability were provided in the ArcGis software environment (Fig. 16). It should be noted that in this study all weights are calculated using Excel software.

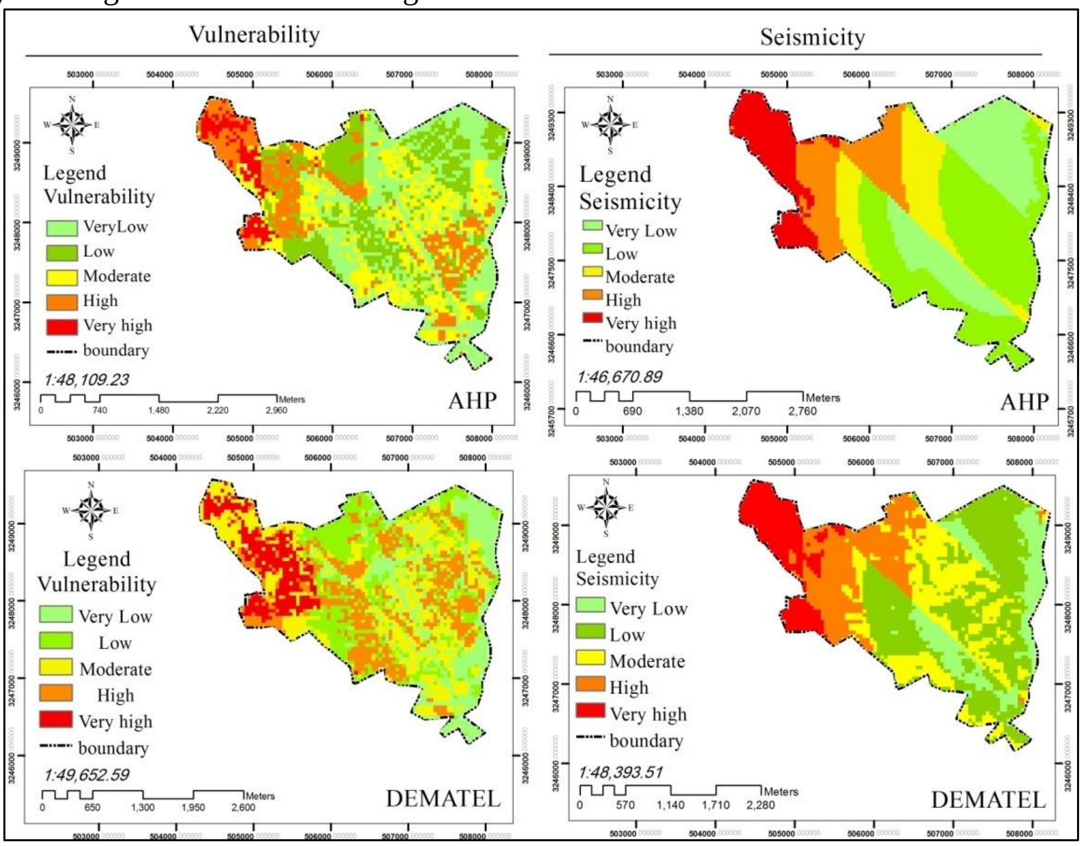

Figure 16. Seismic Mapping and Physical Vulnerability of Abbakhsh city

4. CONCLUSION

Abpakhsh is one of the regions of Bushehr province, where the probability of earthquake occurrence is very high. Due to the presence of numerous and active Qatari-Kazeroon, Borazjan, Rag sefid and Zagros faults, this region has been exposed to numerous and sometimes severe earthquakes with a maximum magnitude 5 on the Richter scale. Therefore, in the present study, after providing basic maps of Abpakhsh's physical vulnerability to earthquakes such as seismicity, urban texture, number of building floors, building materials, access and distance from the relief centers, weighing the parameters and eventually Using two models of hierarchical analysis system and Dematel, we examined the status and map of seismic zoning and vulnerability map in this area. Accordingly, according to the studies conducted by Dematel, the higher the J-R value of each parameter, the most influential parameter is the most significant parameter in comparison with other parameters. Also, when J + R is greater, it has more interaction with other factors. Accordingly, and according to the calculations, although both Dematel and the hierarchical analysis method both compare the paired values of each element with respect to other parameters, there are differences between the two methods. The Dematel model focuses solely on the effectiveness and Impact of an element relative to other parameters and the hierarchical analysis model compares the weight of the classes of each criterion based on the preference of a class for all classes of that criterion, however, the results in both models are similar in terms of land suitability. So, in the hierarchical analysis model, seismicity and earthquake intensity parameters of 0.259 and 0.251, respectively, for the seismicity sub-index and seismic parameters and materials for physical vulnerability were respectively 0.35 and 022 with the highest weighting priority. In the Dematel method, the fault seismicity and earthquake severity were respectively J-R: (0.086 and 0.063) for seismicity and seismicity sub-index and building materials, respectively, with J-R: (0.070 and 0.055) for physical vulnerability, The most influential maternal agents and soil depths with J + R (0.110) and slope with J + R (0.103) for seismicity and building materials with J + R (0.085) and seismicity with J + R (0.079), for physical vulnerability, the most interoperable parameters are in the area of seismicity and physical vulnerability of Abpakhsh city. In other words, in this city, when the slope of the earth is less, the maternal material is more resistant and the depth of the soil is less, the effect will be less than the parameters of the seismicity of the fault and the severity of the earthquake, and therefore the lands with these conditions in the city of Abpakhsh in earthquake will be more resistant. Of course, this should not ignore the role of urban physical parameters such as: type of materials, number of building blocks, building age, distance from relief centers, and so indicators in the aggravation of seismic conditions, increased physical vulnerability and tissue of this city. The accuracy of this issue is well illustrated in the results of this study. In accordance with the results, with increasing effectiveness, the impact is reduced, this issue is well shown in Tables 12.13 and 16. So that when we move towards the northwest of the city, the amount of seismicity and damage will increase. Another example is the urban texture. According to Fig. 10 and Table 13, the old and irregular texture of the city with J 0.035 is one of the most impressive indices relative to the seismic parameter. Therefore, when the urban texture is more regular and the number of classes, the age of the building and the distance from the centers of relief is less, and building materials are more resistant, Less effectiveness to seismicity is observed and as a result, the severity of the damage to the city is reduced. It should be noted that the city lacks a passenger-capable airport, however the city's spraying airport was considered as one of the sub-criteria of the relief centers index due to the ability to cover aircraft landing.

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