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Cover Image by Maria Rosa Tremiterra of Am Sandtorkai, one of the main streets of HafenCity, a new district located on the waterfront of the City of Hamburg. HafenCity can be considered "a city in the city" and one of the most resilient urban areas in the world to the flooding events thanks to its urban redevelopment strategy.

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The Resilience City/The Fragile City.
Methods, tools and best practices.

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MEAURING URBAN RESILENCE TO NATURAL HAZARDS

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ABSTRACT

Natural disaster is an undeniable fact, and preparing to cope with and respond to it is an essential necessity. A resilient city can survive after a traumatic blow to its physical infrastructure, its economy, or its social fabric. Lahijan City, like other cities, requires resiliency measurement. Research tries to survey the degree of resilience of Lahijan encountering natural hazards. The research method is descriptive-analytic; the descriptive method is used to develop theories and literature, and analytical method for the identification of causal relationships and correlations. The performed analyses arebased on the combination of inferential statistics techniques such as one sample t-test and the Delphi technique. The outcome revealed that Lahijan is totally in the low spectrum in terms of resilience (5 > 2.72 > 1), with theoretical median of three, which itself is the result of climate change, urbanization, and globalization. Support and strengthening of community-based activities, disaster risk reduction, and capacity increase of institutional adaptability can assist Lahijan residents to encounter to the human hazards, natural hazards, and increasing risks resulting from change.

KEYWORDS:
Resilience, Natural hazards, Capacity increase.

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城市自然灾害复原能力估量

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摘要

自然灾害是一个不可否认的事实，必须作出应对和响应的准备。如果一个城市具有复原能力，在其有形基础设施、经济或社会结构遭到创伤性的打击之后仍然能够得以生存。拉希詹与其他城市一样，也需要进行复原能力方面的估量。本研究的目的是调查拉希詹在遇到自然灾害情况下的复原能力水平。采用的研究方法为描述性分析；描述性方法用于创立理论和文献，分析方法则用于识别因果关系和相关性。分析基于多种推理统计技术——如单样本检验和德尔斐技术——的组合进行。结果显示，拉希詹在复原能力方面`完全处于低水平（5>2.72>1，理论中位数为 3 的情况下），其本身为气候变化、城市化和全球化的结果。在以社区为单位开展的活动、减少灾害风险和体制适应性能力建设等方面的支持和加强措施，可以在出现人为灾害、自然灾害和变化导致的风险增加时为拉希詹居民提供帮助

关键词:
复原能力，自然灾害、能力建设

1 INTRODUCTION

Resilience like sustainability is an intergenerational and over - generational approach. Seeking to enhance it, communities try to save the current generation from risks and to inform the future one. Hazards normally have the potential to turn to a disaster when there is no access to risk reduction systems. Since predicting these events perfectly has not been attainable yet, increase or improvement of the capacity of a system to resist and recover from the consequences of hazards is highly significant. An urban system is considered to be desirable when not only meets the needs of its inhabitants and improves the social, economic, environmental, and other qualifications, but also protect the city and its inhabitants against potential threats and, in critical cases, manages the crisis that have arisen. Resilience is a relatively new approach to create an urban system. The system must be resilient to potential risks and anticipate any measures in advance of the crisis, since survival is awareness-depended. These risks include not only natural disasters but also all the likely crises in the city.

Having a crisis in terms of being an accident-prone region as well as the crisis of confrontation with this issue, Iran every year is facing irreparable damages resulting from these events in different cities. It is therefore essential that reinforcing process of cities against natural hazards, reducing the vulnerability of critical infrastructure, managing disaster risk reduction, and finally resilience to be on the agenda in order to achieve the goals of sustainable urban development. In this research, the city of Lahijan for its high vulnerability to natural disasters has been chosen as the case. Research tries to survey the degree of resilience of Lahijan encountering natural hazards. For instance, the city encountered heavy snowfall twice in 2015 and in both cases problems such as water and electricity cutoff, long traffic jams, closed schools and even offices, cut trees and so on were witnessed. It must be mentioned that Lahijan is a medium city which is located in north-west of Iran. Further information would be described later. The main goal of this research is to survey that if Lahijan is a resilient city and if it has the needed capacities of resilience in dealing with natural hazards.

The most significant questions raised in such conditions are:

- Are the social, economic, institutional, and physical-environmental capacities of the study area in accordance with the needs of the community to demonstrate resilience in dealing with natural hazards?
- Is the study area considered resilient in terms of the dimensions and measurement criteria in the present study?

2 METHODOLOGY

The current research adopted a descriptive-analytical method, in which the development of the theoretical perspectives and the related literature were carried out through a descriptive method by searching for external and internal resources, and achieving causal relationships and the correlation was performed through an analytical method. The target group are experts in urban planning which have the knowledge about the subject and can opine about it.

Questionnaires and interviews are the source of statistics which are analyzed. The analysis of the study was performed using a combination of inferential statistics techniques such as one sample t-test using SPSS and the Delphi technique. Moreover, the criteria and sub-criteria have been proposed to measure the resilience of Lahijan. Since these criteria and sub-criteria are not of the same level of significance or, in other words, they do not have the same weight, the coefficient of importance, or weighting was taken into consideration. Because of the qualitative nature of the variables, the Likert spectrum was used to quantify and calculate the obtained data.

3 LITERATURE REVIEW

3.1 DEFINITIONS AND CONCEPTS

The identification of urban fragilities could represent a new first step in order to develop and to propose methodological and operative innovations for the planning and the management of the urban and territorial transformations (Papa, 2018). Climate change, resource scarcity, individual or concatenated risks, and environmental degradation are just some of the many and varied factors that threaten contemporary cities and are now the pressure factors capable of triggering processes and modifications of urban systems, altering or changing their status. These factors are characterized by different natures and impacts: some may induce long-term changes (lack of resources); others cause immediate shock (risks). The complexity of the various pressure factors, their close interactions and the characteristics of the urban systems, seem to suggest the need to analyze and manage the response of urban systems to potential impacts of these factors through a systemic approach (De Falco, 2018).

Several definitions of resilience are available, twenty-five of which were examined in this study, and some of them have been mentioned in Table 1. This table indicates that the definitions of urban resilience are contradictive and ambiguous. Since there are differences between two concepts of "urban" and "resilience" and due to various principles associated with their investigations (Da Silva et al., 2012), not surprisingly there are several definitions for this concept available. However, there is broad agreement that the essence or inherent feature of resilience include the "back to the past," the "degree to which the system is able to absorb risks and can organize itself." Many theoreticians recognize resilience as the criterion of returning to the pre-accident condition, as well as to improve it in accordance with further development in the systems (Amaratunga & Haigh, 2011). Resilience is the degree to which a system can absorb disturbance but preserve its condition, the capacity of a system in self-organization, and its ability to create and enhance the learning, and adaptive capacity (Carpenter et al., 2001). A resilient city is a city that could have a post-disaster recovery ability and to be able to maintain balance and to resume activities (Papa, 2012). A resilient city is able to survive a traumatic blow to its physical infrastructure, its economy, or its social fabric. The resilient city bends but does not break; it absorbs impacts without shattering (Campanella & Godschalk, 2012).

3.2 RESILIENCE DEFINITIONS

Different types of resilience, including resilience of ecological, social, economic, organizational, infrastructural systems and capability or qualification of the community, require different types of measurements.

3.3 ECONOMIC RESILIENCE

Resilience in the economy is the inherent adaptability and reaction of individuals and communities to the risks, so that they are able to reduce the potential damage caused by hazards. For the large macroeconomic interconnectedness, economic resilience depends not only on the occupational capacities of individuals but also on the capacity of all institutions (Rose, 2004). This resilience is consist of two components: Firstly, the community's capacity to return to pre-accident economic conditions and, secondly, the capacity of communities to reduce the risk of future accidents and hazards; either in response to an accident that society has experienced or in anticipation of accidents that are still experiencing (Forgette & Boening, 2009).

3.4 SOCIAL RESILIENCE

Social resilience is defined as "the ability of a community to revert back and use its own resources for recovery." Social resilience is planning on internal resources and their capacities to manage demands, challenges, and changes faced during a disaster (Ainuddin & Routray, 2012). Attention paid to social aspects in resilience, if

not more important than the physical infrastructure in crisis management, is at least equally important (Lucini, 2013). Where crimes, homelessness, unemployment, inadequate nutrition, and insufficient education is obvious, disaster prevention can no longer be of great importance (Cutter et al., 2008: 7). Albeit there is still a lot of ambiguity in defining and indexing this concept (Sapirstein, 2006), all the definitions in the social resilience are concerned with capacities of individuals, organizations, or communities to sustain, absorb, adapt, and transform the social threat of any kind (Keck & Sakdapolark, 2013). Social resilience has different stages and significantly increases the durability and solidity of the community. The level of flexibility of different groups in a community and their responses are disparate in critical cases (Maguire & Hagan, 2007). The existence of social groups with different social, economic, and degrees of vulnerability in a community connotes that the resilience to one accident varies for different groups of a society. Socially vulnerable groups are likely to have less available resources and facilities to deal with disasters. In fact, social conditions make some members of society less probable to be affected by the calamity and some more (Oxfam, 2005).

No.	Author	Year	Definition
1	Chelleri	2012	Resilience should be within the framework of flexibility (system resistance), transition (incremental change of system), transformation (re-formation of the system)
2	Hamilton	2009	Ability to retrieve and sustain performance, life, business, industry, government, and social gatherings in dealing with disasters and catastrophes.
3	Brugmann	2012	The ability of systems, locations, and municipal assets to keep performance predictable (benefits and functions, leases, and other financial flows) in a wide range of conditions.
4	Coaffee	2013	Capacity to deal with malicious challenges and return to the previous situation
5	Desouza and Flanery	2013	Ability to absorb, adapt, and respond to changes in urban systems
6	Lu and Stead	2013	The ability of the city to absorb abnormalities while maintaining function and structure
7	Romero-Lankao and Gnatz	2013	Capacity of systems and communities to deal with disasters
8	Asprone et al.	2013	Ability to adapt or respond to unusual malicious events
9	Henstra	2012	Climate resistant city is a city that is capable of coping with the problems created by climate change to respond effectively to the dangers of the climate and quickly retrieve the remaining negative effects.
10	Thornbush et al.	2013	The general characteristics of cities' natural, economic, and social systems for effective future stability
11	Wagner and Breil	2013	The ability and capacity of the community to cope with stress, to restore, adapt, and return to the previous situation after a crisis or rapid passage from it.

Tab.1 Resilience definitions

3.5 PHYSICAL RESILIENCE

Campanella and Godschalk in 2012, pointed to the role of urban uses in mitigating the negative effects of disaster and making the city resilient to the dangers of accidents (Campanella & Godschalk, 2012). Designating similar applications together in a not problematic way at the time of the accident, as well as the identification of multi-functional open spaces within the dense texture of residential neighborhoods in cities, increases urban resilience against accidents. Additionally, the availability of appropriate accessibility in cities and highly permeable urban design, when accidents happens especially earthquakes with the possibility of wall destructions and route blockings, play an important role in increasing and decreasing the resilience rate of cities (Jalali et al., 2015).

3.6 ENVIRONMENTAL RESILIENCE

Adger (2000) believes in all ecological definitions the emphasis is on how much destruction a system can withstand without changing or disintegrating. In his opinion, focuses are often on stability and resilience against destruction and the rate of return to the initial equilibrium point (Rezaei & Rafiyan, 1391).

4 PROCESS ANALYSIS

In current study, the process of analyzing and measuring the resiliency of Lahijan is in accordance with Fig.1. So initially according to the criteria and sub-criteria, the current situation of Lahijan regarding these indicators have been determined, then using Likert spectrum in the opinions of a group of experts in urban planning each of the data were rated 1 to 5. Assumed the same in their level of importance, each of the indicators of the urban resiliency measurement was analyzed using the average score through Excel software. Finally, each indicator and criterion was weighted based on its importance in measuring the resiliency of Lahijan. After statistical analysis using one sample t-test, each dimension has been separately studied.

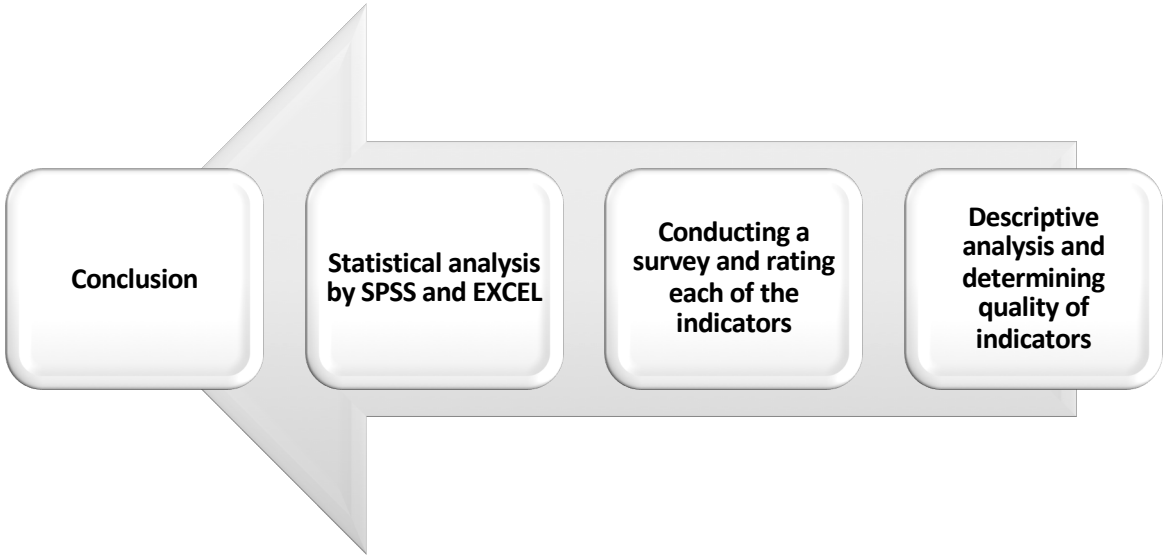


Fig. 1 The Process of resiliency analysis and evaluation

5 CRITERIA AND INDICATORS OF RESILIENCY MEASUREMENT

Since resilience models investigate the flexibility of communities to reduce vulnerability to the consequences of hazards, analysis and study of these models are required.

Most of the proposed models have considered the same factors (e.g. economic resources, capital, skills, information, knowledge, support and supportive networks, access to community services and shared values) which can reduce the vulnerability and increase the resilience of the community following threats such as natural disasters.

In other words, social capital can be regarded as the shared concept in all these models positively associated with social resilience. The limitation of these models, therefore, is focusing on one or more dimension of resilience with low interference and cooperation of local communities, and they do not extensively focus on this concept. Also, in terms of practicality, the proposed models mostly show the conceptual aspect of resiliency rather than its measurement, such as Tobin Model (Tobin, 1999), Sustainable Livelihood Model (DFID, 2005), Linear-Time Model (Davis, 2006), and the Meyunga Model (Mayunga, 2007) that point out certain aspects of resiliency.

Due to the multidimensional nature of resilience (social, economic, institutional, and physical-environmental) with a scientific consensus on it, it is therefore essential to offer and present models that consider all these dimensions as well as the role of local communities through participation. From among the presented models, the combination of cutter's locational model (2008 and 2009) and community-based model (CBDM[1]) is appropriate to assess and measure resilience against natural disasters. Cutter's locational model considers the above-mentioned dimensions and community-based model emphasizes on the key role of local communities and their cooperation in the management process of natural disasters.

In Cutter's model, resilience is a dynamic process depended on the previous conditions, the severity of accidents, the time between risks, and the impact of external factors. In his view, there are various hypotheses in the conceptualization of DROP[2]. Firstly, the model is designed to examine natural hazards, but it can be adapted to other incidents such as terrorism, technological hazards, and famine. Secondly, DROP focuses on resilience at the community level; it differentiates it from other models developed to assess resilience at micro and macro levels or models based on other sectors. Third, this model mainly focuses on the social resilience of places and is inseparable from social processes. This model represents resilience as a predicted or intrinsic condition or a process. The predicted conditions can be considered as images static in time and state; however, post-accident processes make this concept to be dynamic. Cuter in another study in 2010, presented a series of indicators for measuring the existing conditions effective on resiliency of communities against incidents based on DROP model (Rezaei & Rafiyane, 2012). According to the mentioned models, the final criteria and sub-criteria studied, measured, and analyzed in this research have been briefly presented in Tab. 2.

Criteria	Sub-criteria
Social Dimensions	Population literacy rate
	The number of higher education centers in the city
	Available education per capita
	The number of health centers and centers per capita
	The number of hospital beds per 1000 population
Economical Dimensions	Employment status
	The cost of defraying
	The unemployment rate
	Occupational diversity
Institutional Dimensions	The amount of responsibility and responsiveness
	The amount of state institutional diversity in the city
	The number of service centers in the city and region
Physical-Environmental Dimensions	Distance from the center of the province
	Available green space per capita
	Connection diversity with other areas (air, rail and road)
	Number of fire stations per 10,000 population
	City physical integrity (population density and balanced residential density)

Tab.2 Criteria and Sub-Criteria Discussed in Different Dimensions for Resiliency Measurement Studied in This Research

[1] Community Based Disaster Management, A project to achieve safety and sustainability of livelihoods for effective disaster mitigation, focusing on three key elements: self-help, co-operation, and education.

[2] Disaster Resilience of Place; A place-based model for understanding community resilience to natural disasters

6 CASE STUDY

Located in the northwest of Iran with an area of about 1433 hectares, Lahijan city has a mild and humid climate, and its population is 220,000 in 2017, which is the third most populous city in the province of Guilan after Rasht and Anzali.

Lahijan which is a touristic city was selected as the case study due to some crisis that has happened in it, for instance flood and heavy snowfalls. One who has lived in Lahijan, has experienced mentioned catastrophes entirely, in the conditions of the failure of municipality and the absence of city council to attract public participation.

Fig. 2 The location of Lahijan in Guilan province

6.1 LAHIJAN DEALING WITH POSSIBLE NATURAL HAZARDS

THE RISK OF HEAVY SNOWFALL

The study area is under the threat of heavy snowfall. This section outlines the amount of heavy snowfall in a 25-year interval in Lahijan. In the period under review, the first heavy snowfall occurred in 2005. Lasted for 18 days, the heavy snowfall reached a height of 1.2 meters leading to a lot of damage to the city.

Figure 3 shows this 18-day interval. The second relatively heavy snowfall, continued for an 18-day interval and reached the height of 0.6 meters, occurred in 2008. Fig. 4 shows this snowfall.

The next relatively heavy snowfall in this 25-year interval was in 2017. It is worth noting that this precipitation had fallen over a period of two weeks and consequently had a lot of damage. Following this heavy snowfall, roads were blocked and schools and offices remained closed for several days.

In parts of the city, also a failure of electricity and water and the telephone for several days had been witnessed. Fig. 5a and 5b show the snowfall in these two periods. As it can be seen, the interval between the

date of the first precipitation and the start of the second precipitation was seven days. February 10, the first precipitation was over, and on February 17, snow just restarted.

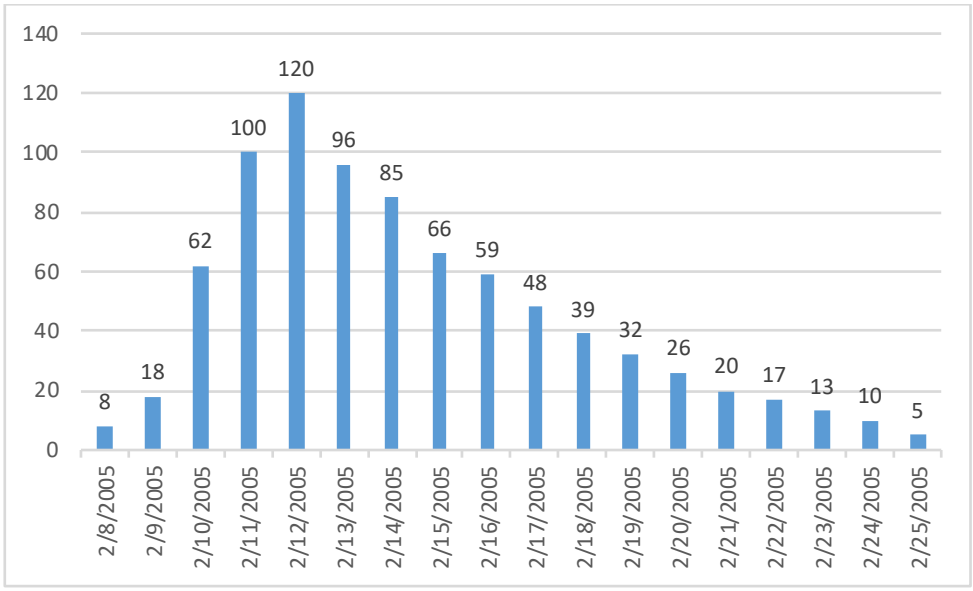


Fig. 3 Snowfall in 2005 in Lahijan

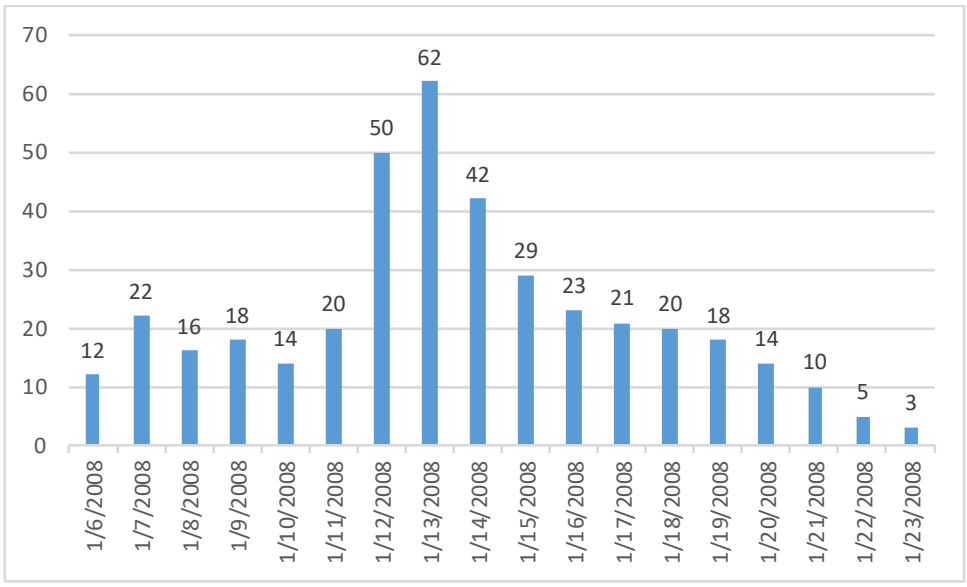
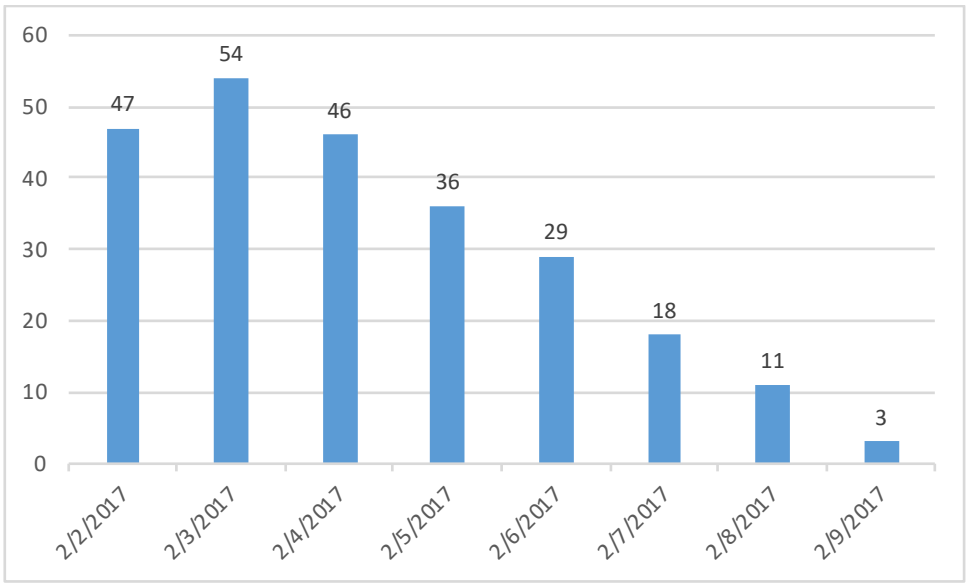


Fig. 4 Snowfall in 2008 in Lahijan



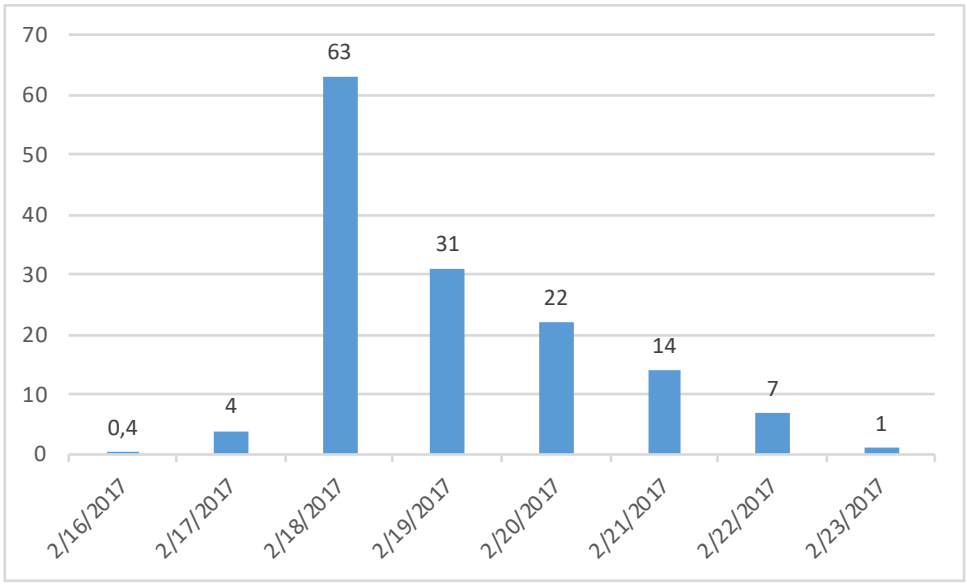


Fig. 5a & 5b Snowfall in 2016 in two dates in Lahijan

EARTHQUAKE HAZARD

In the east of Guilan, there are ten faults that mentioning all their names is time consuming. The most important fault that passes through the city of Lahijan is the Khazar fault with the east-west direction, which passes through Rasht and extends from northern Lahijan to the northern coast of Langroud. Fig. 6 shows these faults in the east of Guilan.

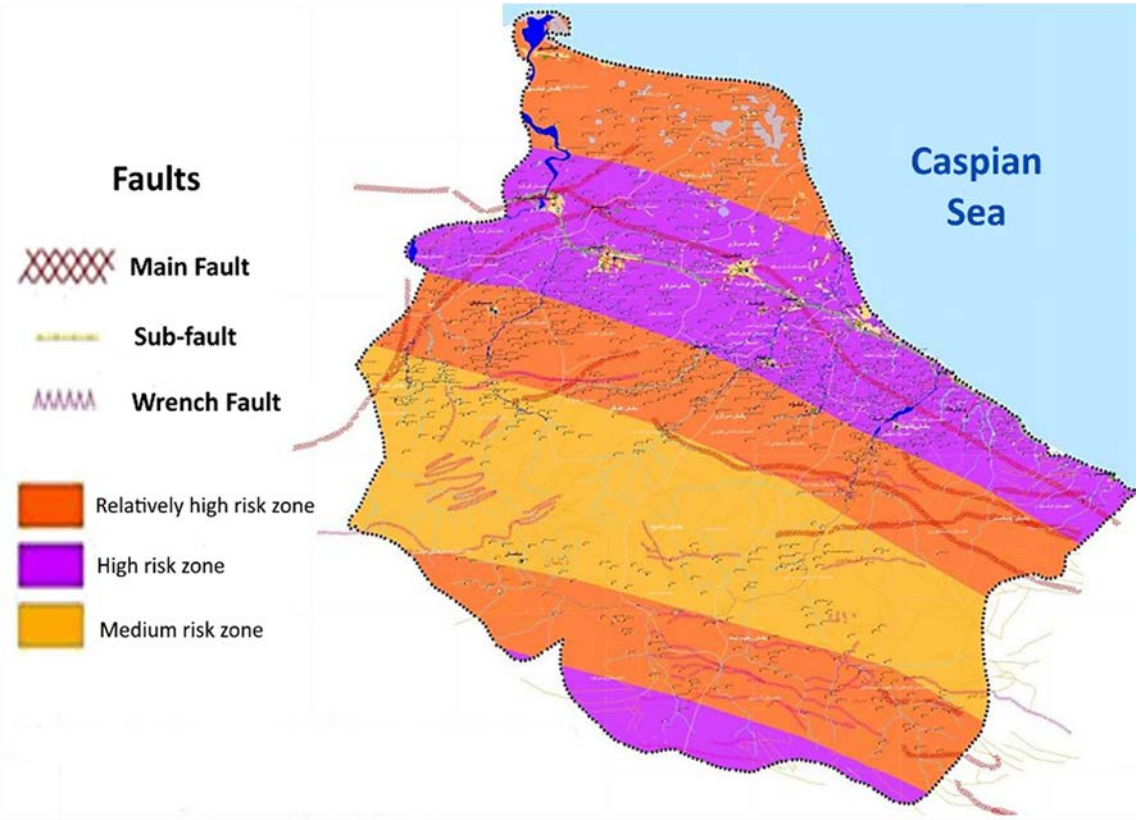


Fig. 6 Faults in the east of Guilan; Lahijan is located in a zone with high risk of earthquake, where the main Khazar fault passes through it.

6.2 RESILIENCY MEASUREMENT IN LAHIJAN

The following table (3) contains the proposed criteria and the sub-criteria to measure the resilience of the city of Lahijan. Due to the qualitative variables, the Likert spectrum was used to quantify and calculate the obtained data. This has been done using the existing standards for some of the sub-criteria and for some others it was based on in-depth interviews. The situation in the city of Lahijan has been compared to the standard situation and the weights of each of the different sub-criteria have been attached to them. In this spectrum, the low values, or those around and near one are considered to be the lowest comparing to the standard and the high values, or those near five, are the highest as compared to the standard. It should be noted that the standard condition is the same as the satisfactory average, and in the Likert spectrum, the value is numerically three.

Criteria	Sub-criteria	Lahijan City Situation
Social Aspects	Population literacy rate	92%
	The number of higher education centers in the city	3
	Available education per capita	1.7 m²
	The number of health centers and centers per capita	2 hospitals Health per capita 0.7 m²
	The number of hospital beds per 1000 population	1.3
Economic Aspects	Employment condition	Employment rate 88.2 (2006)
	The cost of defraying	3.2
	The unemployment rate	11.8

	Occupational diversity	Medium
Institutional Aspects	The amount of responsibility and responsiveness	Low
	The amount of state institutional diversity in the city	Available municipality and government
	The number of service centers in the city and region	Medium
Physical-Environmental Dimensions	Distance from the center of the province	45 km to Rasht
	Available green space per capita	32 hectares and 3.5 m² per capita
	Connection diversity with other areas (air, rail and road)	Road
	Number of fire stations per 10,000 population	2 centers 0.11 centers per 10000 population
	City physical integrity (population density and balanced residential density)	Gross population density 50.9 people per hectare Gross population density 50.9 people per hectare

Tab. 3 The Situation of Lahijan City in Assessing Criteria and Sub-Criteria for Measuring Resiliency

7 FINDINGS

The most important outcome of urban resilience measurement in Lahijan is as follows:
The results of one sample t-test regarding each of the involving criteria in resiliency in the study area is shown in the Tab. 4. This table is the outcome of scoring in the Likert spectrum by the experts, and comparing each of these criteria with the standard conditions as an accepted theoretical median to make them comparable. According to this table, the results is obtained at first, without applying different values of the criteria and sub-criteria involved in the resilience and the second, with the application of these values.

Aspects of study	Social	Economical	Institutional	Physical-Environmental
Without the application of the weights of criteria and sub-criteria				
The Score of Lahijan City	3.2	2.5	2.6	2.6
Theoretical Median	3	3	3	3
With the application of the weights of criteria and sub-criteria				
The Score of Lahijan City	0.64	0.59	0.52	0.5
Theoretical Median	1.05	0.6	0.9	0.45
Aspects of study	Social	Economical	Institutional	Physical-Environmental

Tab. 4 The Situation of Lahijan City in Assessing Criteria and Sub-Criteria for Measuring Resiliency

The results of one sample t-test without the findings of Delphi technique:

- In terms of resilience in the social dimension, the city of Lahijan with a score of 3.2 as compared to the theoretical median score is in the high spectrum;
- This situation is different in the economic dimension, as the city of Lahijan with a score of 2.5 in comparison with the theoretical median is in the low spectrum;
- In institutional dimension, Lahijan with the score of 2.6 as compared to the theoretical median is in the low spectrum;
- Finally, in the environmental aspect, Lahijan with the score of 0.64 was evaluated in comparison with the theoretical median and it is in the low spectrum.

The results of one sample t-test with the findings of Delphi technique:

- In terms of resilience in the social dimension, the city of Lahijan with a score of 0.59 as compared to the theoretical median score of 1.05 is in the low spectrum: 1.05, 0.6, 0.59;
- This situation is different in the economic dimension, as Lahijan with a score of 0.59 as compared to the theoretical median of 0.6 is in nearly medium spectrum;
- In the institutional dimension, Lahijan with a score of 0.52 as compared to the theoretical median score of 0.9 is in the low spectrum;
- Finally, in the physical-environmental dimension, Lahijan with the score of 0.5 was evaluated in comparison with the theoretical median of 0.45 and it is in the high spectrum.

Tables 5 and 6 shows the results of one sample t-test in each of the four dimensions. As follows, each of the dimensions has been separately investigated.

	N	Mean	Std. Deviation	Std. Error Mean
Social	5	0.6440	0.63862	0.28560
Economic	4	0.5975	0.38578	0.19289
Institution	3	0.5233	0.29838	0.17227
Physical	5	0.5000	0.33294	0.14890

Tab. 5 T-Test One Sample Statistics

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Social	-8.249	4	0.001	-2.35600	-3.1489	-1.5631
Economic	-12.455	3	0.001	-2.40250	-3.0164	-1.7886
Institution	-14.376	2	0.005	-2.47667	-3.2179	-1.7354
Physical	-16.790	4	0.000	-2.50000	-2.9134	-2.0866

Tab. 6 T-Test One Sample Test (Test Value = 3)

7.1 THE STUDY OF SOCIAL DIMENSIONS AFTER WEIGHTING

As Table 5 shows, the average social dimension after weighting has been 0.64. Fig. 7 shows the difference between the social dimension of the city of Lahijan and the theoretical median. Since 0.64 is smaller than the social dimension (i.e. 1.05), it can be concluded that Lahijan has been evaluated in the low spectrum in terms of social resilience and needs attention and planning in this regard.

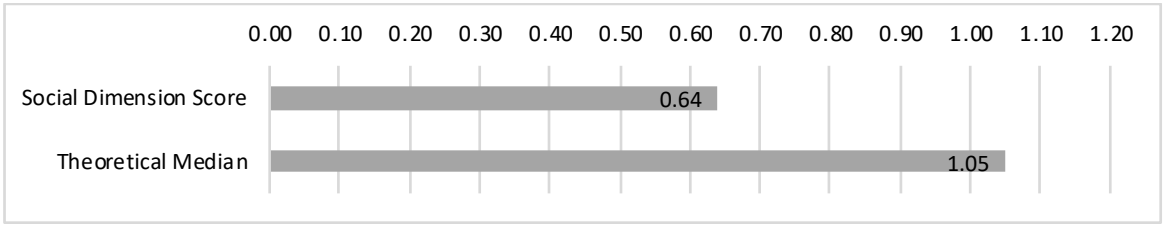


Fig. 7 The difference between the social dimension of Lahijan and the theoretical median

7.2 THE STUDY OF ECONOMICAL DIMENSIONS AFTER WEIGHTING

As Table 5 shows, the result of one-sample t-test showing that the average economic dimension score after applying the weights is 0.59. Fig. 8 shows that the economic dimension with a score of 0.59, considering the theoretical median of 0.6, is placed slightly in the medium spectrum in terms of resiliency and is in a better position than the rest of the studied dimensions.

Fig. 8 The difference between the economic dimension of Lahijan and the theoretical median

7.3 THE STUDY OF INSTITUTIONAL DIMENSIONS AFTER WEIGHTING

As Table 5 shows, Lahijan in institutional dimension, after applying the criteria's weight, has the score of 0.52. Figure 9 shows the difference between the institutional dimension score and the theoretical median. As it can be seen, the institutional dimension with a score of 0.52 is evaluated in the low spectrum in terms of resilience, as compared to the theoretical median 0.9.

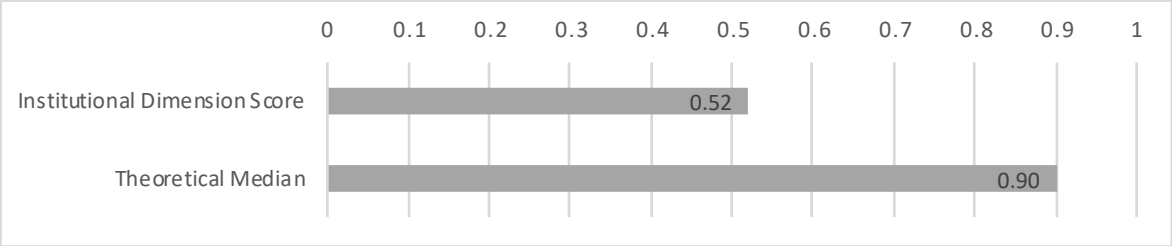


Fig. 9 The difference between the institutional dimension of Lahijan and the theoretical median

7.4 THE STUDY OF PHYSICAL-ENVIRONMENTAL DIMENSIONS AFTER WEIGHTING

As Table 5 shows, the average score of the physical dimension after weighting is equal to 0.5.
Figure 10 shows that the physical dimension with the score of 0.5 in comparison with theoretical median of 0.45 is in the high spectrum in terms of resilience.

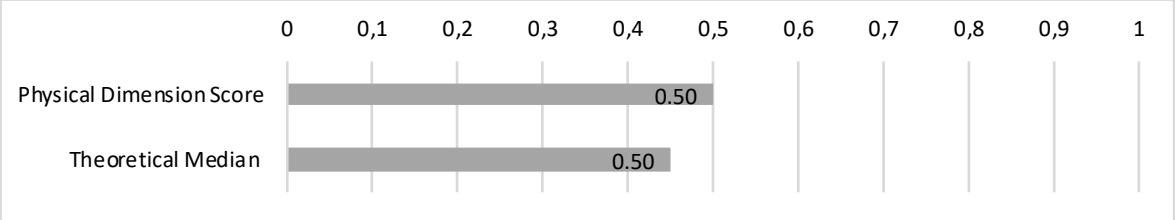


Fig. 10 The difference between the physical dimension of Lahijan and the theoretical median

As noted above, based on the results of the analysis and the obtained scores, Lahijan is totally in the low spectrum in terms of resiliency (5> 2.72>1, with theoretical median of 3). This level of resilience for a city like Lahijan is not satisfactory. Improving the resilience of the city depends on empowering its capacities to deal with natural hazards. In this regard, the final section, the conclusion, is devoted to providing solutions and recommendations.

It seems that the results obtained from the analysis of the study and compared to the existing conditions reveal that the Delphi technique- the use of different weights derived from experts' opinions for each dimension, criteria, and sub – criteria - provide better and closer to the reality measurements of the resilience in the study area. Therefore, the outcomes of the analysis through this technique have been used to answer the research questions.

- Are the social, economic, institutional, physical-environmental capacities of the study area in accordance with the needs of the community to demonstrate resilience in dealing with natural hazards?

- According to the results of the analysis of four dimensions of the study in the area of interest, the social and institutional dimensions of the city of Lahijan are in an unsuitable condition in terms of resilience and they are not sufficiently capable of coping with natural hazards. It has a better condition regarding the economic and physical-environmental dimensions than two social and institutional dimensions. As a result, based on the obtained scores in each of the studied dimensions, Lahijan, especially in social and institutional dimensions requires more attention, planning, and investment to improve the level of indicators and sub-indicators of resiliency.
- Is the study area considered resilient in terms of the dimensions and measurement criteria in the present study? Lahijan with a score of 2.72 as compared to the theoretical median is in the low spectrum in terms of resilience (in all studied dimensions). It means that the components and the capacities of the city do not currently meet the conditions of the area in terms of resilience against natural hazards and improvement of the resilience capacity of the city and providing fundamental plans should be considered.

8 CONCLUSION

Based on the research, the resilience of Lahijan encountering natural hazards is under average and this shows inappropriate conditions of the city. Lahijan has serious social and institutional problems. The city is in a modest condition in economic dimension of resilience however, its physical dimension is considered acceptable. In the social dimension, the main problem in the city is the inadequate number of hospitals and health centers and the inappropriate distribution of them. At the same time, the existence of illiterate citizens (8% of the total population) can also cause problems and create disturbance in crisis management.

In the institutional dimension, there is the issue of the weakness of responsive and accountable institutions. This refers to the structure of the state institutions, including the municipality and the government, where responsiveness is not a defined and organizational responsibility of them.

These suggestions, which are based on research findings, can improve resilience of Lahijan and lead to reduction of damages. Trying to eliminate the problems originated in deficiency of hospitals and health centers, the state can cooperate with private sector for building new hospitals and clinics. The important point is locating these centers according to resilience considerations. Training the citizens of Lahijan, in order to encounter with the natural crisis can be met in various ways including media.

Strengthening the institutions that increase the participation of citizens in the administration of the city and attract them to the wider area of the neighborhoods and their residents can be helpful. Despite the active presence of the people and their cooperation when crisis happen in our country (in case of earthquakes, for instance, the active participation of the people in aids), this presence has not been organized and cannot be considered in a hierarchy that ultimately leads to responsible institutions. The volunteered presence of helping people sometimes adds to the dimensions of the crisis and some other times focuses aids on unessential and subsidiary parts. Organization of people's presence through local councils and the establishment of a hierarchy of governance should be carried out in a normal and clam situation, so that in crisis, the empathy can be used correctly and where it is needed.

It was mentioned earlier that Lahijan is in the low to nearly moderate condition in economic dimension. The biggest reason is the cost of defraying (3.3). This figure shows that every employed person pays the cost of another 3.2 people, and this figure is regarded as a moderate and decent number in comparison with some other parts of the country. The unemployment rate of 11.8 % is also not a critical employment condition for Lahijan, and it can be said that Lahijan has modest conditions in terms of resilience in the economic dimension.

The city, in physical-environmental dimension has been evaluated in the high spectrum of resilience. This has several reasons. The relatively low distance from the center of the province (45 km to Rasht), the available green space per capita, and the physical integrity of the city, which includes a balanced demographic and residential density are of those reasons. In terms of the number of fire stations, these stations should be

increased to meet the standard of a firefighter per 2500 people. Elimination of this weakness will be an important factor in improving the resilience of Lahijan. Particularly, when the predictable critical cases for this city are conditions such as heavy rain or snow, as well as earthquake that firefighters play a significant role in overcoming them. This study has featured weak points of Lahijan regarding resilience and has proposed suggestions to eliminate them. Further researches can focus on every one of the weak points. This means that an independent study can focus on social dimension of resilience in Lahijan which is the boldest weak point of this city regarding resilience. The number of needed hospitals and health centers according to the growth rate of population and the method of locating them in proper places of access hierarchy considering probable traffic jams of urban paths in the case of a severe crisis, would also be subjects of other researches.

Ways of persuading illiterate minority of lahijan to education and attracting others to social instructions would be other subjects of research, in order to improve social participation in a hierarchical and organized manner.

In conclusion, it must be emphasized that resilience is a spatial approach. Prioritizing executive solutions varies depending on the location and conditions, but actually follows the same objective. The resilience of societies encompasses a wide range of goals in increasing resilience in all social, economic, institutional, and physical-environmental aspects and seeks to enhance the capacity of communities in all aspects to confront changes. Resilience in a general and long-term plan can achieve its aim, which is a resilient society with short-term executive plans.

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IMAGE SOURCES

Fig. 1: Author.

Fig. 2: Comprehensive plan of Lahijan.

Fig. 3, 4 , 5.1, 5.2: Author.

Fig. 6: Comprehensive plan of Lahijan.

Fig. 7, 8, 9, 10: Author

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