An Analysis of Earthquake Preparedness in Tehran with Emphasis on the Resilience Theory (Case Study of Tehran District 4)

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Abstract

Earthquake vulnerability is one of the most important challenges faced by metropolises in Iran. Earthquakes are the most unexpected disasters among various natural and unnatural hazards. They cannot be prevented in any special way, and so far, no tools and technology have been able to predict their occurrence. In fact, lack of readiness in times of crisis, especially in earthquakes, causes vulnerability in different levels of a society and increases human and financial losses. Therefore, such preparedness is very important in a metropolis like Tehran because it is at high risk of earthquakes as the largest metropolis and the capital city of Iran. The present research is conducted to asses and evaluate earthquake preparedness in Tehran. The different dimensions of this research, including physical, environmental, social, cultural, institutional, managerial and economic dimensions, were studied with the Resilience Theory. In this research, the descriptive-analytical method with a survey approach has been emphasized to review and answer the research questions. The statistical population studied in this study includes: managers, experts and crisis management experts working in District 4 of Tehran Municipality. After reviewing and analyzing the documents and opinions of managers and experts, which were obtained through questionnaire, the findings of this study showed that the level of social, institutional and managerial preparedness for earthquake in District 4 of Tehran is moderate, and the level of physical, environmental and economic preparedness is not good.

Keywords: Urban resilience, Earthquake preparedness, Crisis management, Tehran metropolis.

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Introduction

Earthquakes are one of the most serious natural hazards, causing enormous economic losses and fatalities. Iran is located on the Alpine-Himalayan seismic belt, which is an earthquake-prone region. Existence of multiple faults and geographical distribution of earthquakes in our country indicates that almost a large area of Iran is at risk of earthquakes, which includes a large population of the country (Azadeh et al., 2017).

At the current level of preparedness, natural hazards, especially earthquakes with a magnitude of more than 6 Richter, can cause serious damage to the city of Tehran due to its geographical and geological location and records of powerful historical earthquakes in its history as the capital city. Moreover, the lack of coordination of resilience indicators with the growth and development of Tehran, increasing migration, especially in recent decades, and the presence of dilapidated texture and physical conditions can cause irreparable damages (Zangiabadi et al. 2006).

Therefore, considering that earthquakes are the most unexpected disasters among various natural and unnatural hazards and cannot be prevented in any special way, and so far, no tools and technology have been able to predict their occurrence, the lack of necessary preparedness at different levels of society increases vulnerability and also financial and human losses.

Based on what has been mentioned, it can be acknowledged that assessing and measuring the level of preparedness are effective and essential actions to improve the processes of crisis management and reduce the effects and complications of anthropogenic and natural disasters. However, preparedness is an issue that is still in a state of ambiguity in Tehran.

Earthquake resilience is one of the most important theoretical and practical concepts in crisis management (Zarghami et al., 2016) that has been used by executive and academic experts and thinkers in all parts of the country to asses and evaluate the level resilience and recovery and to improve the resistance system in times of crisis.

Among the risk reduction programs, resilience can be considered as a more accurate and successful program due to its attention to social and economic dimensions from other measurable dimensions (Jafarian, 2017).

Due to the importance of the above principle and the vulnerability of Tehran, especially in areas with dilapidated structures such as parts of District 4, and due to the imminence of earthquake, the question arises as to whether the city of Tehran is sufficiently prepared for earthquake and according to the theory of resilience, how effective this preparedness is in different physical, social, economic and institutional and managerial dimensions.

Concepts and theoretical grounds Crisis

The concept of crisis can mean a deviation from the general equilibrium state of the organization's relationship with the environment or an understanding of the environmental characteristics that the organization must be constantly aware of. In this view, dealing with critical issues is best understood in a strategic management perspective.

As defined by the World Health Organization, "a crisis is a severe environmental and psychosocial disorder that goes far beyond the adaptive capacity of the affected society."

In terms of the speed of occurrence, crises are divided into the categories of sudden and gradual crises; and in terms of the causes of occurrence, they are divided into the categories of natural and anthropogenic crises. Earthquakes fall under the category of sudden and natural crises.

Readiness

Crisis "readiness" refers to all actions that enable governments, organizations, communities and individuals to respond quickly and efficiently in times of crisis.

The main steps or stages of disaster management before the occurrence of an event include prevention, mitigation, and preparedness. Prevention includes a set of strategies aimed at preventing accidents. In the case of an earthquake, however, since prevention is impossible, this stage does not apply in the sense mentioned. In order to reduce the risk of hazards that cannot be prevented, it is more reasonable to adopt strategies and solutions that can reduce the damage and casualties caused by accidents

(Rustaei, 2006).

Compared to prevention and mitigation measures, the phase of preparedness has a very different quality and nature. Prevention and mitigation measures are usually associated with major decisions at the governmental level and are usually directed at the highest levels of management, but the of preparedness is more related to the activities of the relevant organizations.

The fact that a significant number of organizations and institutions are involved in the phase of preparedness underscores that the need for coordination in this phase is much greater than the phases of mitigation and prevention.

Resilience

The concept of resilience was first introduced in 1973 by Holling in an article entitled " Resilience and Stability of Ecological Systems" from an environmental perspective. In Holling's research, we encounter the emergence of a missing indicator in the concept of resilience called "adaptive capacity", which is the basis of resilience. As defined by Holling, resilience is the "ability of system to absorb change while still maintaining the pervious persistence".

Carpenter's definition of resilience, which has been accepted as a comprehensive definition in many studies, is: (1) the amount of damage that a system is able to absorb, without going out of balance; (2) the amount of ability of a system to organize and reorganize themselves in different conditions; and (3) the ability of the system to create and increase the learning capacity and strengthen adaptation to critical conditions. (Rezaei et al., 2016).

A resilient city is a city that has the components of readiness, strength, adaptability, stability and durability. In fact, the resilient city is a stable network of physical systems and human societies. (Maleki et al., 2018). (Table 1)

Model	Description
Indicator Baseline Model (GARSCHAGEN, 2011)	This model provides a set of indicators to measure the existing conditions affecting disaster resilience in communities.
Tobin Model (Marshall N, 2011)	This model assesses the resilience of communities located in high-risk areas with a more ecological framework.
Timeline Model Davis (Boxer, 2013)	This model shows that a society can gradually improve its vulnerability based on a timeline in specific development-seeking conditions.
Resiliency Assessment Model Hait (Erspective, 2010)	This network evaluation model measures resilience by measuring the relationship between shock, humanitarian aid and resilience.
Federal Emergency Management Agency (FEMA) (Sullivan, o. 2013)	Risk resilience framework; a method and support of details to help understand the characteristics of social institutions and the built environment and how social institutions relate.
National Institute of Standards and Technology (Publication, 2015)	The NIST framework is a way of developing a community resilience program for social aspects.
ResilUS (Publication, 2015)	This model is a community-based disaster resilience model which is based on measurable aspects of social capital, the multidimensional operational model of resilience, household hierarchical comparisons, business, neighborhood, and community - over a wide range of decision-making and policy variables that support each other at every scale.

T1. Models for evaluation of readiness indicators.

Data and Methodology

Case Study

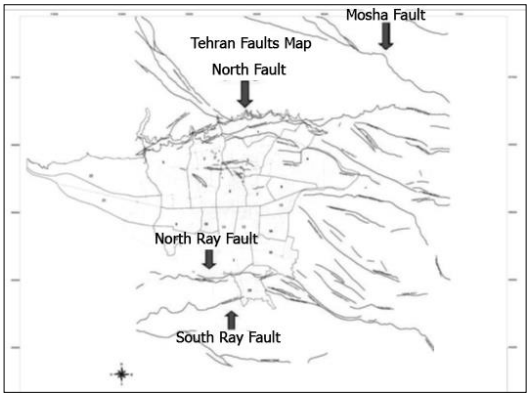
Tehran is the capital city of Iran built on Quaternary alluvial deposits. To the north, it is limited to the southern skirt of the Central Alborz Mountains, and to the south, it is limited to the northwest of the Great Desert of Central Iran. The sudden and severe difference in the height of the city (with an average altitude of 1300 meters) and the existence of a mountain ridge at a distance of less than ten kilometers (resort razor with a height of 3933 meters) are the topographic features of this region (Barbarian, 1992). Moreover, besieged by an active fault line in the north and a seismic belt in the south, Tehran is one of the most earthquake-prone areas of the country (Figure 1).

District 3 of present-day Tehran, has had agricultural farms and gardens in the historical periods of Qajar and Pahlavi eras. Since 1954, this region has become a place for wealthy summer villas, which were abundant in the villages of Sohanak, Ozgol, Araj, Golestan, Mobarakabad and around Heravi Garden. Early residential centers in this region were formed and gradually developed in the areas of North Narmak and Tehranpars during 1955 to 1965, and the modern textures of Narmak and Tehranpars and the industrial workshops and factories located on the east of the region were built

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during 1950 to 1970. Since 1977, a wave of immigrants from other cities and villages arrived to the eastern entrance of Tehran, which was located in Dist. 4. As a result, gradually rural textures and the outskirts of Khak-e-Sefid, Shemiran No, and Kazemabad neighborhoods were formed in this region (Ministry of Roads and Urban Development, 2018). The proximity of District 4 to a number of faults, including Mosha fault and North Tehran fault, and the existence of several others, including Shiyan, Kosar, Deh Narmak, Parchin, and Telo Pa'in, in and around the district, has increased the risk of earthquakes in this area (figure 2).



F1. Tehran Faults Map.



F2. The zoning map of faults in District 4 of Tehran.

Research Method

The method of the present research is descriptive-analytical; a survey approach is used to collect information; and the evaluation method is used to analyze the information. In terms of purpose, this paper is an applied research.

In this research, the required data was collected form ecology and desk research that provided the writers with written theoretical sources. Then, in a field research, the collected data was completed with the information of fire station chiefs, district municipal crisis managers, Tehran municipal crisis managers, emergency base commanders, NGO experts, academic and scientific elites, and commanders of Red Crescent bases. In the desk research, descriptive information has been collected from books, articles and statistical yearbooks; and in the field research, information has been collected through sampling using questionnaire, observation and interview. The most important concept of the research is readiness, the components of which were implemented at the level and scale of crisis management experts in the format of five-level Likert item. Data analysis was performed using statistical software such as SPSS and one-way analysis of variance, Friedman test and one-sample t-test. Finally, Excel and GIS software were used to draw graphs and maps. In this research, a questionnaire has been used to collect the required information.

Dimensions and indicators of research

Indicators can be used as a set of primary requirements to evaluate the performance of programs, policies, and interventions that are designed to improve readiness. In this study, according to a conceptual model and theorical principles of Tehran's readiness for earthquake, and with regard to the selection of appropriate indicators to measure such readiness with an emphasis on resilience, four dimensions including physical-environmental; social; institutional-managerial; and economic are taken into account (Table 2) (Chart 1).

Method of collecting statistics and information

Statistical information was collected using desk research, statistics tables, the results of the population and housing census of 2016 and the urban comprehensive plan. University professors and technical experts in crisis management have been consulted to certify the reliability of data. The field research was conducted, and information from District 4 of Tehran was collected by

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interviewing fire experts, crisis managers of Tehran Municipality, emergency experts, NGO experts, academic and scientific elites and Red Crescent experts, who completed a questionnaire. The questionnaire is a researcher-made questionnaire whose questions have been designed and approved using the calculated indicators based on different models of resilience theory and with the opinion of experts.

Indicator	Operational definition	Source
Incompatible uses (physical)	Accommodation status is considered for households in each area, which includes the status of each area in terms of dilapidated uses in terms of the proportion of low-durable buildings and the quality of hazardous facilities next to them.	(Abdollahi, 2016)
Faults (physical)	Distance of residential areas from faults and the number of faults	(Alizadeh, 2018)
Population density (physical)	Population density is an indicator that determines the traffic load on the roads during earthquakes.	(Rousta, 2017)
Accessibility (physical)	Access to relief centers including: fire department, police, hospital etc.	(Abdollahi, 2016)
Building age (physical)	The age of buildings is directly related to the degree of earthquake resistance of the structure	Au
Type of structure (physical)	From the highest to the lowest strength and resistance, buildings have concrete frame, metal frame, wooden frame and no frame (including: thatch, shed, hut, etc.).	(Author, 2019)
Open spaces (physical)	The condition of the way to exit houses; after leaving the space outside the building, existence of shelter, suitability of the space outside the building and temporary accommodation	(Abdollahi, 2016)
Age structure (social)	The purpose of studying the age structure of the population is to achieve a vulnerable community in the age groups under six years and over 65 years.	(Mohammadi, 2017)
Sex ratio (social)	The analysis of various crises has shown that women are much more vulnerable in times of crisis.	(Mohammadi, 2017)
Level of education (social)	Populations with higher levels of knowledge and awareness are less affected in times of crisis.	(Mohammadi, 2017)
Amount of social capital (social)	Existing social capital according to the variables of neighborhood relationship among people and the degree of their trust in each other in times of crisis	(Mohammadi, 2017)
Health coverage (economic)	Health coverage in this study refers to that proportion of the population that is covered by insurance.	(Mohammadi, 2017)
Institutional context (institutional-managerial)	Being aware of the existence of institutions related to crisis management and volunteer groups in the neighborhood	(Mohammadi, 2017)
Institutional performance (institutional-managerial)	Satisfaction of neighborhood residents with the performance of local institutions that are responsible in times of crisis	(Mohammadi, 2017)
Institutional relationships (institutional-managerial)	The relationships of residents with local institutions such as NGOs, councils, municipalities, etc.	(Mohammadi, 2017)
Amount of damage (physical)	The amount of possible damage to households due to the earthquake, the vulnerability of their property and assets in Tehran (shops, housing, cars, etc.),	(Rezaei, 2013)
Damage compensation capacity (economic-physical)	Capacity or ability to compensate for property damage through savings and financial credits before banks and other institutions	(Rezaei, 2013)
Ability of returning to normal conditions (economic)	The ability of households to return to working conditions and a decent income after the earthquake	(Rezaei, 2013)

T2. Table of operational definitions of indicators for evaluation of readiness.

Statistical Society

The statistical population of this study includes fire experts, crisis managers of Tehran Municipality, emergency experts, NGO experts, academic and scientific elites and Red Crescent experts of District 4 of Tehran. In this study, Krejcie and Morgan table has been used to estimate the sample size; and the sample size of 127 out of 200 people in the statistical population has been determined.

Validity and reliability of the questionnaire

Since the main tool of this study is a questionnaire, it was designed after a number of interviews and expert opinion polls to ensure its validity. One method of determining the reliability of the test by emphasizing internal consistency is called the Cronbach's alpha coefficient method. In this method, test components are used to measure the reliability of the test. If the alpha coefficient is greater than 0.7, the test has acceptable reliability. Cronbach's alpha is generally calculated using one of the following equations.

$$\alpha = \frac{k\bar{C}}{\bar{V} + (k-1)\bar{C}} \qquad \alpha = \frac{k}{k-1}\left(1 - \frac{\sum \sigma_i^2}{\sigma^2}\right)$$

In these equations, ‘k’ is the number of questions, ‘ ’ denotes the variance of the question ‘i’, is the total variance of the questions, is the mean covariance between questions, and is the mean variance of the questions (Table 3).

Analysis

Special statistical methods are needed to analyze the data.

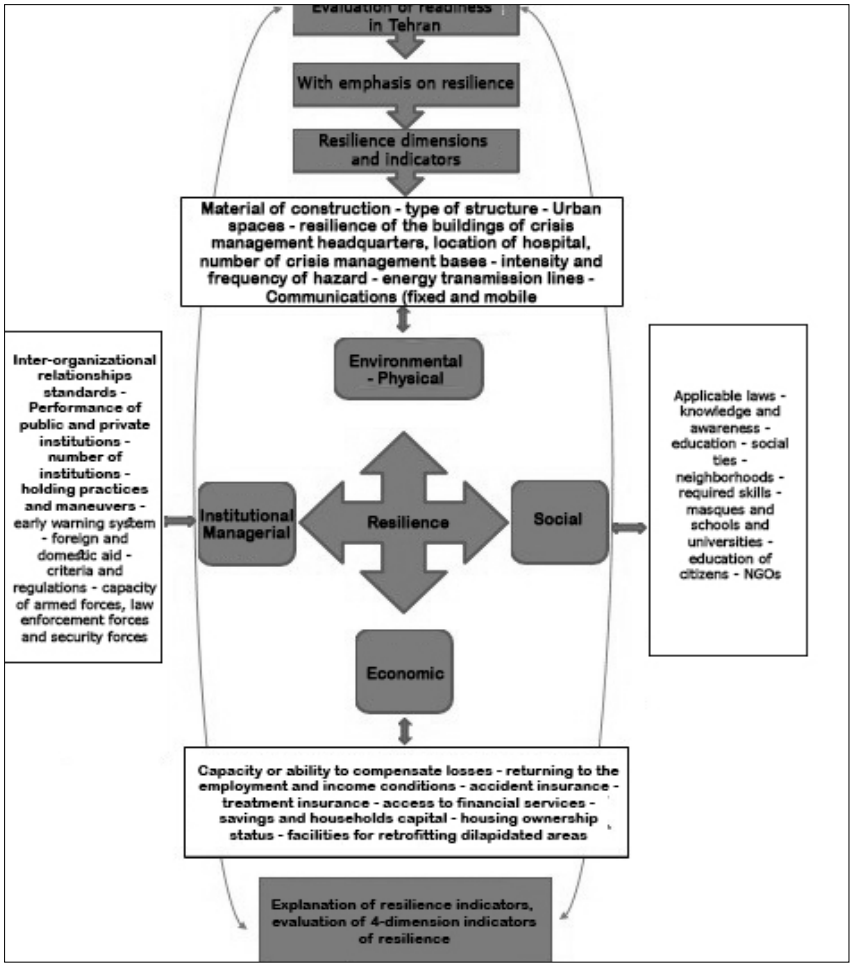
Kolmogorov-Smirnov test

Given that one of the main assumptions for using the parametric t-student test is the

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normality of the data distribution, for this purpose the Kolmogorov-Smirnov test was used, the results of which are shown in the table 4 below.



Ch1. Chart of conceptual model.

Variable	Number of questions	Question rows	Alpha coefficient
Physical-environmental readiness	29	1 to 29	0.944
Social readiness	25	1 to 25	0.939
Institutional-managerial readiness	36	1 to 36	0.925
Economic readiness	19	1 to 19	0.918

T3. Observations normality test results.

Indicator	Significance level	Kolmogorov Statistic	Result
Physical-environmental readiness	0.081	1.472	Normal
Social readiness	0.062	1.835	Normal
Institutional-managerial readiness	0.094	1.348	Normal
Economic readiness	0.078	1.490	Normal

T4. Observations normality test results.

Based on the significance levels obtained from the Kolmogorov-Smirnov test, it is observed that the significance level for all components is greater than the first type error of 0.05 and therefore the hypothesis of normality of all observations is accepted at

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the first type error level of 0.05. Then, using t-test, the questions and answers of the questionnaire are examined. It should be noted that since the process of decision-making in this research is multi-criteria, the VIKOR method has been used to weight the indicators and criteria. In the evaluation of examinees, the indicators of marriage, education, work experience in the field of crisis management, age and the level of the expertise relationship to the field have been examined.

Analysis of the first question: What is the status of physical-environmental readiness indicators in District 4 of Tehran in earthquakes?

A one-sample t-test was conducted to answer the first question. After analyzing the data obtained from the questionnaire based on the scores and equal weights of each question, the operational definitions of indicators were defined, and the results are shown in Table 5.

According to table 5, because the significance level is Sig = 0.000, the difference between the calculated mean and the hypothetical mean among the respondents is significant at the confidence level (95%) and measurement error (5% =) with the degree of freedom (df = 126); and since the calculated mean value obtained for the respondents is equal with 2.756 that should be higher than the standard average (3), it is concluded that the physical-environmental readiness indicators of Tehran District 4 in earthquake are not in a good position compared to the standard average.

Analyzing the data obtained from the questionnaire, it was found that the indicators of physical-environmental readiness in District 4 of Tehran in an earthquake are not in a good position. Dilapidated areas, population density, inadequate access to main and secondary passages, as well as access to medical centers can be the most effective issues in the weak physical-environmental condition of this area. In order to increase the level of readiness, according to the results obtained, the following suggestions are recommended:

Variable under study	Group of respondents	Number	Mean	Standard deviation	Standard error of mean	
First question	Respondents	127	2.756	0.3770	0.03345	
Variable	T	df	Sig	Mean difference	The upper and lower endpoint of the 95% confidence interval	
First question	22.612	126	0.00	07564	0.6902	0.8226

T5. Results of the one-sample t-test to evaluate the effect of physical-environmental readiness in District 4 of Tehran.

- Providing a mechanism to reconstruct and renovate the dilapidated texture of this area.
- Designing future plans in a way that they can make balance in the population density and standardize residential spaces.
- Examining the main and secondary accesses in the general space of the region as well as in each of the neighborhoods, planning for them in times of crisis and implementing them in double-urgency plans.
- Planning to establish medical centers, especially emergency medical centers and services in the neighborhoods of this area by relevant authorities.
- Preparing appropriate grounds for providing safe shelters for the injured after crisis.
- Paying attention to the height of the buildings, the open space of the residential building, green space, and environmental density in designing the urban environment to prepare for crisis management.
- Having a better supervision by the organizations responsible for the type of materials, strength of the building, quality and age of the building, properties, and type of construction.
- Paying attention to the design of infrastructure and pipelines (water, electricity, gas, etc.) and considering the required relationships with emphasis on crisis management.

Analysis of the second question: What is the status of social readiness indicators in District 4 of Tehran against earthquakes?

To answer the second question of the research, a one-sample t-test was used and after analyzing the data obtained from the questionnaire based on scoring and equal weights for each of the questionnaire questions according to the operational

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definitions of indicators, the results are shown in Table 6.

According to this table, because the significance level is Sig = 0.000, at the level of confidence (95%) and measurement error (=5%) with the degree of freedom (df = 126), the difference between the calculated mean and the hypothetical mean is significant among the respondents; and since the calculated average value of 3.765 obtained for the respondents is higher than the standard average (3), we conclude that the indicators of social preparedness in district 4 of Tehran in earthquakes are in the upper middle condition according to the standard average level.

Variable under study	Group of respondents	Number	Mean	Standard deviation	Standard error of mean	
Second question	Respondents	127	3.765	0.3487	0.03094	
Variable	T	df	Sig	Mean difference	The upper and lower endpoint of the 95% confidence interval	
Second question	24.736	126	0.00	07539	0.7042	0.8266

T6. Results of the one-sample t-test to evaluate the effect of social readiness in District 4 of Tehran.

Analyzing the data obtained from the questionnaire, it was found that the indicators of social readiness in District 4 of Tehran are in an upper average position. Appropriate demographic composition as well as popular coordination and social support among the residents are the main factor in the situation of this index. The approved laws in the field of crisis management, the codified programs implemented by the Crisis Management Organization of Tehran, including ready school, safe emergency evacuation plans, etc., have increased social readiness in District 4. The presence of organized public institutions and formal NGOs in the region has also been one of the important reasons for this increase in readiness. Therefore, according to the results obtained from this test, the following suggestions are recommended:

- Providing the necessary training to social groups so that social groups and communities have adequate preparedness and capacity to recover during and after a crisis.
- Improving awareness and appropriate skills in social groups in the field of crisis management
- Considering to improve social networks due to their good capacity in the field of crisis management
- Strengthening cultural standards in society before and after the crisis and its control and management.
- Holding the necessary courses and public maneuvers by cultural and social centers at the district

Analysis of the third question: What is the status of institutional-managerial readiness indicators in District 4 of Tehran in earthquakes?

To answer the third question of the research, one-sample t-test was used and after analyzing the data obtained from the questionnaire based on scoring and equal weights for each of the questionnaire questions, according to the operational definitions of the indicators, the results are shown in Table 7.

Variable under study	Group of respondents	Number	Mean	Standard deviation	Standard error of mean	
Third question	Respondents	127	3.786	0.3835	0.03403	
Variable	T	df	Sig	Mean difference	The upper and lower endpoint of the 95% confidence interval	
Third question	23.120	126	0.00	0.7867	0.7194	0.8541

T7. Results of the one-sample t-test to evaluate the effect of institutional-managerial readiness in District 4 of Tehran.

According to the above table, because the significance level is Sig = 0.000, at the level of confidence (95%) and measurement error (= 5%) with the degree of freedom (df = 384), the difference between the calculated mean and the hypothetical mean is significant among the respondents; and since the calculated average value of 3.786 obtained for the respondents is higher than the standard average (3), it is concluded that the indicators of institutional-managerial preparedness of Tehran Region 4 in earthquake according to the standard average level is in the upward average position.

Analyzing the data obtained from the questionnaire, it was found that the indicators

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of institutional-managerial readiness in District 4 of Tehran in earthquakes are in an average upward position. It is noteworthy that most of the questions are set in the formal sector and the results were obtained from service providers and official institutions responsible for crisis management in Tehran and military and security institutions. In the field of informal sectors, due to the lack of control, the need for knowledge and the unavailability of data and information, it is not in a favorable position. In this regard, the responsible organizations should have the necessary planning.

According to the results obtained from this test, the following suggestions are recommended:

- Estimating relationships and performance of earthquake response institutions periodically and correcting them as needed.
- Strengthening the physical characteristics of institutions such as the number of local institutions and the readiness and training of local institutions to deal with earthquakes.
- Managing and responding to disasters in areas such as organizational structure, capacity, leadership and experience of related institutions to be improved and upgraded.
- Improving the interaction of formal and local institutions with the people and the capacity of the people in this regard to increase the quality of crisis management.
- Outsourcing some crisis management activities to other provinces and strengthening and adjusting the necessary job descriptions for certain provinces in order to provide more support in the event of an earthquake and reduce potential damages.
- Establishment of an organization with extra-legal powers in order to coordinate the organizations in the event of a crisis that can be effective in creating a synergy of all formal and informal bodies.
- Identifying the capacities of local and extra-local informal institutions and, while having strong communication with the trustees, providing them with the necessary training in this regard and periodically evaluating their level of capability and readiness.
- Using the capacity of international institutions in this regard with careful planning.
- Holding joint maneuvers with service providers, military, law enforcement and security agencies using the capacities of Sarollah base in Tehran for further coordination and periodic evaluations in this regard and according to the approvals of the Supreme National Security Council in compiling the organizational instructions of the executive and legal authorities

Analysis of the fourth question:

What is the status of economic readiness indicators in District 4 of Tehran in the face of earthquakes?

To answer the fourth question of the research, a one-sample t-test was used and after analyzing the data obtained from the questionnaire based on scoring and equal weights for each of the questionnaire questions, according to the operational definitions of indicators, the results are shown in Table 8.

Variable under study	Group of respondents	Number	Mean	Standard deviation	Standard error of mean	
Fourth question	Respondents	127	2.767	0.3868	0.03432	
Variable	T	df	Sig	Mean difference	The upper and lower endpoint of the 95% confidence interval	
Fourth question	22.347	126	0.00	0.7670	0.6991	0.8350

T8. Results of the one-sample t-test to evaluate the effect of economic readiness in District 4 of Tehran.

According to table 8, because the significance level is Sig = 0.000, at the level of confidence (95%) and measurement error (= 5%) with the degree of freedom (df = 126), the difference between the calculated mean and the hypothetical mean is significant among the respondents; and since the calculated average value of 2.767 obtained for the respondents is less than the standard average (3), it is concluded that the economic readiness indicators of Tehran District 4 in the event of an earthquake are not in a good position.

Analyzing the data obtained from the questionnaire, it was found that the economic readiness indicators of District 4 of Tehran in the event of an earthquakes are not in a good position. The composition of occupations in

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the residents of this area, most of whom have self-employed and non-governmental occupations and cannot return to their work after an earthquake, is influential in the status of this index. Another major reason for this decrease in the level of preparedness in the economic index is the lack of regulation of accident insurance policies and health insurance among the citizens of the region, which has been significantly effective in this regard.

According to the results obtained from this test, the following suggestions are recommended:

- Establishing compensation capacity and the ability to return to appropriate working conditions and income
- Due to the lack of financial stability in some neighborhoods in the region, the organizations responsible for entrepreneurship and local jobs should work in a sustainable and flexible manner at the neighborhood level.
- Planning and strengthening financial, banking and insurance infrastructure in times of crisis.
- Providing access to financial services by responsible organizations if needed for crisis management or compensation.
- Examining and improving the ability to revive various economic activities in the region after each accident.
- Covering the district by appropriate insurance with high compensation and empowerment capabilities.
- Establishing the mechanism of public economic financial support (contingency funds) in this regard before the crisis and doing the necessary planning.

Analysis of the main question: What is the status of earthquake preparedness indicators in District 4 of Tehran from the perspective of resilience theory?

To answer the main question of the research, a one-sample t-test was used and after analyzing the data obtained from the questionnaire based on scoring and equal weights for each of the questionnaire questions, according to operational definitions of indicators, the results are shown in Table 9.

According to table 9, because the significance level is Sig = 0.000, at the level of confidence (95%) and measurement error (= 5%) with the degree of freedom (df =126), the difference between the calculated mean and the hypothetical mean is significant among the respondents; and since the calculated mean value is 3.775 and for respondents is more than the standard average (3), it is concluded that in general, the sum of all four dimensions of resilience indicators of District 4 concerning earthquake preparedness according to the standard average level, is in a medium and almost upward position. It is appropriate for the authorities to use the available results to improve the level of earthquake preparedness of this region and to consider the necessary arrangements and coordination.

Variable under study	Group of respondents	Number	Mean	Standard deviation	Standard error of mean	
Main question	Respondents	127	3.775	0.5621	0.03214	
Variable	T	df	Sig	Mean difference	The upper and lower endpoint of the 95% confidence interval	
Main question	21.511	126	0.00	0.5122	0.6812	0.8523

T9. Results of the one-sample t-test to evaluate the effect of readiness in District 4 of Tehran.

Ranking and prioritizing the importance of each dimension of resilience in the region

The Friedman ranking non-parametric test was used to prioritize the studied dimensions. The results of this test are presented in Table10. In this test, the components are ranked based on the size of the average rating, and any component that has a higher average rating among the other components is of higher importance.

Dimension	Rank	Mean rank
Institutional-managerial Indicators	1	2.97
Social Indicators	2	2.85
Economic Indicators	3	2.77
Physical-environmental Indicators	4	2.75

T10. Friedman test results.

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According to the prioritization table, and due to the significance of the test (significance level less than 0.001), it can be said that institutional-managerial indicators (with a mean rank of 2.82) is the first priority. This means that institutional-managerial indicators are more important than other indicators in dealing with the earthquake in District 4 of Tehran. Indicators of social readiness are in the second priority; indicators of economic readiness are in the third priority and indicators of physical-environmental readiness are in the next priority. In a way, it can be said that perhaps by paying more attention to the institutional (formal and informal) and then social dimensions in the region, we can cover the problems of earthquake preparedness that can be seen in other dimensions and increase the region's earthquake preparedness. .

Conclusion

The results of the analysis show that the metropolis of Tehran, especially District 4, does not have a favorable response to earthquake. The occurrence of such an incident with high power in the city of Tehran will cause a serious catastrophe. This study shows that the physical dimension of District 4 is very unstable facing with problems such as inadequacy of buildings and passages, weakness in urban and neighborhood communication, lack of adequate emergency urban services and appropriate relief in urban areas. The problem of dilapidated urban areas and unsuitable urban infrastructure has caused this city to be physically exposed to severe vulnerability in such accidents. From the economic point of view, this and other researches have shown that many dilapidated areas and neighborhoods of Tehran due to the economic inability of citizens and the lack of appropriate facilities in urban reconstruction and unsustainable and temporary jobs in the city has caused this city to be vulnerable. District 4 is vulnerable to earthquakes, and if this problem is not considered from now on, it will have much more severe economic consequences for this city and country after the accident. Also, this study showed that in the social dimension of this region, it has a moderate situation, which indicates appropriate educational measures by the authorities, but in this regard, there is more work to be done in creating more social solidarity and training to deal with this incident. This research showed that in terms of government agencies and urban services, the institutional-managerial dimension is in a moderate situation, and it has managerial readiness in such incidents. However, there are some weaknesses in this regard, such as not paying attention to the non-governmental sector and formal and informal NGOs and not recognizing and communicating with them, which reduces institutional resilience in Tehran and requires serious planning by those in charge, especially crisis management agencies. Since this city is the center of government and the most strategic city for the Islamic Republic of Iran, this issue should be considered with a strategic view at the highest levels of policy and decision-making in the country and according to the pathologies made in this regard with seriousness in the form of long-term and short-term plans. The country should take steps against natural disasters. All government agencies and urban services, especially municipalities, by recognizing their small disadvantages in this regard and with more synergy and interaction and giving a greater role in terms of participation to people and NGOs, shall try to minimize these damages and reshape the areas and neighborhoods of Tehran metropolis with a neighborhood-oriented view.

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