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Park as a Driver in Mitigation of Vulnerability during and after Earthquake Case of Tehran's Beryanak Neighborhood

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Abstract: Nowadays, vulnerability of cities to earthquake, especially in deteriorated urban areas, has become a global issue for the experts of different fields. Tehran's Beryanak neighborhood as an old and worn-out texture, with perfect green spaces, is exposed to the risks of earthquake. Given the role that parks and green spaces play, by providing immediate shelter and escape for the residents and as there are numerous parks in Beryanak neighborhood, this area was chosen and its green spaces were analyzed. But every park should have some features to be more functional and usable during an earthquake and its aftermaths. In this study, a good park's physical and functional criteria for its performance against an earthquake and after it are introduced, and then using Analytical Hierarchy Process (AHP) the neighborhood's parks are evaluated and prioritized in terms of these criteria. The obtained results suggest that the physical criterion, compared to functional criterion, has more weight in terms of its function during and after earthquake. Similarly, the neighborhood's Hezarshahid Park, due to the low number of its floors and as its surrounding buildings are new, as well as because of its large size and fairly regular geometric form is quite functional during and after earthquake.
Keywords: Beryanak neighborhood; park or green space; AHP; earthquake; vulnerability

Introduction

Nowadays, vulnerability of cities to earthquake, especially in deteriorated urban areas, has become a global issue for the experts of different fields. This issue, in earthquake-prone countries including Iran has drawn more attention to itself in recent years. Tehran's being located in an area which seismicity is one of the natural hazards has exposed the city to the hazards of a possible earthquake and its different consequences.

Tehran's beryanak neighborhood is one of the oldest areas in Tehran with old buildings and narrow streets which has a worn-out texture and if a disaster happens can be held to huge losses. Therefore, to deal with this natural phenomenon and mitigate its aftermath hazards in the neighborhood, preparedness is inevitable. Preparedness to deal with earthquake has different aspects and using urban planning arrangements, urban planning and design can be done in such a way to reduce the possible damages during an earthquake.

When, because of limited time, it is impossible to move people into a fixed accommodation, temporary shelters such as parks can be offered to the victims to take a refuge after a disaster and during the rescue period. When a natural disaster happens, people in the area are usually evacuated primarily into the parks or other large open spaces. In such situations the shelter is often a temporary one. Planning

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safe and near places, such as parks where people can be immediately accommodated after an earthquake, is typical of this kind of temporal and emergency shelter planning in a neighborhood (Xu et al, 2006). But the crucial point is that every park should have some features to be more functional and usable during an earthquake and its aftermaths. In this regard, the current study is going to answer the following two questions:

1. What are the features and standards of a perfect and usable park during and after earthquake?
2. Which park in Tehran's Beryanak neighborhood can be more functional if an earthquake happens?

Materials and Methods

In this study, for the first step, the theoretical foundations of the subject which have been collected by means of library and archival methods are discussed so that based on it we can provide a theoretical framework that includes the most important criteria and sub-criteria considered in the performance analysis of the parks during an earthquake. Then the selected area and its green spaces are identified in terms of the chosen criteria and sub-criteria that are: 1- the physical criterion consists of the following six sub-criteria: the age of the buildings surrounding the park, quality of the buildings surrounding the park, the number of floors of the buildings surrounding the park, leading accesses to the parks, the park's form and geometry and the size or area of the park; and 2- the functional criterion consists of two sub-criteria of the park's compatibility with its surrounding uses and environment, and attracting the population of the surrounding uses. After obtaining opinions of the experts, Analytical Hierarchy Process was used to prioritize and evaluate the parks' functions during and after an earthquake. For this purpose, binary comparison matrices of the criteria and sub-criteria are made. Then these matrices are entered into the Expert Choice software in order to estimate the importance coefficient of the research's criteria and sub-criteria.

The Role of the Parks against the Hazards of an Earthquake

A fixed seismic shelter is a place where evacuated people, who are influenced by a disaster, can stay for a longer time in order to receive help. In an earthquake evacuation planning, instead of very specific places, only those places are recommended that provide "emergency seismic shelters for evacuation arrangements." The most leading seismic shelters are usually the large-sized places that have specific facilities. Therefore, the most vital action in an earthquake evacuation planning is to select a fixed seismic shelter for evacuation (Chua and Su, 2012).

A perfect park or green space can prevent and mitigate the hazards of different disasters, either natural or man-made. Similarly, because of its large size and accessibility it can be used as an emergency shelter. A green space can be used both as a shelter for the homeless people and provide them with emergency medical services. "Small green places of the central parks" and green places attached to the residential areas are among the emergency shelters. Green spaces can provide emergency shelters and immediate escape (3 to 7 min) when a disaster unexpectedly happens (Fan et all, 20112).

Such emergency places as parks play a leading role to guarantee people's safety and mitigate the losses before, during and after earthquakes (Tiejun et al, 2012).

Green spaces can provide a large number of people, who need to be adapted very quickly with their new environment, with a sanctuary and temporary shelter (Allan & Bryant, 2010). When a severe earthquake happens, a green space like a "second city" provide people with many functions such as "gathering and shelter, the distribution of goods and services, the re-establishment of commerce, temporary inhabitation, commemoration, and the storage of contaminated or hazardous materials" (McGregor, 1998, Middleton, 2007).

According to what was mentioned and several researches done in this area, some criteria are suggested to improve the function of the green spaces both during and after earthquake. These criteria are as follows:

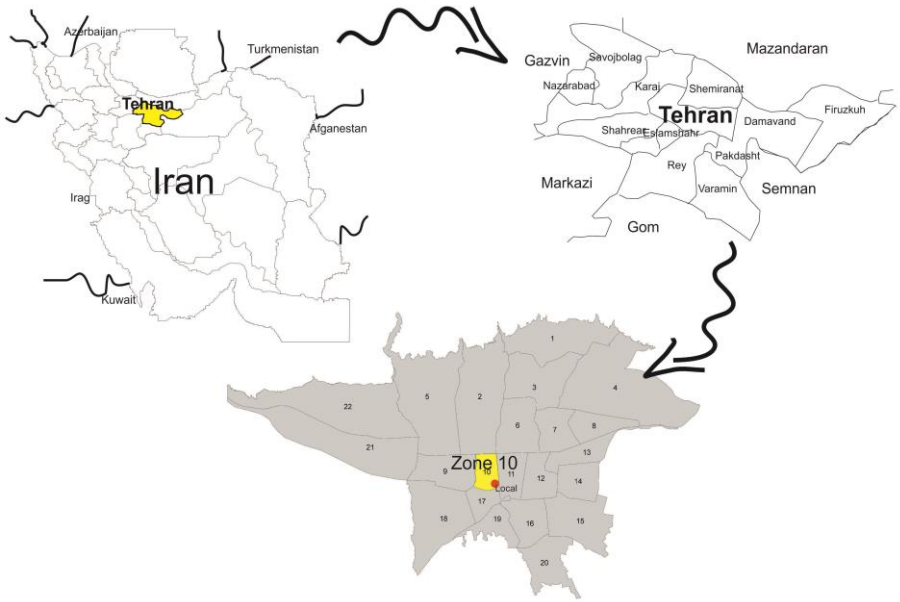
Table 1: physical and functional criteria of a perfect park during an earthquake

criterion	Sub-criterion	Descriptions
physical	the age of the buildings surrounding the park	Parks' nearby old buildings increase the amount of the damages during an earthquake (ICNDRM,1993;Ma & Ohno, 2012)
	quality of the buildings surrounding the park	The poor quality of the buildings adjacent to the park will increase the losses (ECPFE & OASP, 2002; ICNDRM,1993; Ma & Ohno, 2012).
	floors of the buildings surrounding the park	Higher the adjacent buildings to the park, more vulnerable they will be (ECPFE & OASP, 2002; ICNDRM,1993; Ma & Ohno, 2012).
	leading accesses to the parks	The more suitable and accessible the park is, the less people affected by the earthquake (ECPFE & OASP, 2002; Chua & Su, 2012; Xu et al, 2006;Chang & Falit-Baiamonte, 2002; ICNDRM,1993; Ciborowski, 1982).
	the park's form and geometry	The more regular and geometric the form of the park is, the more usable it is during a crisis (Fan et al, 2012; Yueyun et al, 2012; ICNDRM,1993).
	The size of the park	Vaster and larger green places in the city and their rational and efficient distribution among the other uses will lead to less losses and damages (ECPFE & OASP, 2002; Chua & Su, 2012; Fan et al, 2012; ICNDRM,1993; Ciborowski, 1982). The vastness of the parks in each area should be commensurate with population density in that area (ECPFE & OASP, 2002; Chua & Su, 2012; Yueyun et al, 2012; Xu et al, 2006; ICNDRM,1993; Ciborowski, 1982).
functional	The park's compatibility with its surrounding uses and environment	Hazardous actions near the parks may increase vulnerability (ECPFE & OASP, 2002; Chua & Su, 2012; ICNDRM,1993; Ciborowski, 1982). The more compatible the park's surrounding uses are, the less these uses will be vulnerable to earthquake (ECPFE & OASP, 2002; ICNDRM,1993). The parks' good location in the city due to the natural features will reduce losses (ECPFE & OASP, 2002; Chua & Su, 2012; ICNDRM,1993).
	Attracting population of the surrounding uses	Closer the parks are to the residential areas and places with many visitors and users, the less vulnerable the city would be (ECPFE & OASP, 2002; Chua & Su, 2012; Chang & Falit-Baiamonte, 2002; ICNDRM,1993).

Source: the authors

Discussion and Results:

Beryanak neighborhood, with an area of 250712 square meters and a population of 8171, is one of the old neighborhoods in Tehran which is located in zone ten. It has been formed based on the development of Beryanak village in the southwest of Tehran over the last 100 years (Project Consulting Engineers and Architects, 2007).



Map 1: the area's location

Very old buildings and narrow streets are very typical of this neighborhood that a possible earthquake will bring many hazards. Old buildings and narrow streets of the neighborhood are shown in figure 1.

Figure 1: Old buildings and narrow streets of the neighborhood

There are over 39,800 square meters green spaces in the neighborhood that given the total area of the neighborhood they have dedicated about 16 percent of the neighborhood's area to themselves (Project Consulting Engineers and Architects, 2007). There are four parks in different parts of the area. Hezarshahid Park with an area of 16,000 square meters and Shahid Arab Park with an area of 9,600 square meters are located in the west of the neighborhood, and Noor Park with an area of 12,000 square meters and Flower Park with an area of 2,200 square meters are located in the south of the neighborhood. Figures 2 and 3 are examples of green spaces in the neighborhood.

Figure 2: Shahid Arab Park

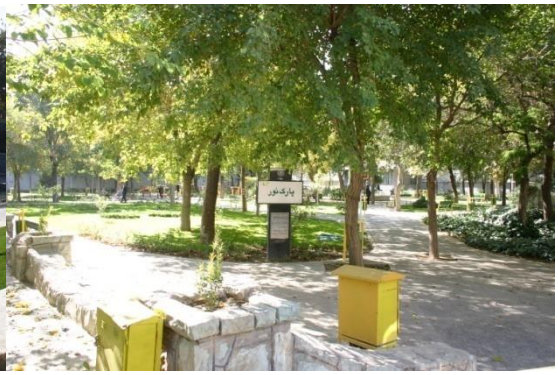
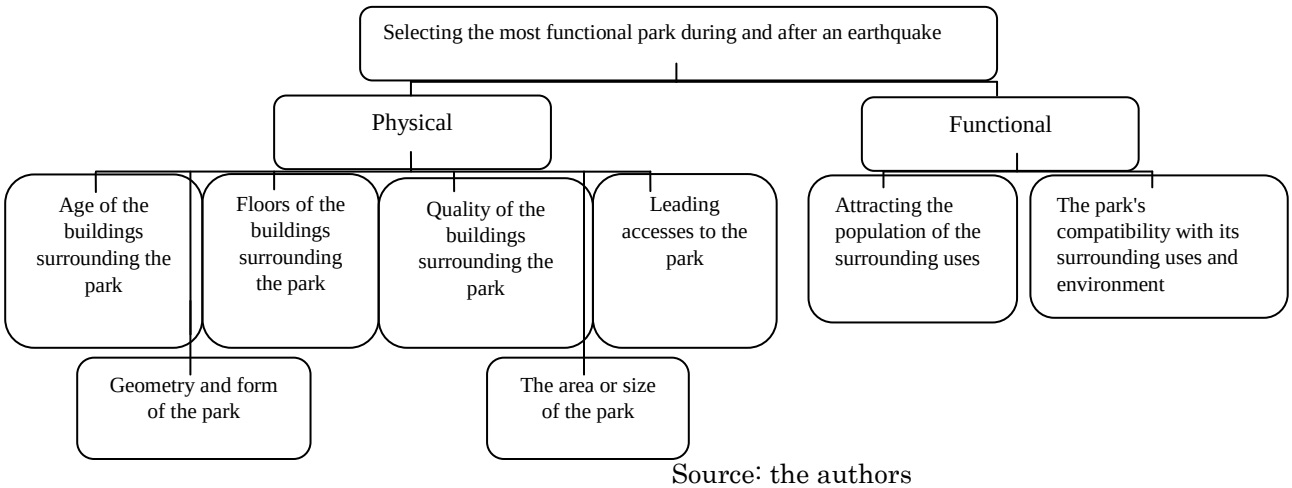


Figure 3: Noor Park

In order to measure and prioritize the function of green spaces in the neighborhood, Analytical Hierarchy Process is used.

Diagram 1: Analytical Hierarchy Process



Source: the authors

To determine the importance coefficient (weight) of the criteria and sub-criteria, they are mutually compared by the experts of urban planning. To measure the weight of each criterion and sub-criterion, binary comparison matrices were formed in Expert Choice software. This software, by using Analytical Hierarchy Process method, has been designed for the analysis of multi-criteria decision-making problems. The weight of each sub-criterion is shown in table 2.

Table 2: The weight of each sub-criterion

Sub-criterion	The park's compatibility with its surrounding uses and environment	Attracting the population of the surrounding uses	Age of the buildings surrounding the park	Floors of the buildings surrounding the park	Quality of the buildings surrounding the park	Leading accesses to the park	The area or size of the park	Geometry and form of the park
Weight	0.270	0.135	0.034	0.127	0.270	0.083	0.050	0.032

Source: the authors

Then each park's situation in the neighborhood, in relation to the designed sub-criteria, was determined. Results are shown in table 3.

Table 3: features of the parks in Beryanak neighborhood based on the criteria and sub-criteria

Features / Name	Physical criterion						Functional criterion	
	Age of the buildings surrounding the park	Quality of the buildings surrounding the park	Floors of the buildings surrounding the park	Leading accesses to the park	Geometry and form of the park	The area or size of the park	The park's compatibility with its surrounding uses and environment	Attracting the population of the surrounding uses
Shahid Arab Park	Over thirty years	renovated	1-2 floors	6 m 12 m 20 m	Irregular rectangle	9,600 sq.m	Relatively compatible	Relatively high
Hezarshahid Park	5 to 10 years	New-built	1 floor	6 m 20 m	Regular trapezoid	16,000 sq.m.	incompatible	Relatively high
Flower	20-25	Maintaina	1-2	4 m	Irregul	2,200	Relatively	High

Park	years	ble	floors	4 m 30 m	ar trapezoid	sq.m.	compatible	
Noor Park	10-15 years	Maintainable	2-3 floors	4 m 6 m 6 m 30 m	Regular rectangle	12,000 sq.m.	Quite compatible	Average

Source: the authors

Finally, by making binary comparison matrices, the neighborhood's parks were compared in relation to each sub-criterion, and entering these matrices into Expert Choice software, the final rank was obtained for each of them. Results are given in table 4:

Table 4: final scores and ranks of the parks in terms of their function against the hazards of earthquake

Name	Final score	Final rank
Hezarshahid Park	0.374	1
Noor Park	0.291	2
Shahid Arab Park	0.179	3
Flower Park	0.152	4

Source: the authors

Conclusion

In this research, AHP method was used to measure the efficacy of Beryanak Neighborhood's parks during and after earthquake. By this method, the compiled criteria and sub-criteria have been compared mutually in the form of comparison matrices and then, using Expert Choice software, importance coefficients or weights of the sub-criteria have been measured. Also, the status of each park in the neighborhood in relation to each sub-criterion was determined. Considering the importance coefficient of each criterion and each park's calculated score, the final score has been calculated for each park. Results show that Hezarshahid Park because it is surrounded by new buildings that have a low number of floors, and also due to the vast area of the park and its regular geometric form, is more functional during and after earthquake. After this park, respectively stand Noor Park, Shahid Arab Park and Flower Park.

Given the function of open spaces and parks in providing relief and rescue, evacuation and emergency measures during earthquake, researchers are expected to do more research in this field to determine which park is more functional. Also, they should be encouraged to enhance the parks' functions.

References:

- Allan, P. ; Bryant, M. (2010), The Critical Role of Open Space in Earthquake Recovery: A Case Study. 2010 NZSEE Conference
- Chang, Stephanie; Falit-Baiamonte, Anthony. (2002), Disaster vulnerability of businesses in the 2001 Nisqually earthquake. Environmental Hazards 4, 59–71
- Chu, Jianyu ; Su, Youpo. (2012), The application of TOPSIS method in selecting fixed seismic shelter for evacuation in cities. Systems Engineering Procedia 3 , 391 – 397
- Ciborowski, Adolf (1982),Physical development planning and urban design in earthquake-prone areas. Eng. Struet., Vol. 4, July
- European Centre on Prevention and Forecasting of Earthquakes (ECPFE), Earthquake Planning and Protection Organization (OASP). (2002) Emergency Evacuation of The Population In Case of An Earthquake. Handbook No 3. Athens, Greece.
- Fan, Liangxin; Xue, Sha ; Liu, Guobin. (2012), Patterns and its disaster shelter of urban green space: Empirical evidence from Jiaozuo city, China. African Journal of Agricultural Research Vol. 7(7), pp. 1184-1191
- Iranian Center for Natural Disaster Risk Management (ICNDRM) (1993), Case Study and Design of Open Spaces to Reduce the Damages Caused by Earthquake, Housing Foundation of Islamic Republic of Iran
- Ma, Xue and Ohno, Ryuzo (2012), Examination of Vulnerability of Various Residential Areas in China for Earthquake Disaster Mitigation., Procedia - Social and Behavioral Sciences 35, 369 – 377
- McGregor, R. 1998. The Hawke's Bay earthquake: New Zealand's greatest natural disaster, Napier, N.Z., Art Deco Trust.
- Middleton, D. 2007. A roof over their heads? The challenge of accommodation following disasters. In 2007 Emergency Management Conference.Wellington: New Zealand.
- Project Consulting Engineers and Architects. (2007). The Improvement Project of Beryanak Neighborhood - Haft chenar. Tehran.
- Tiejun, Zhou; Dachuan, Wang; Dexin, Zong ; Xiaoli, He. (2012), The Study of the responsibility space regionalization of emergency shelters in the urban center and the evaluation of evacuation road based on microscope computer simulation: A Case of Chongqing Three Gorges Square Area. Disaster Advances Vol. 5 (4)
- XU, Wei; OKADA, Norio; HATAYAMA, Michinori ; HE, Chunyang. (2006), Conceptual Model of Shelter Planning Based on the Vitae System. Annuals of Disas. Prev. Res. Inst., Kyoto Univ., No. 49 B
- Yueyun, He; Xiongzhi, Xue ; Liang, Zhou. (2012), Evaluation of Rationality of Emergency Shelters Distribution through Application 0f Landscape Index. Disaster Advances Vol. 5 (4)