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Identification and evaluation of physical indicators affecting emergency accommodation and safe places with physical resilience approach Case study: District 11 of Mashhad

Hamideh Deloui[1], Sanaz Saeidi Mofrad[2]

1. Islamic Azad University, Mashhad Branch, Faculty of Art and Architecture, Department of Urban Planning, Iran
2. Depatment of urbanism, Mashhad branch, Islamic Azad univesity, Mashhad, Iran

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Abstract
One of the factors that can affect crisis management is the resilience of urban areas. If we can make the regions resilient, in the next step we will be able to take the necessary measures after the crisis. The aim of this study is to analyze the physical indicators of resilience in District 11 of Mashhad. Research indicators in the discussion of physical resilience are the length of the main pipes of the facility, the network of arterial passages, buildings over 30 years old, hospital beds in proportion to population, area built and earthquake-resistant buildings. In relation to the location of these spaces, indicators of access to the communication network, medical services and population density and distance from fault factors, canals, aqueducts, gas and CNG stations, gas and electricity transmission lines, high-rise areas, high-rise buildings, the measurement is located. The research method is descriptive-analytical and applied in terms of purpose. For data analysis, the method of average sum of optimal distance distances is used, which is a quantitative method. In discussion of locating safe spaces, GIS software with Boolean location model method has been used. The results indicate that region 11 of Mashhad is physically resilient and the region has been proposed as suitable and unsuitable zones for location.

Keyword: *urban resilience, physical-environmental resilience, emergency accommodation, safe places*

1.Introduction
The environmental problems associated with the subject of urbanization are rooted in both ecological and urban planning [1]. This has led to the formation of common research areas in these two sciences. One of these fields of research is the resilience of the urban system [2]. Factors such as natural disasters, climate change, political instability, financial crisis, food security and terrorist attacks play a significant role in threatening cities [3]. The intersection of environmental, economic, social crisis and the growth of spontaneous urban settlements on a global scale draws attention to the urban resilience approach with a more comprehensive view of previous approaches such as crisis management in these settlements and is considered on the global agenda [4].
Today, new approaches to crisis management have prescribed the transition from the concepts of vulnerability to resilience and strengthened the ability of people to deal with the dangers of natural and man-made disasters. In fact, resilience as a framework goes back to a concept that can easily relate to all stages and sections of disaster and crisis management [5]. Resilience is introduced with four dimensions: institutional, social, economic and infrastructural (physical-environmental) ones. Physical factors act as the body of the city and act like human body anatomy, arteries and muscles in times of danger. The physical system must be able to play its role and function under the pressure of dangers, a city without a resilient physical structure will suffer a lot [6]. Emergency accommodation and identification of safe places after natural disasters in order to organize people and prevent them from wandering and planning in better and more appropriate services play a significant role. In the field of urban planning issues, the location of emergency accommodation sites is one of the issues that is both a function of multiple variables and consists of interrelated variables that are affected by broad social, economic, political, physical and environmental aspects [7]. During the crisis, temporary accommodation takes place depending on the type of threat in the parts of the city that have the highest security factor [8]. In locating accommodation centers, elements such as network of roads, vulnerability of areas, proximity to medical centers are important [7]. These elements are also related to the physical-environmental resilience of the city. For example, the city's communication network plays a critical role in determining resilience in the face of crisis. If the city's communication network is not damaged during and after the crisis, the casualties will be greatly reduced and it will be possible to escape to

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*Corresponding author.
Saeedi.s@mshdiau.ac.ir

safe areas away from the crisis as well as rescue management [9]. Despite significant advances in recent years, existing methods for measuring urban resilience have only been analyzed for specific disturbances, either in terms of engineering resilience or ecological resilience and from an environmental perspective [10]. Therefore, despite the presentation of some indicators of urban resilience based on a review of the theoretical literature, it is necessary to further investigate this issue from different angles, especially based on the physical dimensions of urban resilience. And this issue should be addressed in relation to post-accident crisis management, including the need to identify safe places for housing. Mashhad, which is located in a construction hole in the north-east of Iran, is approximately 20 km from the east and south-east with a fault with a length of about 10 meters and about 2 km from the south and south-west with a fault with a length of about 90 km. Also, according to studies, Mashhad is in a moderate risk area in terms of seismicity. The fault south of Mashhad has the most impact in region 11 and unfortunately at present most of this fault is covered by residential units. Regarding the risk of floods, it can be said that about 32% of the total canals in the city of Mashhad are located in the south-western part of the city. A significant percentage of the canals have been constructed, blocked or covered by Canalization. Many roads have been abandoned and the lack of attention to these points inside the city and residential areas has created defenseless spaces and insecurity for the urban fabric of District 11. The Main purpose of this study is the Analysis of indicators and physical measures of resilience in District 11 of Mashhad Municipality according to selected indicators in resilience. Therefore, the research most important question that we are trying to answer is: How is the situation of the nine districts of Mashhad, in terms of physical indicators of urban resilience?

2. Literature Review

2.1. The concept of resilience

In the 1980s, the approach of reducing vulnerability and dealing with crisis, dominated the theoretical texts of crisis management. From the 1980s, and especially the 1990s, social scientists have argued that vulnerability also has a social character and is not limited to demographic and physical damage. Since then, efforts have been made to change the prevailing paradigm of crisis management [11]. The common denominator of all these definitions is the capacity for reversibility, adaptation, disaster absorption, system failure, flexibility and survival, which is used to deal with disruption and adaptation of societies to it.

2.2. Physical-environmental resilience

Physical resilience includes assessing community response and post-disaster recovery capacity such as shelters, housing units, health facilities and infrastructure such as pipelines, roads and their dependence on other infrastructure. Also includes physical systems such as number of pipelines, roads and critical infrastructure, transportation network, land use, type of housing (villa-apartment), material type, building strength, building quality and age, ownership, type of construction Structure, height of buildings, open space of residential building, green space, density of built environment, type of housing, potential for evacuation access, geographical features (geotechnical characteristics-slope), intensity and recurrence of hazards, identification of safe places, fault identification, Distance from vulnerable areas, proximity to hazardous areas [12]. Ahmadzadeh Kermani and Aminzadeh Goharrizi (2020) [6] in an article entitled Evaluation of urban resilience dimensions using the average method of total distances from the optimal limit of resilience indices in three dimensions of social, economic and physical. In the table below, these indicators are specified along with the definition, relationship and measurement: Table2.

2.3. Emergency accommodation and safe places

Providing settlements for victims in times crisis is called housing, which includes four sections: emergency shelter, temporary shelter, temporary housing and permanent housing [13]. Safe space refers to a space that is less at risk of the effects of loads caused by the explosion and has more safety and resistance than the spaces of ordinary buildings or open space [14]. In the times of crisis, temporary housing, depending on the type of threat and relying on the evacuation and emergency housing zoning plan, becomes necessary when parts of the city lose their residential safety and at the same time other parts of the city are safe [15]. This accommodation in the city, in addition to making the evacuated population feel better psychologically, reduces evacuation costs and makes it easier to access due to the familiarity of the people with the structure of the city [16]. Criteria for locating assist and accommodation centers include four indicators of safety, efficiency, effectiveness and equipment:

A- Efficiency means the suitability of the intended area for the establishment of bases. Criteria of this section include physical characteristics of the tissue (including worn tissue layer), physical characteristics of the area (including appropriate area layer), population density criteria (including population density layer) and communication network access criteria (including grade 1 arterial road layers, 2nd degree arterial road and local streets).

B- Compatibility: One of the main goals of urban land use planning is to locate different uses in the city and separate incompatible uses from each other.

C- Safety: Safety means the location of the base against the dangers of crisis conditions that occur at the base or affect the area around the base. The criterion of geological characteristics and the criterion of

observance of privacy with incompatible uses are placed in this section [7].

3. materials and methods

The research method in this article is descriptive-analytical and in terms of purpose is considered as applied research. The collection of materials has been done through the use of library resources and documents. This method was first introduced by Seyed Ainuddin [17], in assessing the resilience of two provinces in Balochistan, an article published in the journal Natural Hazards in 2012. In this study, the numerical value of each index is expressed as a percentage so that there is no need for the process of normalization of indicators. Determining the resilience of District 11 of Mashhad Municipality requires defining the optimal limit or standards that this optimal level obtained by Hadi Dadashpour [11] in the article Resilience Capacity Measurement, published in the Bi-Quarterly Journal of Crisis Management. According to the method of average sum of distances from the optimal limit to obtain the distance to the optimal limit, the situation in each index should be divided by the specified optimum limit on that index. Thus, the resilience distance of each index with the optimal limit is obtained:

Optimal standard / actual amount of each indicator in percentage: FRI [1]

For data that is inversely related to resilience, this formula would be the opposite; The actual amount of each indicator to the desired percentage / standard level: FRI

By summation of the distances obtained for each index of the optimal value in each dimension of resilience, we can calculate the amount of resilience distance of the 11th district of Mashhad Municipality from the optimal resilience in that dimension of the physical body. Accordingly, the amount of resilience in various dimensions is:

$$\boldsymbol{CRI}: \sum_{1}^{n} \frac{\boldsymbol{RFI}}{\boldsymbol{n}}$$

According to the desired indicators and their comparison with optimal numbers, a spider diagram is drawn to better understand the pattern so that the difference between resilience and the standard limit can be understood. The optimal limit of urban resilience components of these numbers is expressed as a percentage, which is shown in the table below: Table 3. In the second step, in order to locate safe spaces and emergency accommodation, a combination of effective criteria in locating this issue has been used. It is noteworthy that the basic and effective criteria for location in this study have been collected with reference to scientific and specialized sources. This operation has been done in GIS software. There are different models for locating with GIS, the use of these models depends on the type of location desired by the researcher. Therefore, in this study, the Boolean model has been used due to its valuation system, which is a suitable model for locating emergency and relief accommodation centers and other cases that have a special sensitivity. The weights of the gauges (layers) are applied evenly. Determining the total value of each point, after converting the raw data into a raster structure and classifying the layers, is summarized in the ArcGIS environment. The output is obtained by overlapping the collected items, which leads to the production of a map according to the results of multi-criteria decision analysis.

4. Understanding the field of research

Mashhad plain is formed due to tectonic movements of several parallel faults that run parallel to the mountain range of the region from north-west to south-east and have a steep depression. Due to the existing faults, this city is always exposed to destructive earthquakes. The fault south of Mashhad has the greatest impact in the District 11 and unfortunately at present most of this fault is covered by residential units. About 32% of all existing roads in Mashhad are located in the south-western part. but there is now an environmental risk of flooding in the area. This issue becomes even more important when we refer to the strategic plan for organizing the canals and realize that a considerable percentage of the canals have been constructed or blocked or canalized indoors [18].

According to the statistics presented in the statistical yearbook of the municipality in 2016, the municipality of the 11th district of Mashhad with an area of 1592 hectares is composed of two service areas and has a population of 200,161 people [19]. Therefore, it has a population density of 125 people and this amount is higher than the average population of the city, which is about 86. The high population density in this area doubles the importance of crisis management planning compared to other areas of the city. Of the total area (1592 hectares), 758 hectares with a relative share of 49.40 percentage are allocated to full texture and 777 hectares with a relative share of 50.60 percentage are allocated to open urban lands in which no construction has been done and includes uses of canals, roads and parks. Considering that the necessary preparations have been made at all levels of the region; It can be said that the facility lines are distributed throughout the region. Occupying 540 hectares of land in the region, after residential use, the road network is the widest type of land use in the area. The area of the road network is about 40.72% of the net urban land area of the region and 33.97% of the total land area of the district. This area, which has been formed and developed mainly in the last 30 years, has very few buildings with a lifespan of more than 30 years. But earthquake-resistant buildings also have a small percentage in terms of type of structure, so that only 21% of buildings in the area have steel structures and reinforced concrete. There is

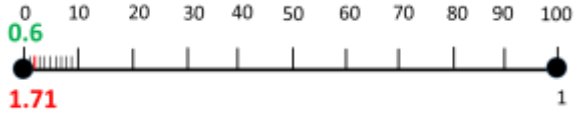
no hospital in District 11, but there are two hospitals on the border between Districts 9 and 11 that can provide assistance if needed.

5. Results and discussion

In this section, first the indicators mentioned in the physical dimension will be mentioned along with the relevant number. For a better comparison, the optimal limit numbers are shown in green and the percentages in the area are displayed in red on the chart.

1.The length of the main pipes of gas, water, oil and…:

2.The area of 1592 hectares of District 11 of the municipality is covered by 272,435 meters of water, gas, electricity and telephone facilities, so the ratio of the length of installation pipes to the area is 1.71%, while this value is based on the optimal limit of 0.6:

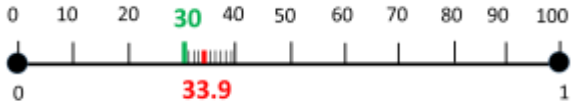


Graph No. 1: Comparison of the optimal limit and the numerical amount of the length index of the main gas, water, oil and ...

3.The level of the network of passages with arterial function

According to the land use table in the studies of the south-western part of Mashhad, out of 1592 hectares, the area of District 11 of the municipality, 540,5592 square meters, is allocated to the road network.

Therefore, it can be said that 33.93% of the region is covered by the road network. The optimal limit in this index is 30% and this index is directly related to resilience:



Graph No. 2: Comparison of the optimal limit and the numerical amount of the road network index with arterial function in the region

4. Buildings over 30 years' old

According to the detailed plan of the year of completion of the building, out of 24,911 registered buildings in 1938, it is more than 30 years old, which covers 7.78% of the buildings. The optimum limit in this index is 25% and considering that the mentioned index is inversely related to resilience, region 11 is in a very good position in this index:

Graph NO. 3: Comparison of the optimal limit and the numerical value of the index of buildings older than 30 years

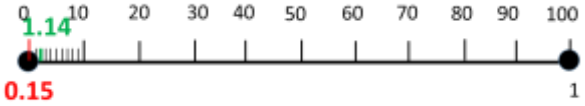
5. Number of hospital beds per population

There is no hospital in District 11, but there are two hospitals on the border between Districts 9 and 11 that can provide assistance in times of need. Hospitals are as follows:

-Javad Al-A'meh Hospital: Meybashd Heart Specialized Hospital is located at the beginning of Honaristan Boulevard and has 100 beds.

- Farabi Hospital: This hospital is located at the corner of Kowsar and has 302 beds.

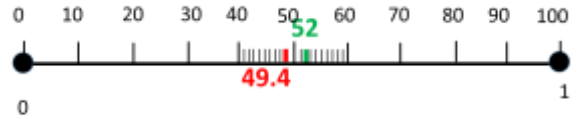
Considering the population of the region and dividing the total of 302 beds by the population of the obtained index, it is about 0.15%. While this number is in the optimal range of 1.4%:



Graph No. 4: comparing of the optimal limit and numerical amount of hospital bed index to population

6.Level made in the area

The higher the level built in the area, the more vulnerable the area will be. The percentage of the built-up area relative to the total area is used to measure this index. Therefore, the built-up area of the area is 49.40, with an optimal limit of 52%:



Graph No. 5: Comparison of the optimal limit and the numerical amount of the constructed level index

7.Percentage of earthquake resistant buildings

According to the definitions of the executive regulations of the Engineering System Organization, buildings can be considered earthquake resistant if they follow this regulation and also have mainly steel frame and reinforced concrete. According to the statistics of the detailed plan of the south-western basin in region 11, out of 42243 residential units, 42243 have steel frames and reinforced concrete. Therefore, it can be said that the number covers only 21% of the houses in the area. While the optimal limit for this index is 60%:

Graph No. 6: Comparison of the optimal limit and the numerical value of the index of earthquake resistant buildings

In the table below, the optimal limits of all indicators are examined and the percentage of indicators in the region is also extracted. Quantitative values of FRI and CRI are obtained according to the formula, which determines the degree of resilience in the indices and the physical dimension. It was found that the indices of installation pipe length, number of hospital beds and earthquake resistant buildings in the region is not in a good position to withstand the approach. But in general, in the physical space dimension of the region, with a CRI of more than 1.36, it is in a good position (quite resilient) compared to the optimal number After determining the physical resilience in Region 11, safe places for these spaces can be identified. In this study, effective criteria are classified into three indicators of accessibility, safety and physical space. For each indicator, metrics are considered, which are given in the table below with explanations: The final output of the linear combination is made by overlapping the layers produced for each measure in the GIS software environment. Map 1 shows the final location of these spaces. As we can see in the map, these places are classified into two categories, appropriate and inappropriate (based on Boolean logic). As it turns out, the northern part of the region which is called "Chehel Bazeh" Canal and also being non-residual, is not suitable for this purpose, and often the central and eastern parts of the region have been suggested for location.

Table 1: Different definitions of urban resilience from theorists [6]

The Writer	Definition
Holling, ۱۹۷۳	The ability of stressed systems to recover and return to their original state.
Timmerman, ۱۹۸۱	Resilience is the capacity of a system or part of it to absorb and recover after an accident.
Adger, 2000	The power of groups and societies is to adapt to external pressures and the destruction that results from social, political, and other changes.
Pelling,2003	The ability of a social factor to cope with or adapt to risky tensions.
Pickett et al,2004	The ability of a system to adjust to changing conditions.
Campanella,02006	The capacity of a city to recover from destruction.
Norris,2008	The ability of social units to reduce risks includes the effects of events and disasters, and to minimize social disturbances during reconstruction activities and reduce the destructive effects of future earthquakes, also to perform recovery activities to reduce social disruption by taking advantage of opportunities.
Ernston et al, 2010	Create a transformation capacity to protect a dynamic and specific organization in the face of uncertainty and change.
Leichenko,2011	Ability to withstand a wide range of shocks and stresses.
Asprone and Latora, 2013	The capacity to adapt or respond to events is usually of destructive and unusual origin.
American Psychological Association,2014	Resilience is the process of adapting properly in the face of adversity, threats and even significant sources of stress and strain.
Kutum and AlJaberi,2015	Resilience refers to the capacity of ecological systems to absorb disturbances as well as to maintain feedback, necessary and inherent processes of the system.

Table 2: Investigation of physical indicators of urban resilience [6]

Indicator	**Relation**	**Measurable gauge**
Adherence to construction principles and laws	Direct	The ratio of buildings that have complied with this regulation of the building engineering and control system to the total number of buildings.
Response rate of health services	Direct	Ratio of hospital beds to population.
The amount of access to texture	Direct	Ratio of arterial pathways to the total area.
Life of buildings	Reverse	Ratio of buildings over 30 years old to total buildings.
Distribution rate of urban facilities	Reverse	The ratio of the length of the main pipes of water, gas, electricity, oil, etc. to the area.

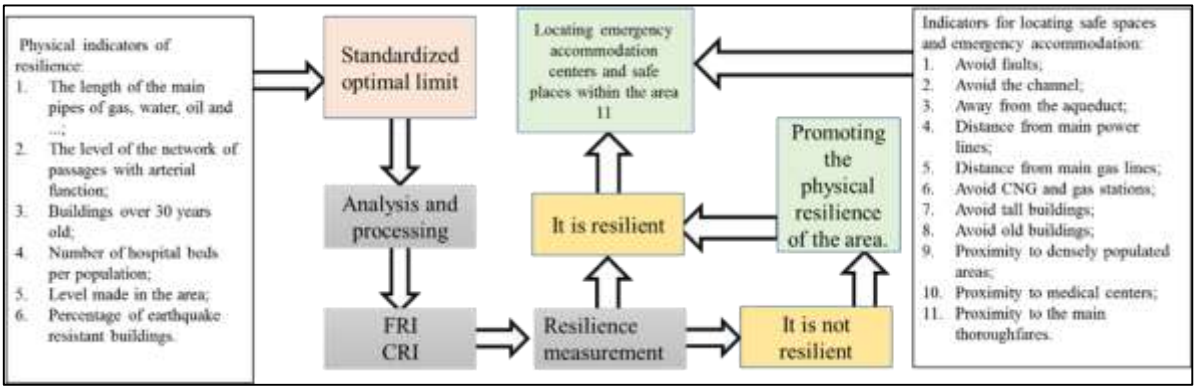


Figure 1: Conceptual model of research

Table 3: Optimal limits of physical resilience indices [٦]

Indicator	**The optimal limit**
The length of the main pipes of gas, water, oil and ...	0.6 percent
The level of the network of passages with arterial function	30 percent
Buildings over 30 years old	20 percent
Number of hospital beds per population	1.4 percent
Level made in the area	52 percent
Percentage of earthquake resistant buildings	60 percent

Table 5: Quantitative values in the region and measurement of resilience indices in the physical dimension

Dimension	**Indicator**	**The optimal limit (Percentage)**	**Percentage in the area**	**FRI**	**CRI**
Physical	The length of the main pipes of gas, water, oil and ...	0.6	1.71	0.4	1.36
	The level of the network of passages with arterial function	30.0	33.9	1.1	
	Buildings over 30 years old	40.0	7.78	5.1	
	Number of hospital beds per population	1.4	0.15	0.1	
	Level made in the area	52.0	49.4	1.1	
	Percentage of earthquake resistant buildings	60.0	21	0.4	

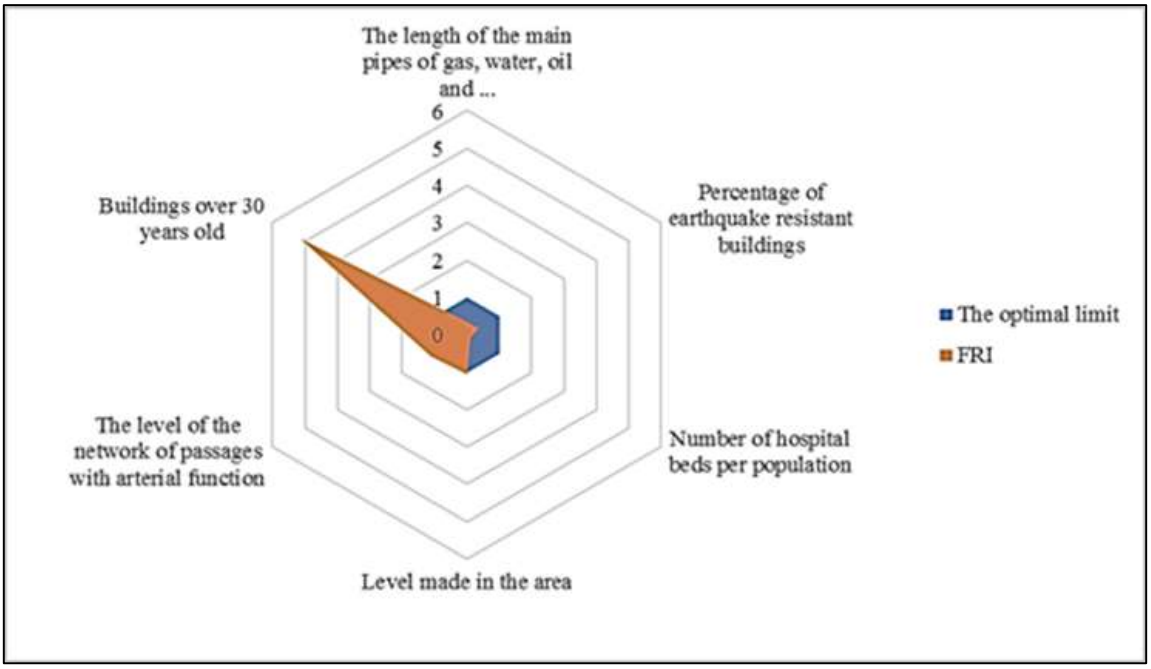
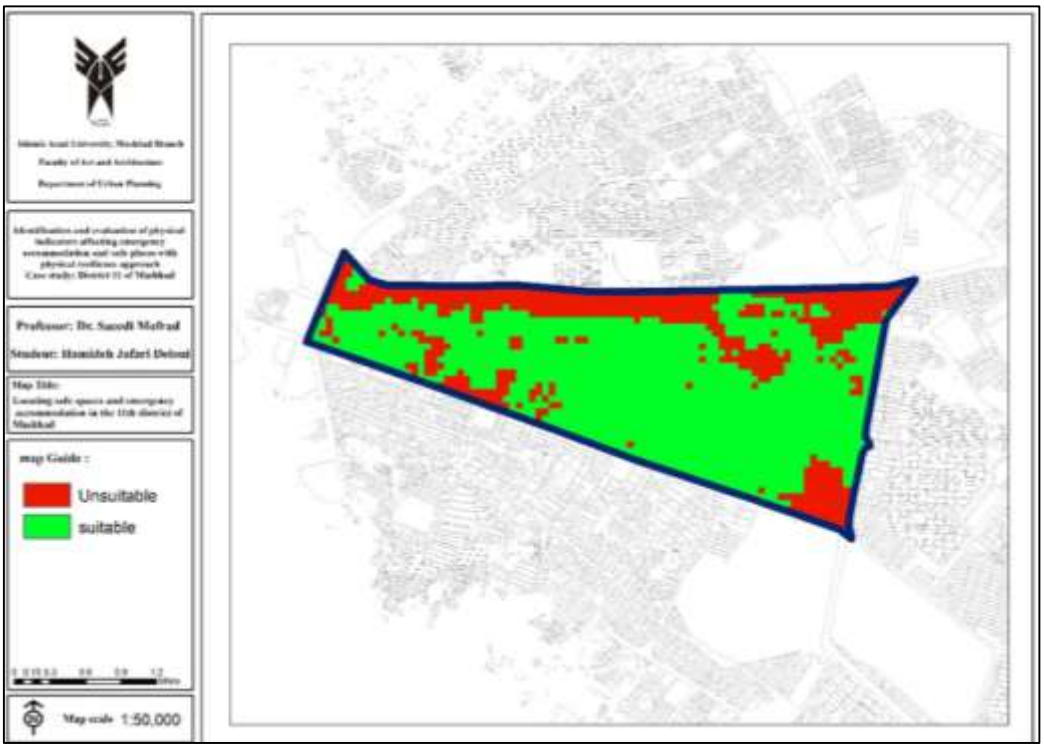


Figure 2: Spider model Comparison of resilience indices with standard limits in the physical dimension.

Table 6: Factors affecting the location of safe spaces and emergency accommodation in District 11 of Mashhad

Indicator	**Measurement**	**Description**
access	Access to the communication network	Facilitate the delivery of humanitarian aid within 100 meters of the main road
	Access to health care	Distance from clinic and health centers 700 meters
Safety	Distance from the fault	Distance from the fault: 200 meters
	Distance from the channel	Distance from the aqueduct and the river: 100 meters
	Distance from the aqueduct	
	Distance from gas and CNG stations	Distance from the station: at least 200 meters
	Distance from the gas transmission line	Distance from the gas route: at least 50 meters
	Distance from power transmission line	Distance from high voltage power tower: more than 100 meters
Physical - environmental	Distance from highly dated areas	Avoid areas with a long history
	Distance from tall buildings	Distance from high places: $\mathbf{1/2}$ height of the building
	Population Density	Proximity to denser residential areas



Map No. 1: Locating safe spaces and emergency accommodation in District 11 of Mashhad

6. Conclusion and Recommendations

The aim of this study was to investigate the physical measures of resilience in District 11 of Mashhad Municipality according to selected indicators in resilience. Physical indicators include the length of the main pipes of gas, water, oil, etc., the level of the network of arterial passages, buildings over 30 years old, the number of hospital beds per population, the level built in the area and the percentage of Earthquake resistant buildings.The results obtained in the discussion of physical resilience shows that District 11 of Mashhad Municipality is not resilient to the indices of the length of the main pipes of gas, water, oil, etc., the number of hospital beds per capita and the percentage of earthquake resistant buildings. Therefore, it is important to pay significant attention to these indicators. But in general, Region 11 is resilient; Therefore, it is possible to locate for emergency accommodation and safe places in the event of an accident within the area. Following this step, secure spaces were located in the GIS environment. According to the information collected from geographical layers and access restrictions, criteria for avoiding faults, canals, aqueducts, high pressure gas and electricity lines, gas and CNG stations, tall and old buildings as a limit or measure Privileges and access to main thoroughfares, access to medical centers and placement in areas with high population density are considered as positive facilities or measures. The results show that the northern zone (Chehel Bazeh Canal) is completely unsuitable, but a large part of the area, often in the center and east, is suitable for location.The following are suggestions for increasing the physical resilience of the region in order to locate emergency accommodation and safe places in Region 11:

1. Construction of a new hospital in District 11 and location of a safe place within a radius of 1000 meters;
2. Location of medical centers near the arterial roads of the region;
3. Rehabilitation of the building of the region using modern retrofitting methods;
4. Proximity to open and unbuilt spaces in the area such as parks and green space.

In this study, only the urban resilience of District 11 was physically examined. It is suggested that more extensive research should be conducted on the various dimensions of resilience.

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