Research Paper: Socio-Economic Structures Affecting Resilience of Rural Settlements to Earthquake (Case Study: Kanduleh, Sahneh County)

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ABSTRACT

Purpose: The proper planning for disaster management in local communities does not merely address the vulnerability of the areas and requires the understanding of resilience. This is because identifying the resilience indicators and assessing the strengths and weaknesses if properly managed, can reduce the vulnerability of each community to natural disasters.

Methods: This is an applied research in terms of purpose and has a descriptive-analytical nature and is conducted using the survey method and questionnaire tool. The collected data are analyzed by SPSS software. In this study, the researchers investigate the socio-economic structures affecting the resilience of rural settlements and rank the villages of the region in terms of resilience using the TOPSIS FUZZY method by applying the resilience indicators in different dimensions (social, economic, institutional-infrastructural, etc.). The statistical population includes all 18 inhabited villages of Kanduleh County which are studied by random sampling.

Results: The results indicate the low resilience level of Kanduleh villages, and the economic and social factors have a significant role in increasing the resilience of the rural settlements. In addition, there was a significant correlation between different socio-economic, infrastructural and institutional dimensions, social capital, etc. However, there was no significant relationship between the service factor and the dependent variable of socio-economic factors in the villages.

Conclusion: According to the results of the study, the villages of this district were ranked into 8 levels. Tazeh Abad had the highest resilience among the villages, while Kortavij Olya had the lowest resilience.

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1. Introduction

Natural disasters, defined as the processes involving an event or a set of events, often have a wide range of human, material, economic, and environmental impacts. The negative consequences of natural disasters potentially undermine society and disrupt public welfare even for a long time (Cui et al., 2018). In fact, natural disasters have historically been one of the inescapable problems of human life and occasionally occurred at different scales in the world and, in addition to human mortality and destruction of homes, have displaced large numbers of individuals. The earthquake is among the most destructive disasters in Iran and the world. Throughout life on earth, this recurring phenomenon has always been a serious threat to development, especially in developing countries. Regarding the natural hazards, the evidence suggests that the developing countries are more vulnerable to natural hazards, as eleven natural hazards occurred during the twentieth century with the frequency of 16689 have caused 10,052,401 deaths and approximately $631 billion damage, mostly in the developing countries. According to global statistics, Asia has been indirectly affected by a number of large-scale natural disasters in recent decades. The impacts of the disasters are increased with the increase in population (about four billion). The occurrence rate of accidents in Asia is 39% of the world's population, which accounts for 53% of the global fatalities and covers 88% of all people affected by such accidents (Kaku & Helder, 2013).

Natural disasters have different impacts; for example, drought has a negative impact on the growth in agriculture, but hazards such as earthquakes rarely damage the capital in the agriculture sector - at times, by creating springs due to the developments in the land, they are even useful for agriculture - but the reconstruction costs a great deal in the investment sector. In fact, such a hazard as drought threatens the agriculture sector of the economy, but earthquake impacts the industry sector of a country (Norman et al., 2010).

In general, it can be stated that currently, on average, three million people become homeless every year, and about 80% of those are the people whose homes are destroyed by earthquake (Asefi et al., 2016). However, the rural areas have long been exposed to natural hazards (earthquakes) due to their close link with the natural environment and insufficient capacity to deal with the environmental threats, and have been highly vulnerable to earthquake disasters. Numerous earthquakes occur in rural areas around the world every year. These areas are faced with extensive damages due to vulnerability, fragility of the rural economy, lack of proper physical and social infrastructure, severe physical decay, low width of rural roads, inadequate access to communication routes, use of inappropriate structures and less durable materials, etc. (Roomian et al., 2014), which poses major challenges for rural development. The high population density in rural areas of developing countries, type of used materials, and longevity of the buildings highlight the necessity for crisis management and attention to the vulnerability of these areas (Tsai & Chen, 2012).

Coping with the hazards is one of the main challenges for most countries (Cuter et al., 2016), which not only causes death and emotional suffering but also damages the local economy and thwarts the development achievements (AlNamari & Alzaghal, 2015). Due to the fact that the earthquake is one of the unpredictable natural disasters and causes significant casualties in the cities and villages of the world every year, the significant issue in dealing with such natural and unpredictable disasters that cannot be avoided even in the developed and advanced countries is to adopt a resilience-promoting approach for mitigating the resulting human and financial losses. Although the resilience-promoting approach and the reduced casualties and financial losses resulting from such approach have been proved to be successful in the earthquake-prone countries, the question remains that in a country like Iran with the highest population of seismic cities on active faults (as the Ministry of Housing and Urban Development estimated in the National Framework Plan, 50% of the Iran urban population lives in the areas with the high risk of seismicity), and in the case of Iranian villages, this can show the deteriorated situation of the villages in the country, so much so that in the recent earthquake in Kermanshah, seven cities and 1930 villages were seriously damaged (Kermanshah Governorate portal, 2018), why should the crisis-driven approach not be replaced with the resilience-promoting approach? The answer to this question recalls the human and financial losses caused by the catastrophic earthquakes in Roudbar, Manjil, Bam, and now Kermanshah, which incur huge financial, social, and psychological costs to compensate for such events due to the neglect of authorities and people. Although the costs of resilience promotion in Iranian cities and villages may be overwhelmingly significant, amounting to several billion dollars, if we closely look into the damages caused by natural disasters such as earthquakes, we will undoubtedly notice that the psychological damages inflicted on those affected by these incidents are so high that it can be argued with great certainty that we will see the impacts

of such catastrophes in future generations. This bitter reality means that the shift from the crisis-driven approach to the resilience-promoting approach is not only a necessity but despite the human costs in recent years, it should be argued that such an approach is vital for the cities and villages of the country (Kermanshah Governorate portal, 2018).

Given that the Iranian plateau lies on the active Alpine-Himalayan orogenic belt, the occurrence of numerous earthquakes in this country is natural. There are three earthquake-prone zones in Iran: Zagros, Alborz, and Central Iran, where we have witnessed extensive damages throughout history. In the last 90 years, more than 85 destructive earthquakes have occurred in Iran, leading to more than 120,000 deaths, making Iran one of the ten most disaster-stricken countries, as well as the sixth most earthquake-prone country in the world (Bahrami, 2008), which is vulnerable to earthquakes due to its geological position. The experiences gained from past earthquakes indicate that the existing rural buildings, which are often traditionally constructed, are highly vulnerable to earthquakes, and even the less severe earthquakes have proved destructive and caused significant financial and human damages. The historical earthquakes of the twentieth century as well as the fault activities indicate that Kermanshah province is a highly seismic zone (due to the young seismic fault of Zagros), where devastating earthquakes may occur at any moment. 6023 square kilometers, 23.82% of the province area, is located in the high earthquake hazard zone and outside the province, 100% of the Sahneh and Kangavar area, 77% of the Harsin area, 70% of the Sonqor area, and 20% of Kermanshah are located in the high earthquake hazard zone (Maleki, 2011). Meanwhile, Sahneh county is at high risk of being hit by an earthquake due to the presence of the Dinavar fault. In the past decades, earthquakes have caused many damages, especially in rural areas, including the 1957 earthquake of 5.2 magnitude (near Sahneh, Kangavar, and Farsinaj) and the 2002 earthquake of 5.1 magnitude (near Sahneh), which caused extensive damage and complete destruction of some villages, especially in Dinavar and Kanduleh districts. Most of the buildings in this area were made of clay and mud with flat roofs, and due to the poor quality of materials, the level of devastation of these buildings was very high, especially in the village of Tarazu Bareh, which was completely displaced after the earthquake due to its geographical position and inadequate safety of the area against earthquake, and villages such as Hojjatabad, Melehaneh, Amirabad, and Tazehabad, which were rebuilt after the earthquake because they had suffered the greatest damages. However, other villages were not spared from the earthquake and were also damaged. However, despite the reconstruction of the houses in the area and renovation of most buildings, they still have little resistance to earthquake motion, and the recent earthquake in Ezgeleh, Kermanshah caused damages to the villages, which shows that, to some extent, the problem still exists in the area. Therefore, the main question in this study is "how do the social and economic structures influence the resilience of rural settlements to earthquake in Kanduleh district?"

An earthquake is a natural hazard which has currently received the interest of communities and nations. The earthquake history in Iran clearly shows that no part of Iran can be assumed safe from earthquake. Earthquakes such as those that occurred in Roudbar, Manjil, Zarand, and Bam indicate the importance of serious and scientific attention to this disaster.

The earthquake is one of the natural features that have consistently caused the destruction and loss of many lives throughout history. Gradually, with the evolution of science and technology, especially in the construction sector, the structural strength of the buildings was increased to the extent that there has been great progress in Japan due to the high seismicity, as most earthquakes are less likely to threaten human lives. However, earthquake prediction has not yet been made possible.

The Bam earthquake is significant in three respects: first, because the high social cohesion of the people and their sympathy towards each other somewhat eased the suffering; second, the loss of several thousand innocent people, the physical and mental injuries of many survivors, and the disability of some people which doubled the burden of the social welfare sector; third, it showed that crisis planning and management should be seriously considered as a necessity in the components of urban and rural management. The earthquake is a natural feature of the earth, not divine wrath, and we must provide the necessary context in the urban development process in the country based on the technical and engineering principles. The natural context on which most of Iranian cities and villages have been located and developed over time has the potential for various events to occur. The possibility of an earthquake is evoked considering the site selection of most cities and villages of the country on the slopes, the tectonic status of the country, the Alpine-Himalayan orogenic belt, the existence of numerous faults in the geological structure, and the bed on which the cities and villages are located (Ghadiri, 2016).

Iran is one of the world's most vulnerable countries to natural hazards, especially earthquakes, due to the climatic, geological and socio-spatial development characteristics, so that on the one hand, the location of urban and rural populations and settlements in the geographical area of the country, and on the other hand, the quality and manner of growth and expansion and the adaptation to the natural environment as well as the level of socio-economic and institutional development have created a vulnerable, fragile, and critical situation in the country. Therefore, the reduction of vulnerability to natural hazards, especially earthquakes, in Iran is a major factor in achieving full sustainable socio-ecological development. This requires the clear and targeted programs and documents to direct the vulnerability reduction activities in various aspects and in a consistent manner, and the national five-year development plans are the focus of attention for developing such programs and documents (of course, according to the upstream documents and policies including the vision document and general policies of the system). Besides, developing the appropriate documents and programs is necessary to reduce vulnerability to earthquake and have a sound and comprehensive attitude towards the various causes and dimensions of this vulnerability. This is because unilateralism or over-simplification of the problem may not only not lead to problem-solving, but also create new problems (Ghadiri, 2016).

The Asian Disaster Reduction Center (ADRC) has promoted the disaster reduction culture by supporting disaster reduction as a central part of government policies and raising public awareness in Asia. The Asian Disaster Response Unit at the UN Office for the Organization and Coordination of Humanitarian Affairs has developed the disaster risk management initiative as an effective and strategic disaster mitigation approach that is the result of many years of experience in dealing with natural disasters around the world, especially in Asia (ADRC, 2007).

In the disaster management phase, the ADRC considers the following to be essential in systematic planning:

1. Establishing coordination mechanism and legal framework, 2. Integrating the concept of reduction of casualties in development planning, 3. Improving information sharing and management, 4. Promoting public awareness and education, and 5. developing multilateral participation (ADRC, 2007).

Considering the location of a large part of the geographical area of the country in the Alpine-Himalayan earthquake belt, and the fact that more than 90% of the settlements are vulnerable to a 5.5 magnitude earthquake (Akasheh quoted by Einali et al., 2014: 95) and 17.6% of destructive earthquakes occur in Iran every four years (Bayat quoted by Sharifi et al., 2009: 2), it is very important to pay attention to resilience in Iran. Resilience is defined as a kind of resistance to shock and disaster, and as defined by the Oxford dictionary, it means the ability of people or society to return to the normal state after disasters such as shock, injury, and so on. It also means the capability of materials to return to the original state after bending, stretching, or compressing. This term was coined by Hölling, ecological theorist, in 1973 (Partoei et al., 2016).

2. Literature Review

In fact, resilience is of Latin derivative (resilio) meaning jumping backward. Resilience, in principle, is applied to an environment developed in social systems and human-environment systems and aims to focus not only on the ecosystem or society itself but also on the social integration and the environmental system. Different meanings have been proposed for the concept of resilience: 1. Flexibility as the biophysical and social characteristics specific to areas, 2. Flexibility as the biophysical characteristics in terms of environmental variability and key characteristics of systems; 3. Flexibility as the amount of disruption that can occur in a system in times of crisis which has already been maintained in the system, 4. Flexibility as the ability of human society to withstand external shocks or underlying disorders (Zhou et al., 2010).

Practically, the term resilience was first used by Timmerman who was one of the first people who discussed the resilience of society to climate change and used the term resilience in relation to vulnerability and also as a tool to measure the resistance and strength of a part or a system to return to its original state after an accident (Mohammadi Serin Dizaj et al., 2017). The main approaches to resilience are: (a) Sustainability: This approach, -which defines resilience as the ability to return to the former state, is expanded from the ecological studies and defines resilience as the disturbance a system can tolerate or absorb before being transferred to another state; (b) Recovery: This approach is related to the ability of a community to return to the previous condition before the change or the pressure factor and return to its original state and is a criterion that measures the time a community has taken to recover from the change; (c) Transition: It is more about social resilience and the capacity of society to respond to change, which can mean

shifting to a new state that is more sustainable in the current environment rather than simply returning to the former state. This approach is more concerned with the adaptation of communities to the events. In a resilient socio-ecological system, the disruption creates the potential for the opportunities to experience new works for the innovation and development associated with the concepts such as renovation, revitalization, and self-organization (Maguire & Hagan, 2007; Holling, 1973).

Resilience has the following social, economic, institutional, and physical dimensions:

The first component of resilience is the social dimension that results from the difference in social capacity between communities. In other words, it is the capacity of social groups and communities to return to the initial state or positively respond to disasters. In this context, major forms of capital, especially social capital, have been identified as important and useful concepts in the areas of hazard and disaster. Recent research in community development theory shows that the success and sustainability of a community's ability to cope with the hazards depend on the understanding, accessing, and using major forms of capital.

The second component is the economic dimension. In economics, resilience is defined as the inherent reaction and adaptation of individuals and communities to the hazards so as to allow to mitigate the potential losses caused by the hazards and to stabilize the economic growth and distribution of income among the community.

The third component is the institutional dimension that contains the features related to risk reduction, planning, and experience of past disasters. Here, resilience is affected by the capacity of communities to reduce risks, engage local people in risk reduction, build organizational links and improve and preserve social systems in a community (Paton & et al. quoted by Ramezan Zadeh, 2016).

The fourth component is the physical-environmental (infrastructural) dimension, which is essentially an assessment of community response and disaster recovery capacities such as shelters, vacant or rented housing, and health facilities. Also, these indicators present an overall assessment of the private properties which may be particularly vulnerable to permanent damages and potential economic losses. One of the most critical vulnerable infrastructures is the less durable homes that are susceptible to a catastrophic accident (Rezaei & Rafieian,, 2010).

Among the mentioned dimensions of resilience, the economic dimension is one the most important ones. Indeed, it is possible to assess the economic structures by identifying the strengths and weaknesses of the economic system to promote the economic resilience caused by human and natural disasters. In this regard, Wasilewski et al. (2014) showed that the physical damage to infrastructure, disruption to business and facilities, etc. caused by disasters and accidents highlight the need to pay attention to economic resilience (Sasanpour et al., 2017).

The basic principles of the regional resilience planning process for disasters are classified into five groups:

1. Apply a method to consider infrastructure interdependencies: This includes preventing and mitigating the impacts, securing, preparedness, response, recovery, maintenance, and long-term modification. From the lowest levels to the global levels, infrastructures are increasingly interconnected, causing physical and virtual vulnerability (cyberspace). Therefore, it is necessary to understand the dimensions and effects of such interconnections, responsibilities, missions, and business continuity, especially in the case of widespread or long-term infrastructure disruption.

2. Interaction and cooperation between units (public and private) with different rules and regulations: The inter-sectoral cooperation should include all levels of government, service, product distribution, manufacturing, processing, distributors of necessities, and non-profit service providers such as social service organizations, universities, educational institutions, schools, mosques, and religious sites.

3. Assessment, planning and mitigating of impacts for regional resilience: The government and key sectors need to work together to develop sustainable, practical, and flexible methods for the resilience and the methods and indicators for measuring the resilience of various units and organizations of the community or region.

4. Regional crisis management and coordinated decision making: The effective organizational identification and coordination and the determination of tasks, roles, and responsibilities in a crisis are crucial for establishing regional resilience. Therefore, proper defense integration for dealing with the crises requires transregional essential resources.

5. Threats to communication, information exchange, and status reporting: It is essential to manage and maintain the security of essential information regarding the infrastructure interdependencies and predict the potential conditions before, during, and after an accident or crisis, which are achieved by the inter-sectoral collaboration, definition of bilateral exchange and sharing procedures, and identifying, collecting, protecting, combining, and analyzing information.

The promotion of resilience and adaptation to changes and environmental crises and reducing the risk level among local communities enable community development to continue in the face of environmental threats constantly and sustainably so that subsequent disasters may not disrupt the lives of people. However, providing suitable living conditions to rural people can be effective in the resilience of the villagers. Under suitable rural living conditions, the empowerment and resilience of rural communities to environmental hazards can be pursued, as protective, empowering, and adaptive factors are formed under favorable living conditions (Sadeghlou & Gheidari, 2017).

In general, it can be stated that in terms of resilience and vulnerability, due to the differences within and among the communities caused by the differences in structural factors such as inequality and power relations, each society emphasizes a particular factor for promoting resilience. Some consider the effectiveness of social and economic situation, gender and race, age, construction quality, and density as well as household characteristics, while others stress the importance and impacts of local culture in the disaster. The effect of different factors on resilience and the emphasis of communities on different characteristics can be summarized at two levels: at the individual level, it is believed that women with lower education level, children, and the elderly are most affected by natural disasters; at the community level, the main factors of resilience such as geography, economy, government, and social and cultural capital are involved (Hsu, 2017).

The main approaches in the field of resilience include:

A: Sustainability: This approach has expanded from ecological studies - which define resilience as the ability to return to pre-existing conditions - and defines resilience as a disorder that a system can tolerate or absorb before it is transferred to another state.

B: Recovery: This approach is about society's ability to return to the previous condition before the change or the cause of pressure and return to its original state, and a measure that is measured by time, society is measured to recover from change.

C: Transition: It is more related to social resilience and the capacity of society to react to change, which instead of simply returning to the previous state can mean a change to a new state that is more stable in the existing environment. This approach is more concerned with adapting communities to events. In a resilient socio-ecological system, disruption creates the potential to provide opportunities for new work experiences for innovation and development that are associated with concepts such as renewal, revitalization, and self-organization. (Maguire & Hagan, 2007: 1; Holling, 1973).

Mohammad Poor Lima et al. (2020), in the paper entitled "Physical and social resilience of residential areas of historical Context (A case study of District 12 of Tehran)", state that physical environment can help shape gatherings and make them dependent on certain places, as well as increase the bond between residents. Therefore, the attention of urban planners to such spaces is very important and can help to make them more resilient in the future.

Kazemi (2019) says in the paper entitled "Development of earthquake resilience scenarios based on rural-urban links (Case study: Shemiranat, Damavand, and Firoozkooh counties)" that the indicators proposed in the design of resilience scenarios based on rural-urban links are indicators that have a two-way effect, i.e. they are affected by other indicators as well, and none of them is dependent. In addition, the rules are indicators that can control the whole system, which should be considered in the design of scenarios. These two findings once again highlight the importance of paying attention to regional planning and avoiding spatial segregation of settlements.

Abdollah Zade Maleki et al. (2019) say in a paper entitled "Prioritization of factors affecting social resilience against natural hazards with emphasis on earthquakes" that one of the effective criteria in social resilience to deal with earthquakes, social capital with the highest weight is in the first rank and the later stages of human capital, population characteristics, individual characteristics, quality of life, social security and psychological readiness of society with weight is in the last rank.

The results of the study by Savari and Abdeshahi (2019) entitled "Analysis of the role of social capital in improving the resilience of rural households in drought conditions in Divandere city" showed that the studied

households were in a good position in terms of social capital status but were not in a good position in terms of resilience status. Also, the results of correlation analysis showed that there was a positive and significant relationship between all dimensions of social capital (social trust, participation and collective action, social cohesion, and group membership) of the studied households and their resilience.

Fei Du et al. (2018) conducted a study entitled ''Natural disaster research in a historic village in Sichuan highlands, China" concluding that the highland villages have a critical situation owing to the high-density wooden buildings, poor spatial communications during the earthquake, etc. These villages have become highly vulnerable due to the insufficient awareness of local people about risk recognition, poor public participation, and top-down management which has made people dependent on the government.

Cui et al. (2018) in a study entitled ''Resilience of earthquake-stricken rural community in southwest China: correlation and association with disaster risk reduction efforts using linear regression" examined the relationship between the behavioral and demographic characteristics including age, ethnicity, gender, education, income level, employment status, marital status, and resilience status. The results showed that those who participated in the crisis management training courses and also had higher incomes and better economic status had higher resilience to earthquakes.

In the context of this study, Shakour et al. (2017) in a paper entitled ''Analysis of rural settlements against earthquake in villages of Lamerd county using the TOPSIS model" ranked the districts of this county. The results of this study showed that in terms of the seismic vulnerability level using the TOPSIS model, Kal with 5284 scores, Sigar with 5221 scores, and Ashkenan with 4754 scores have the first to the third rank. There are also two high-risk, one medium-risk, and four low-risk earthquake-prone districts at Lamerd county.

Doma Lamaa et al. (2017) conducted a comparative study between two Nepalese villages under the shock (disaster) to examine the relationship between adaptation and resilience. The results showed that the concerns about the vulnerability of communities to natural disasters and risks cause to pay greater attention to adaptability and flexibility as important policies. In fact, to discuss the resilience of communities, the concepts of adaptability and resilience used in the field of risk and sustainable rural development need to be explicit in considering the values, goals and aspirations and correct spatial and explicit definition of timing.

Noori and Sepahvand (2016) in a paper entitled ''Resilience analysis of rural settlements to natural hazards with emphasis on earthquake (a case study of Shirvan, Boroujerd) using analytical descriptive method" concluded that the resilience of the studied villages to earthquake is below the average level and there is a significant difference between the villages. The results showed that among the socio-economic, infrastructural, and social capital dimensions of rural areas, the social capital dimension has a greater effect on the resilience of rural settlements.

Dogulu et al. (2016) in a study entitled ''How do survivors perceive community resilience? The case of the 2011 earthquakes in Van, Turkey" showed, through qualitative research, that resilience greatly contributes to the fair distribution of timely services and good governance, financial resources, and also pre-earthquake awareness, preparedness, and social solidarity.

At the rural level, Arouri et al. (2015) examined natural disasters (storms, floods, and droughts), household welfare, and resilience among rural households in Vietnam. The results indicated that the household characteristics influence resilience so that the household and community characteristics can strengthen the resilience to natural disasters. Despite the negative impact of natural hazards on household income and spending, the households with higher average costs, education, income levels, and better income distribution were more resistant to natural disasters. Access to micro-credits, remittances, and social grants also help households to strengthen their resilience.

Cutter et al. (2011) carried out another study on the design of criteria and indicators resilient to disasters where the main purpose was to develop and design the resilient indicators of the risks to test or determine the resilience conditions of communities. In this study, Cutter et al. examined the selected indicators in terms of social, economic, institutional, infrastructural, and social capital resilience.

Hutter (2011) conducted a study on the social resilience to natural disasters and concluded that the small local groups can influence the social resilience process. Mengjie Sun et al. (2010) in a study entitled ''Evaluation of natural disaster impacts on rural homes in Wenchuan region" concluded that there is a significant relationship between the extent of damage to rural homes after a disaster and poverty, and compared with the villagers

who are engaged in other jobs in addition to agriculture, those whose only occupation is agriculture are more vulnerable because of their lower-income, as they are unable to build resistant housing due to their poor financial situation.

In this article, the research questions are as follows:

• What is the relationship between the Index of Effectiveness and the importance of mitigating measures with the index of resilience?

• What is the relationship between the Index of Service facilities and the index of resilience?

• What is the relationship between the Socio-cultural Index and the index of resilience?

• What is the relationship between the Economic Index and the index of resilience?

• What is the relationship between the Institutional Index and the index of resilience?

• What is the relationship between the Infrastructural Index and the index of resilience?

• What is the relationship between the Index of Effect of community capability capital and the index of resilience?

• What is the relationship between the Index of Social Capital and the index of resilience?

The conceptual model of the research is presented below (Figure 1).

In Table 1, indexes of investigation show:

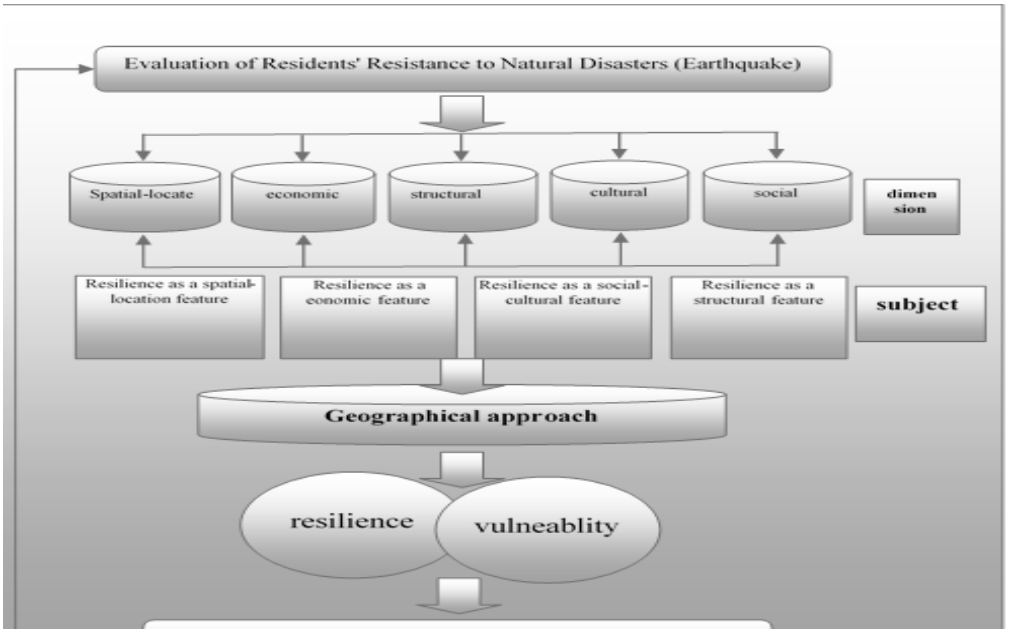

Figure 1. Conceptual model for assessing the resilience of residents to natural disasters (earthquake)

Table 1. Indexes of investigation

cultural and social Index	Index of resilience
1. Access to and use of the Internet	Bad situation of the village
2- Having physical health in the community	Observance of technical rules and principles of construction
3- Possessing mental health in the society	Use of high strength materials
4. Access to a doctor	Obligation to retreat and move buildings from the danger zone.
5. Services provided by social security insurance or medical services	Implementation of rural housing insurance plan and insurance of economic activities
6- Performance of housing insurance	Implement support and incentive schemes such as loans to strengthen and improve housing
7- Agricultural insurance performance	Implement training and information programs for exposure
8- Doing administrative work to insure housing, farms and gardens	Economic index
9- The amount of payment paid by the insurers	1- The level of satisfaction with the strength of housing
Institute resilience index	2- The level of awareness of the resistance of your residential house against earthquakes
1- Education	3- Satisfaction level of housing function
2- The performance of councils and villages	4- Satisfaction level of future work
3. The role of local managers to insure your housing and property	5- Status of income equality between different strata of the village
4. Ability to attract help from executive agencies	6. Satisfaction with your personal income
5- Planning to reduce earthquake risk	Infrastructure index
6- Supporting vulnerable local communities (especially women, the elderly and children)	1- Exposed to earthquake destruction (location of access roads in the village)
7- Evaluating the amount of destruction	2. Satisfaction with access to the hospital at the time of the earthquake
8- Awareness about risk management	3- The villages of the region have piped water
9- Land use policies	4- The villages of the region have a national gas network
10- Supervising the construction of housing	5- Access to hospital, emergency, pharmacy and health centers
11-Management and maintenance of infrastructure	6- Access to kindergartens, schools, high schools and universities
12- Implementing support and incentive schemes such as mortgages	7. Access to aid agencies (Red Crescent) or crisis management center
13- Reducing the psychological effects and adverse social effects of disasters	8. Access to the police and law enforcement
14. Access to resources and expertise	9- Access to fire department
15. Preventive measures	10. Access to the main thoroughfare network
Capital index	11- Access to temporary accommodation
1- Non-governmental organization (such as local funds, Islamic Association) in the village	Social capital index
2. Act as a member of the council or village head	1. The tendency to stay in the area
3- Giving up your interests for the benefit of society	2. Solidarity between people during an earthquake
	3- Helping each other
	4. Help local managers
	5. Participation between communities, the private sector and local authorities
	6- Observing the principles and regulations of building construction

3. Methodology

The present research is an applied study in nature and a case study in terms of scope, and it is a descriptive-analytical study in terms of methodology. Accordingly, the descriptive method is used to explain the findings and the analytical method to test the hypotheses. In addition, to assess the resilience of the residents of the villages under study based on the documentary studies, the indicators and items will be developed and evaluated using the survey method. To achieve the objectives of the study, the questionnaire will be developed using the closed-ended and open-ended questions. This questionnaire has certain characteristics. First, according to the questions and topics under study, it will be designed, and attempt will be made to determine the relevance of the questions to the variables, indicators, and finally, desired indices, if possible, to obtain the required data for the desired index through the questions. The validity of this research is based on the content, and the experts in geography and rural development planning were used to validate the research tool and judge its accuracy and validity. The aim of reliability is the stability and validity of measurements at different times using Cronbach's alpha coefficient in the questionnaire. Also, in the economic resilience index, three items, namely the problem and disruption of business activity in the event of an earthquake, amount of dependency on a job in the employment questions, and reduction of household income in the event of an earthquake were removed from the questions due to the lack of enough scores. In this regard, two items of the infrastructural resilience index were removed, namely the access of villages to the power grid and access to public transport in the area, and in the case of the effect of community capability capital on the resilience, one item, namely the willingness of people to join the Council and village administrations, and in the individual ability, two questions, namely to cope with the earthquake-related events in terms of mental conditions and the duration of a job if losing a job, were also eliminated, where the valid test scores are compared for repeating the experiments at different times, and the results will be the same. After the design, the researcher presented the questionnaire to professors and several rural management and planning experts. They made comments after the necessary reviews, and the researcher made the necessary adjustments to enhance the formal and content validity of the measuring instrument and prepared the final questionnaire where the alpha values and coefficients for measuring the reliability are given in Table 2, indicating the appropriate reliability of the questionnaire.

According to the latest population and housing census in 2016, the statistical population is 1152 households living in 26 villages of Kendoleh district of Dinevar district with a population of 3667 people. For sampling, out of 26 villages in Kondoleh village of Sahneh city, which, according to the population statistics and also the nature of the research, i.e. the villages that have suffered the most damage due to the earthquake, were in 18 villages, including 1066 households and 3435 people are selected as the sample population. To determine the sample size using Cochran's formula, 283 out of 1066 rural households were selected based on the calculation, which determines the sample size or in other words, the number of questionnaires required. Then, to increase the quorum of the questionnaires, the minimum number of questionnaires in the villages were increased to 15. The sampling method in each village was systematic random sampling.

Kanduleh village is a part of Dinavar district in Sahneh, Kermanshah province with the area of 199.1, 47° 13' east longitude and 34° 39' north latitude, located 52 km south of Sahneh and 75 km Kermanshah away from the province center. Region map is presented in Figure 2.

Table 2. Reliability of research instrument

No.	Likert indicators	Cronbach's alpha
1	Risk mitigation and village situation	0.92
2	Social and cultural dimension	0.87
3	Economic dimension	0.77
4	Institutional dimension	0.87
5	Infrastructure dimension	0.76
6	Community capability in resilience	0.72
7	Social capital	0.75
8	Individual ability	0.77

Source: Research findings, 2019

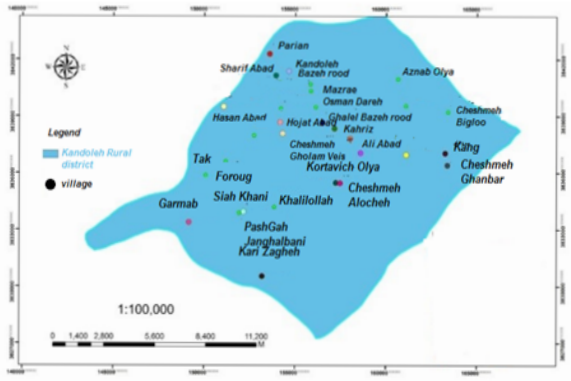

Figure 2. Map of the region

4. Findings

This section assesses the correlation between the study indices.

Analysis: According to the results of Table 3, it is observed that there is a correlation between all indices, and only the index of service facilities has no significant relationship with the socio-cultural and economic indices, the importance of mitigating measures, and their effect on the area. There is also a significant relationship between the service facilities index and the institutional resilience and infrastructural resilience indexes, community capability impact, social capital, and individual ability to impact indices. For example, the first part of this table shows that the mitigating measures 1 index, which covers the importance of a number of measures in the region such as the location in the hazard area and supervision of housing construction and compliance with construction laws, is highly correlated with the mitigating measures 2 index, because the mountainous condition of the study area located in the hazard area, the situation of settlements, etc. caused a low resilience to earthquake, and this confirms the importance of the first index. Also, the poor economic situation, inadequate infrastructure, etc. caused the resilience in the region to be reduced and the settlements to be built with low strength. This means that to promote resilience, the problem cannot be solved one-dimensionally, and all the indicators are linked together as a single system; the weakness in one index leads to the weakness in the other ones.

Table 3. Assessment of the correlation between study indices

First variable	Second variable	Correlation coefficient	Significance level
Index of effectiveness and importance of mitigating measures	Area situation in terms of mitigating measures	0.550	0.000
	Service facilities	0.034	0.531
	Socio-cultural resilience	-0.263	0.000
	Economic resilience	-0.204	0.000
	Institutional resilience	-0.108	0.046
	Infrastructural resilience	-0.192	0.000
	Effect of community capability capital	0.226	0.000
	Social capital	-0.176	0.001
	Individual ability	-0.146	0.007
Index of area situation in terms of mitigating measures	Service facilities	0.079	0.146
	Socio-cultural resilience	-0.356	0.000
	Economic resilience	-0.335	0.000
	Institutional resilience	-0.432	0.000
	Infrastructural resilience	-0.391	0.000
	Effect of community capability capital	-0.267	0.000
	Social capital	-0.294	0.000
	Individual ability	-0.243	0.000

Table 3. Assessment of the correlation between study indices

First variable	Second variable	Correlation coefficient	Significance level
Service facilities	Socio-cultural resilience	-0.051	0.352
	Economic resilience	-0.095	0.079
	Institutional resilience	-0.203	0.000
	Infrastructural resilience	-0.242	0.000
	Effect of community capability capital	0.316	0.000
	Social capital	-0.200	0.000
	Individual ability	-0.192	0.000
Socio-cultural resilience	Economic resilience	0.627	0.000
	Institutional resilience	0.477	0.000
	Infrastructural resilience	0.618	0.000
	Effect of community capability capital	-0.210	0.000
	Social capital	0.455	0.000
	Individual ability	0.291	0.000
Economic resilience	Institutional resilience	0.436	0.000
	Infrastructural resilience	0.509	0.000
	Effect of community capability capital	-0.263	0.000
	Social capital	0.379	0.000
	Individual ability	0.220	0.000
Institutional resilience	Infrastructural resilience	0.640	0.000
	Effect of community capability capital	-0.325	0.000
	Social capital	0.434	0.000
	Individual ability	0.422	0.000
Infrastructural resilience	Effect of community capability capital	-0.368	0.000
	Social capital	0.577	0.000
	Individual ability	0.408	0.000
Effect of community capability capital	Social capital	-0.266	0.000
	Individual ability	-0.226	0.000
Social Capital	Individual ability	0.324	0.000

Source: Research Findings, 2019

In this section, the results of the regression analysis are examined, where the analysis is done as a multivariate linear regression in multiple analysis methods.

Analysis: In this section, all variables are simultaneously introduced into the analysis, and the effects of all independent variables on the dependent variable, which is the socio-economic index, are investigated. The service facilities index was excluded from the analysis due to its lack of correlation with the dependent variable. According to the results of the above table, all variables have a significant role in the socio-economic resilience. The results of this analysis are presented as a first step in the path analysis in Figure 3. In this analysis, the coefficient of determination is 51%, which means that the socio-economic index overlaps for all indices to the same level. In fact, as explained above, it can be stated that all indices affect the economic and social resilience, and this relationship is both direct and indirect, which is then used to assess the direct and indirect effects of all indices on the socio-economic index using the path analysis (Table 4).

Regression equation:

$$Y = -1.37 + 0.22X1 + 1.95X2$$

Table 4. Results of regression analysis

Dependent variable	Independent variable	Determined variance (R^2)	Beta	B	ignificance level of fit line
Socio-economic index (x1)	Mitigating measures 1 (x2)	0.510	-0.125	-0.294	294.0
	Area situation in terms of mitigating measures 2 (x3)		0.002	0.003	0.000
	Institutional resilience (x4)		0.231	0.177	
	Infrastructural resilience (x5)		0.477	0.479	
	Effect of community capability capital (x6)		0.087	0.330	
	Social capital (x7)		0.076	0.170	
	Individual ability (x8)		0.014	0.027	

Source: Research Findings, 2019

Step 1.

In this section, the direct effects of all indices on the socio-economic (dependent) index are assessed. In the first step, the correlation between the indices having a significant level with the socio-economic index is shown (Figure 3).

Step 2.

In the second step of path analysis, the relationship of independent variables with each other is investigated using the simple regression method, and each independent variable is considered once as the dependent variable and the effects of other variables are assessed. For example, the mitigating measures 1 index, which is an independent variable, is considered here as the dependent variable and the effects of other independent variables such as mitigating measures 2, institutional variable, infrastructure, the impact of community capability, social capital, and individual ability are assessed. Then, the same is done for other variables (Figure 4).

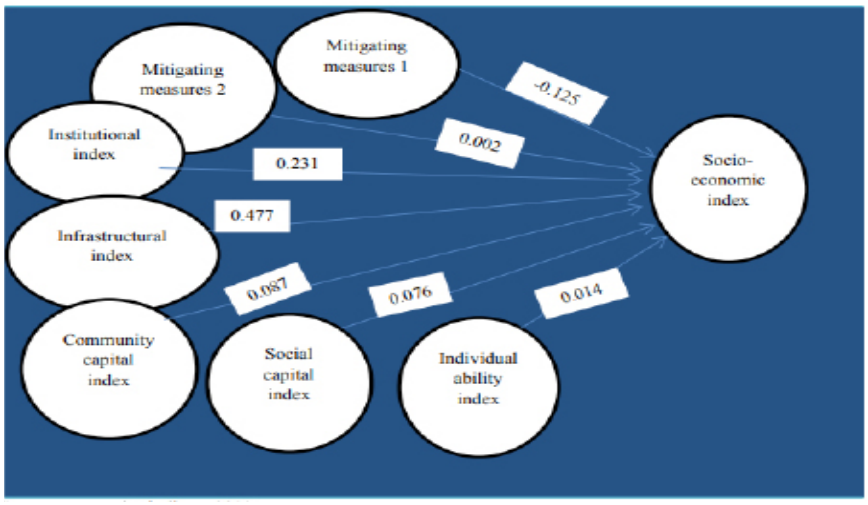

Figure 3. Direct effects of all indices on socio-economic index

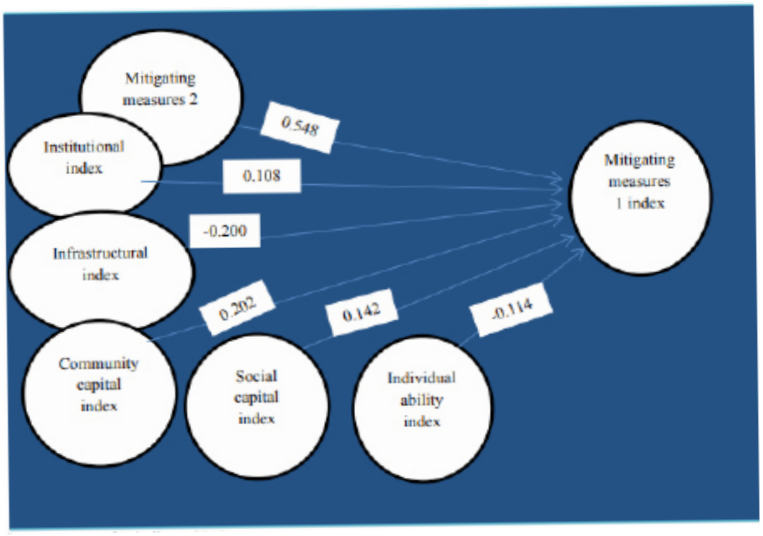

Figure 4. Results of the effect of independent variables on x1

For the other variables, the same effects were assessed and the following results were obtained:

In this section, stepwise regression was used. In this analysis, the coefficient of explanation is equal to 51%, which means that the socio-economic index has the same overlap for all indicators. In fact, it can be said that all indicators affect the state of economic and social resilience, and this relationship is both direct and indirect.

The results of the regression analysis, which examines the direct and indirect effects of all indices on the dependent variable of the research (socio-economic index), show that, for example, the individual ability index affects the social capital, and with the increase of individual abilities in the desired local community, the capability and social capital will be increased, because every individual is a part of the community, and the increase of individual skills and abilities in a local community that has a tight link with the community - this is one of the outstanding properties of a village - and therefore, when the community has a high potential and the social capital - including the participation - is increased. As a result, with the collaboration of rural residents, some of the infrastructures can be improved, so that all of the factors, both directly and indirectly, affect the socio-economic structures, which are shown in Table 5.

Figure 5 shows the impact of each index on other indices and thus, on the socio-economic index:

Table 5. Sum of direct and indirect effects of independent variables on the dependent variable

Independent variable	Direct effect	Indirect effect	Sum of direct and indirect effects of each variable
Mitigating measures 1 (x2)	-0.125	-	-0.125
Area situation in terms of mitigating measures 2 (x3)	0.002	-0.0002	0.0218
Institutional resilience (x4)	0.231	-8.618	-8.38
Infrastructural resilience (x5)	0.477	0.234	0.711
Effect of community capability capital (x6)	0.087	5.053	5.14
Social capital (x7)	0.076	-13.76	-13.69
Individual ability (x8)	0.014	-35.664	-35.650

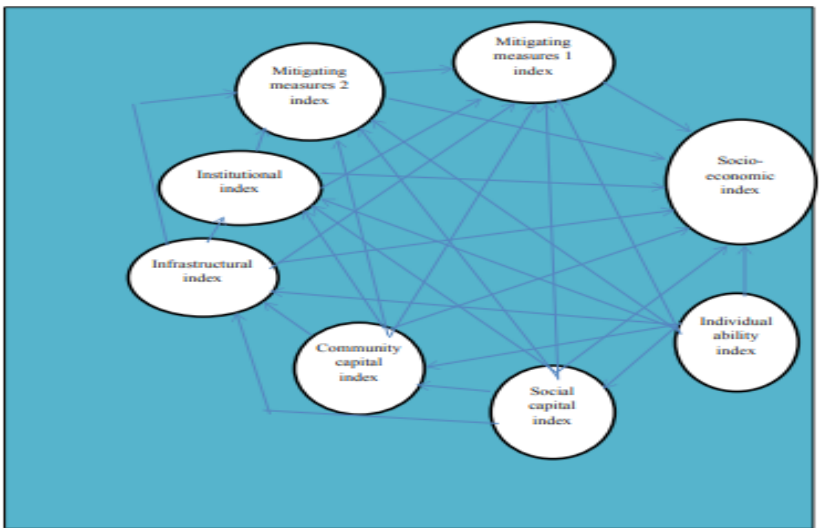

Figure 5. Direct and indirect effects of independent variables on x1

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Fuzzy TOPSIS Model

In this section, the fuzzy TOPSIS method is used to rank the villages. This method is one of the best multi-criteria decision-making methods based on fuzzy variables. The method is based on the conventional TOPSIS method, except that it uses fuzzy variables to express the preference of options over the problem indices, which in turn substitutes the fuzzy calculation relations for the computational relations in the presence of deterministic data during the problem-solving process.

Step 1: Develop the decision matrix

In the first step of the fuzzy TOPSIS, according to the number of criteria, number of options, and evaluation of all the options for different criteria, the decision matrix is developed as follows. The matrix columns are related to the criteria (different indices) and the rows are the options (villages).

According to the results of Table 6, the data used in this study are fuzzy. The used fuzzy numbers are also triangular fuzzy numbers. Also, all the criteria have positive aspects. To assess the importance of the criteria, a number of questionnaires were given to experts, specialists, and authorities in the district governor's and village administration of the area, and using their opinions on different indices, the weight of different criteria was determined and assigned to each criterion.

The results of this model are as follows.

Therefore, according to Table 7, Aliabad with the highest similarity index (0.58) has the highest (1) rank and Kortavij Olya with the lowest similarity index (0.40) has the lowest (8) rank among the villages. In other words, Aliabad has the largest relative distance among other options, and thus, it has the highest rank. Other villages are placed in the next ranks. It is important to note that the villages of Kanduleh district are very close in terms of resilience, as the similarity index suggests. Some villages may also have a better position economically or in respect to some other indices than other villages, but this measurement in the fuzzy TOPSIS model has weighed all the factors together, thus ranking lower in this classification.

Table 6. Weight of criteria from the point of view of experts

Criterion	Mitigating measures	Mitigating measures 2	Service	Social-cultural	Economic	Institutional	Infrastructural	Effect of community capability	Social capital	Individual ability
Weight	very high	very high	low	relatively low	high	null	relatively high	very low	very low	very low

Source: Research Findings, 2019

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According to Table 8, the region is not in a good position in terms of resilience due to the mountainous nature of the region, the weak economy of the majority of households, and low resilience in other indicators, and this village has low resilience to earthquakes. In other indicators, this village has low resistance to earthquakes.

In the following section, the Friedman test is used to assess the difference between rural areas in terms of resilience. The reason for using this test is to determine whether the differences between rural settlements in terms of resilience to the earthquake are real or are just a meaningless coincidence. The results show that there is a significant difference between the villages at 90% probability (Table 8).

Table 7. Ranking of villages based on the level of resilience

Village	Similarity index	Rounded	Ranking
Aliabad	0.578873	0.58	1
Kanduleh	0.523484	0.52	2
Parian	0.478318	0.48	3
Korizagheh	0.465293	0.47	4
Garmab	0.465385	0.47	4
Keng	0.473630	0.47	4
Sharifabad	0.462617	0.46	5
Cheshmeh Gholam Weys	0.455745	0.46	5
Kortavij Sofla	0.462150	0.46	5
Qaleh Bozeh Rud	0.447478	0.45	6
Hojjat Abad	0.448457	0.45	6
Tarazu Bareh	0.454460	0.45	6
Cheshmeh Aloocheh	0.453043	0.45	6
Cheshmeh Ghanbar	0.445659	0.45	6
Kahriz	0.442417	0.44	7
Siakhani	0.435040	0.44	7
Tazeh Abad	0.396954	0.40	8
Kortavij Olya	0.400466	0.40	8

Source: Research Findings, 2019

Table 8. Friedman test

Villages	Chi-square	DF	Significance level
Kanduleh	351.487	9	0.000
Parian	124.326	9	0.000
Sharifabad	140.859	9	0.000
Qaleh Bozeh Rud	132.336	9	0.000
Kahriz	105.489	9	0.000
Cheshmeh Gholam Weys	140.442	9	0.000
Hojjat Abad	212.460	9	0.000
Tarazu Bareh	131.985	9	0.000
Tazeh Abad	119.075	9	0.000
Korizagheh	112.434	9	0.000
Garmab	123.900	9	0.000
Siakhani	112.476	9	0.000
Cheshmeh Aloocheh	153.236	9	0.000
Aliabad	202.918	9	0.000
Kortavij Olya	120.197	9	0.000
Kortavij Sofla	117.745	9	0.000
Cheshmeh Ghanbar	124.326	9	0.000
Keng	Foothill	9	0.000

Source: Research Findings, 2019

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5. Discussion

In this study, 18 villages of Kanduleh district were studied due to their higher vulnerability as a result of their high population. In this district, the topographical conditions governing the mountainous areas have created special constraints for physical-environmental development. This problem and the inappropriate morphology of the villages in the district have caused the housing of most villages to be on steep slopes, facing problems such as narrow streets and low width. These issues have made it difficult to provide relief to these villages when the earthquake strikes. The location of the Kanduleh district in the Dinavar region on the Farsinaj Dinavar fault has increased the vulnerability of the villages in the region relative to other villages. The housing of this district has a physically inappropriate situation because, in addition to the mountainous area, most of the villages have old-textured housing and are not safe against earthquake. In terms of resilience, this district is faced with problems such as the high distance of most villages from the road, lack of transportation facilities and services, lack of infrastructural facilities, and so on. Therefore, this study tried to identify the most important resilience indices by assessing the resilience indices in Kanduleh district. Then, to investigate the resilience, all frequency percentage tables were used to determine the resilience of each of the components. The findings of this study indicate that the region is in a moderate position concerning individual ability, social capital, and community capability, but it still has low resilience with respect to the results of the tables as well as the statements of the villagers. This was in addition to the loans and facilities provided in some villages in the study area for housing reconstruction, but the locals stated that due to poor economic conditions, they were forced to build low-strength housing without observing the safety principles. This indicates that economic factors play a major role in the resilience of villages in the region. Regarding the regression of the research variables, after the economic factor, the role of social factors in increasing the resilience of the region is important, and these two factors overlap with more than half of the research components. The relationship of these components with each other and consequently, their relationship with the socio-economic structures that are the dependent variable in this study were investigated. Then, using the fuzzy TOPSIS model, it was attempted to rank the villages. The indices used in this study were categorized into 10 groups: the importance of mitigating measures, the impact of the measures in the study area, service, economic, socio-cultural, institutional, and infrastructural indices, the effect of community capability on resilience, social capital, and individual ability. To assess the resilience, the frequency of index tables was

initially obtained, and the results showed that using the Spearman correlation test, the relationship between the resilience indices was evaluated, and the results showed that except for the service facilities, other components of research have a significant relationship with each other. Then, the direct and indirect relationship of each component with socio-economic factors was investigated using the path analysis test. Finally, the fuzzy TOPSIS was used to rank the villages, where Aliabad with the highest similarity index (0.58) had the highest (1) rank, and Kortavij Olya with the lowest similarity index (0.40) ranked lowest (8) among the villages. In other words, Aliabad has the largest relative distance compared to other options; therefore, it has the highest ranking. Other villages are in the next ranks. It is important to note that the villages of Kanduleh district are very close in terms of resilience, as the similarity index suggests. Some villages may also have a better position economically or in respect to some other indices than other villages, but this measurement in the fuzzy TOPSIS model weighed all the factors together, thus ranking lower in this classification. In the remainder of this chapter, the Friedman test is used to measure the differences between the villages in terms of resilience. The results indicate that there is a significant difference between the villages in terms of earthquake resilience at a 99% probability.

In terms of resilience indices, this study is very similar to the indices used in the research by Cutter et al., except that in the latter, only the indices were identified and the main purpose of this research is the same, while in the present research, the indices such as the mitigating measures and their importance in the region were used where the items such as the location of the district and the importance of any mitigating and safety measures in the region were used. The purpose of this study is to analyze the socio-economic structures affecting the resilience of rural settlements.

The study by Dogulu et al. (2016) entitled ‘’How do survivors perceive community resilience? The case of the 2011 earthquakes in Van, Turkey” showed that resilience greatly contributes to the fair distribution of timely services and good governance, financial resources, and also pre-earthquake awareness, preparedness, and social solidarity. Focusing on the resilience, this research seeks to investigate the community’s understanding of resilience and its impact on the society, while the present study examines the factors affecting resilience, as opposed to examining only the social resilience. This research systematically explores resilience.

In a research, Arouri et al. (2015) examined natural disasters (storms, floods, droughts), household welfare, and resilience among rural households in Vietnam. The results indicated that the household characteristics influence resilience so that the household and community characteristics can strengthen the resilience to natural disasters. Despite the negative impact of natural hazards on household income and spending, the households with higher average costs, education, and income levels and better income distribution were more resistant to natural disasters. Access to micro-credits, remittances, and social grants also help households to strengthen their resilience. This study only considers the household characteristics, especially the economic factor, in strengthening resilience, while the results of the present study consider the economic factor as the most important one, yet the factors such as social, infrastructural, institutional, etc. are also considered important in this area. The results of the present study, which considers the economic factor as the most important factor in promoting resilience, can be deemed similar to the results of the study by Cui et al. (2018) entitled ‘’Resilience of earthquake-stricken rural community in southwest China: correlation and association with disaster risk reduction efforts using linear regression” that showed that those who participated in the crisis management training courses and also had higher incomes and better economic status had higher resilience to earthquakes, except that attending the courses has a more pronounced role in promoting resilience and the economic factor is in the next rank.

Also, the results of this study and the one conducted by Fei Du et al. (2018) are similar in that both studies show that the mountainous condition of the regions has decreased resilience and increased vulnerability.

It should be noted that in the research conducted by Noori and Sepahvand, which investigated the most important factor in the resilience of rural settlements, the social capital factor has the greatest role in increasing the resilience of rural housing, while in this study, unlike the study of Noori and Sepahvand, the social capital is in a relatively good position, but the region still has low resilience, and according to the findings of the study, the economic factor, followed by the social factor, has the greatest role in increasing the resilience of Kanduleh rural settlements. Thus, the results of this study are similar to the results of the study by Mengjie Sun et al., except that the purpose of their research was to investigate the impact of natural disasters on the rural settlements in terms of vulnerability, while the present study, on the contrary, addresses the issue of resilience and the

impact of socio-economic factors on the resilience of rural settlements.

In a study conducted by Shakour et al. (2017) on the analysis of rural settlements under earthquake in the villages of Lamerd county, as in the present research, they used the TOPSIS model to rank the districts in this county. The results of this study showed that in Lamerd county, two high-risk districts, one medium-risk district, and four low-risk districts are vulnerable to earthquake hazards, while in the present study, the fuzzy TOPSIS model is used to rank the resilience of the villages, and the first rank belongs to the village with the highest level of resilience to earthquake.

In general, it can be stated that the innovation of the present study, and in other words, the gap of the problem is that the domestic and foreign studies are only one-dimensional and only partially explore the subject of resilience, while in this research, as mentioned at the beginning of the discussion, in addition to identifying the indicators and examining their relationship with each other, the most important resilience index was identified and then, the study villages were ranked in terms of resilience.

While the purpose and subject of the study by Meng Ji Sun et al. is to investigate the effect of natural disasters on rural settlements in terms of vulnerability, the present study discusses resilience and the effect of socio-economic factors on the resilience of rural settlements. In a study conducted by Shakoor et al. in 2017 under the title of analysis of rural settlements against earthquake in Lamerd villages, as in the present study, using the TOPSIS model, they have ranked and categorized the villages of this city into various levels. The results of this study in Lamerd city have shown that in this city, two villages with high risk, one village with medium risk, and four villages with low risk are vulnerable to earthquake risk. The fuzzy TOPSIS model has been used to rate the resilience of villages and has ranked them. The first rank belongs to the village that has the highest level of resilience against earthquake.

Parishan et al. (2013) in a study aimed at ranking and assessing the level of vulnerability of rural settlements in Qazvin province to earthquake risk, like this research, used the Topsis technique to rank rural areas and like the research by Shakur and colleagues, ranked the villages in terms of risk and the highest score belongs to the village that has the highest risk, while in the present study, the lowest score belongs to the village that has lower resilience; in other words, the village that has the highest level of risk-taking. Also, Fal Soleiman et al. (2012) in a study by selecting an earthquake-prone geographical axis in eastern Iran (Ghainat and Zirkuh cities), tried to classify the vulnerability of villages according to their location in the earthquake zone. It can be seen that most of these studies have examined vulnerability.

Poortaheri et al. (2015) in a study evaluated the physical vulnerability of rural settlements to natural hazards (earthquake) using the Coopras decision model in the villages of Chalan Cholan of Dorod city and concluded that Baba Pashman Do Sar and Garaj villages had the highest vulnerability and Heshmatabad, Behzad Abad and Vahed Abad villages had the lowest vulnerability to the 2010 earthquake in Silakhor plain of Lorestan province. While in this study, the fuzzy TOPSIS model has been used for ranking and also, unlike Poor Taher's research which has examined the physical vulnerability of villages and is one-dimensional, this research has examined all resilience indicators and the situation of the village.

This study is similar to the research conducted by Fei Du et al. (2018), since the results of both studies show that the mountainous situation of the regions has reduced resilience and increased vulnerability.

In general, it can be said that the innovation of the present study, and in other words, the problem gap is because domestic and foreign studies are one-dimensional and have only studied part of the issue of resilience, while in this study, as mentioned at the beginning of the discussion, in addition to identifying the indicators and examining their relationship with each other, the most important resilience index was also identified, and then the studied villages were ranked in terms of resilience.

Therefore, it can be concluded that the villages of Kandoleh village are different from each other in terms of the resistance of rural settlements. However, in the end, the resilience of these areas is not satisfactory and all the villages, for various reasons such as weak economy, inadequate infrastructure, etc., are highly vulnerable to earthquake, but in the following, more details will be provided about the situation of these villages; for example, Kandoleh, Sharifabad, and Paryan villages are in a similar situation and need serious reconstruction under the supervision of engineers, and due to the mountainous nature of these villages and the seismicity of the Dinur region, this issue needs to be planned as soon as possible, because with each passing day, due to delays in the reconstruction and repair of these houses, we may once again witness an earthquake similar to the recent earth-

quake in Kermanshah in Sarpol-e Zahab and Azgeleh, Bam, Rudbar, and Manjil and similar earthquakes that have left irreparable damage to local communities. The most important issue in the discussion of resilience is primarily to save the lives of the people who live in these houses. Also, villages such as Cheshmeh Ghanbar, Keri Zagheh, Garmab, Siakhani, Qarchang, and Amirabad are among the villages whose residents claim that the authorities do not pay any attention to their situation and that they have been forgotten. These villages are in a dangerous situation in terms of rockfalls and floods, as well as earthquakes, and require relocation or at least reconstruction, which is not considered by anybody or any official due to the marginalization of these areas.

Villages such as Kortavij-e Sofla, Kortavij-e Olya, Cheshmeh Gholam Veis, Aliabad, Kahriz, Bozrud, Hojjatabad, Tarazo Barreh, and Tazehabad also need to be rebuilt, although in the model conducted in this study, they are different in terms of ranking, as mentioned in Chapter 4, this difference is very small.

While in countries such as France and India, the rural economy is developing day by day, developing countries such as Iran do not have the minimum basic facilities that are a house durable against risks. Therefore, villages such as the villages of Kondoleh and other villages in the country need serious attention to prevent the recurrence of events that have occurred in the past in these areas (such as the 2003 earthquake in Dinur).

Suggestions:

1. Provide context for the creation of indigenous knowledge among villagers when dealing with environmental hazards.

2. Strengthen rural housing to minimize vulnerability to environmental hazards.

3. Provide facilities for rehabilitation and reconstruction of housing for villagers at once at beginning of work.

4. Directly supervise the construction work in the villages to ensure the observance of rehabilitation principles and rules.

5. Building culture among villagers for serious risk of natural hazards if housing is not reinforced.

6. Displace some villages by the government before serious disasters occur to residents in high-risk areas.

7. Establish NGOs (such as local funds, Islamic associations) in the village. There are no NGOs in the village under study.

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Conflict of Interest

The authors declared no conflicts of interest.

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