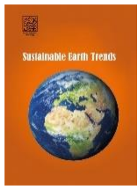
Sustainable Earth Trends 4(3) 2024 31-47

Shahid Beheshti University

Sustainable Earth Trends

Journal homepage: http://sustainearth.sbu.ac.ir



The analysis of urban settlements resilience of Qazvin City against floods using confirmatory factor analysis method

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A B S T R A C T

Today, improving flood resilience has grown to be a significant and comprehensive area in flood risk management. The present study aims to analyze the urban settlements resilience against floods in the Qazvin city. The data collection instrument is a questionnaire, and the data analysis is done using the Confirmatory Factor Analysis method. In this study, indicators were first identified and hypotheses were developed based on these indicators, and finally, all the hypotheses were confirmed using statistical techniques. Here, four hypotheses were defined: 1) Social factors affect the resilience of urban settlements against floods in Qazvin city, 2) Environmental factors affect the resilience of urban settlements against floods in Qazvin city, 3) Technical factors affect the resilience of urban settlements against floods in Qazvin city, 4) Managerial factors affect the resilience of urban settlements against floods in Qazvin city. The effect of all the indicators in the dimensions of social factors, technical factors, managerial factors, and environmental factors was confirmed. The results show that social, technical, environmental, and managerial factors affect the urban settlements resilience against floods in the Qazvin city. Social factors have the most influence with an importance value of 0.8. The influence of social factors on the resilience of urban settlements against floods in Qazvin city has been investigated using T-statistics. The estimated value is equal to 5.640. Considering that all considered factors are significant, they have been identified as relevant and influential in resilience.

A R T I C L E I N F O

Keywords:
Environmental factor
Managerial factor
Risk management
Social factor
Technical factor

Article history:
Received: 11 Mar 2024
Accepted: 02 May 2024

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Citation:
Kakavand, F. et al., (2024). The analysis of urban settlements resilience of Qazvin City against floods …, *Sustainable Earth Trends:* 4(3), (31-47).

DOI: 10.48308/set.2024.235783.1052

1. Introduction

Nowadays, there have been significant shifts in attitudes toward risk, and the prevalent perspective has shifted from emphasizing merely reducing "vulnerability" to boosting "resilience" against accidents. Resilience, as a matter of fact, means improving the capability of society, planning, and preparation for absorption, improvement, and more success to cope with the unwanted effects after disasters and restoration, and it improves the affected society socially, economically, environmentally, and physically. Flood is a natural phenomenon that human societies have accepted as an inevitable event.

A group of natural events that humans have labelled as natural disasters are not always disasters per se and what has made them disasters is our invented interactions. If humans did not expose themselves and their settlements and property to floods without defence, this natural phenomenon would not have left such a horrifying image in the memory of mankind that it would be at the top of the list of natural hazards threatening collective life. Because this is mankind in a superior position has turned this destructive flood into energy and food production. Today, increasing resilience against flood has become an important and extensive area in flood risk management.

Recently, its importance is largely due to the experience of the failure of development plans in the 1950s and 1960s. In the review of these plans, the lack of people's participation has been evaluated as the main factor in the failure of development plans, because what comes from the flow of development planning in the past decades indicates that these plans have been mainly based on centralized and top-down design. The inadequacy of this type of view is that the general public has rarely participated in development planning and they have not played an active role in development plans (Manyena, 2006). Urban managers and policymakers are constantly trying to promote resilience in cities. The resilience of urban systems against floods has been defined as the resistance of these systems to flood damage and their ability to improve and return to normal conditions after floods. Conducting this research can make a great contribution to solving the problems in this field. In this research, City of Qazvin located in Qazvin province is selected to be studied regarding the matter of resilience of urban systems against floods. The province of Qazvin with an area of 15,623 square kilometers is located in the central area of Iran between 48 degrees 44 minutes to 50 degrees 51 minutes east longitude from the Greenwich meridian and 35 degrees 24 minutes to 36 minutes to 36 degrees 48 minutes north latitude relative to the Equator. This province is bordered by Gilan and Mazandaran provinces from the north, Zanjan and Hamedan provinces from the west, Markazi province from the south, and Tehran province from the east. This province is located in the southern slope of the Alborz mountain range, which is considered one of the temperate parts of the country due to its high altitude and average rainfall. The highest mountains of the province are "Siahlan, Kay Jakin, Sefid Kooh, and Siah Kooh", the maximum height and the northern mountains of Siah Lan are 4175 meters above sea level. The central and eastern region of the province is made up of a plain whose slope extends from the northwest to the southeast and is 1130 meters at the lowest point. Its minimum height is in the northwest and in the Tarom Sofla District and the shores of Sefid Rood Lake with a height of 300 meters above sea level, and this province is among the provinces that are less at risk of floods than other provinces. However, heavy rains have caused a lot of damage to this province in different periods of time, and given the importance of this issue, the researcher intends to analyze the resilience of urban settlements against floods in the city of Qazvin and provide a solution to it. Since development is a multi-dimensional phenomenon, and this has caused people's participation in different dimensions at the level of society to be considered as one of the areas of development. It was recommended by the Economic and Social Council of the United Nations in 1975 that people's participation be used as a basic policy in national development strategies. In this regard, crisis management and problem solving in third world countries depend more than anything on popular participation and citizen empowerment. The lack of these public participations during a crisis provides the basis for clashes and differences and conflicts among the performance of public and private institutions, and most of the scarce resources of these organizations are spent on tackling with the adverse effects of these clashes. Therefore, the attitude of the planners and the policy of the managers of the relevant organizations during a crisis should be aimed at increasing the role of people's participation in the process of solving the problem and reducing the damages caused by collective risks, including floods. In this regard, natural disasters are among the important issues that have always affected human life throughout history and are considered as one of the main obstacles to development. Thousands of people annually fall victim to natural hazards, most of which are due to mismanagement and lack of necessary infrastructure. In today's world, unexpected events annually impose a lot of material and spiritual costs on human societies in all countries across the world. Disasters such as floods, earthquakes, tsunamis, and horrifying sea storms, which have increased in intensity with global warming, make human life on the planet face serious risks. The conditions resulting from these events, which are called crisis conditions, cause a disruption in the functioning of a society due to damage to people, the economy, and the environment, and it requires management beyond the ability of that society and requires external assistance. Controlling these conditions requires an approach that reduces resilience against damages caused by natural disasters, including floods. Accidents and disasters, whether natural or caused by human, have destructive effects and results that may be deep and obvious or unknown. The published statistics of disasters in the world show that over the past two decades, over three to four million people have lost their lives in natural disasters, and millions of people have been injured, and tens of billions of dollars have been spent to compensate for financial and human losses. According to its climatic and geographical location, Iran is one of the most dangerous countries in the world in terms of the occurrence of accidents and disasters. Iran has always been among the top 10 countries in terms of the statistics of natural disasters and deaths caused by them, as from 1900 to 2015, approximately 190 disasters have been recorded in Iran. Natural hazards, especially floods, always threaten human settlements and human lives, and they can leave extensive losses and casualties in a short period of time. Disaster risk reduction (DRR) methods related to the above-mentioned disasters have been fully developed at the level of the scientific community; however, the expansion of the above-mentioned methods in reducing the level of vulnerability caused by disasters through prevention, mitigation, preparedness, emergency response, and early reconstruction are done, still has a long way to go (Arouri et al., 2015; Afsari et al., 2022).

According to above mentioned aims to investigate and assess the resilience of urban settlements in Qazvin City against floods. This research focuses on utilizing the Confirmatory Factor Analysis (CFA) method to analyze the factors influencing the resilience of urban areas in Qazvin City in the face of flood events. The primary goals of this research include:

- Identify and analyze the key factors that contribute to the resilience of urban settlements in Qazvin City when dealing with flood occurrences.
- Quantitatively assess the impact of various factors on the resilience of urban areas against floods using the Confirmatory Factor Analysis method, which allows for a rigorous statistical analysis of the relationships between variables.
- Evaluate the effectiveness of current urban planning strategies in enhancing the resilience of Qazvin City against floods and to propose potential improvements based on the analysis conducted.
- Provide insights into potential risk mitigation measures and preparedness strategies that can be implemented to enhance the resilience of urban settlements in Qazvin City and reduce the vulnerability to flood events.

By conducting this research, the aim is to contribute to the field of urban resilience planning and disaster management, specifically focusing on flood resilience in Qazvin City. The findings of current study are expected to provide valuable insights for policymakers, urban planners, and stakeholders involved in enhancing the resilience of urban settlements against flood hazards.

Current study contributes significantly to the broader field of flood risk management and urban resilience in several ways, both in terms of methodological advancements and practical implications:

- By utilizing Confirmatory Factor Analysis (CFA), the study introduces a sophisticated statistical method to assess the relationships between latent constructs and observed indicators related to urban resilience against floods. This methodological advancement enhances the precision and rigor of the analysis, providing a more nuanced understanding of the factors influencing resilience.
- CFA allows for the modeling of complex relationships between multiple variables, enabling researchers to identify the underlying factors that contribute to urban resilience in the face of flood events. This methodological approach helps in uncovering the interdependencies and interactions among various factors, offering insights into the dynamics of urban resilience.
- The study's use of CFA enables the quantitative validation of research hypotheses related to environmental factors and their impact on urban resilience. This methodological rigor enhances the credibility and robustness of the findings, contributing to the empirical evidence base in flood risk management and urban resilience research.
- The study provides valuable insights into the specific factors that influence urban resilience in Qazvin City against floods. These findings can inform decision-makers, urban planners, and policymakers in developing targeted strategies and interventions to enhance flood risk management and urban resilience in the city.
- By identifying the key drivers of urban resilience through CFA, the study offers a basis for designing tailored interventions and policies that address the specific vulnerabilities and strengths of Qazvin City in mitigating flood risks. This targeted approach can lead to more

effective and sustainable resilience-building measures.

- The research outcomes can contribute to capacity building efforts by highlighting the managerial factors and strategies that can strengthen the city's preparedness and response capabilities in the event of floods. This knowledge can empower local authorities and stakeholders to implement proactive measures for enhancing urban resilience.
- The study's methodological advancements and practical implications can serve as a valuable reference for researchers, practitioners, and policymakers working in the fields of flood risk management and urban resilience. The transfer of knowledge and best practices derived from this research can benefit other cities facing similar challenges.

Overall, the analysis of urban settlements' resilience in Qazvin City against floods using CFA not only advances methodological approaches in the field but also offers actionable insights and recommendations that can drive positive change in flood risk management practices and urban resilience strategies, not only in Qazvin City but potentially in other urban areas facing similar challenges. Mododi Arkhodi et al. (2020) conducted a study titled "explaining the resilience of rural areas against natural hazards with an emphasis on floods". This research aimed to identify the factors affecting the formation of floods and flood risk zoning in the Qaen watershed along with the explanation of the resilience of rural areas in the face of floods. In this research, for the purpose of zoning the villages at risk of flooding, the geographic information system (GIS) and the analytic hierarchy process (AHP) technique were used, and as a result, the land slope criterion with a weight of 0.280 was the most important factor, and the focal point and height criteria with weights of 0.224 and 0.150 were among the main factors of the formation and occurrence of floods in the area, respectively. In general, the results showed that the resilience of the studied villages is at an average level. Nezamfard and Pashazadeh (2018) conducted a study titled "evaluation of urban resilience against natural hazards (case study: Ardabil city). This article aims to investigate the resilience of Ardabil city against natural hazards. The library and survey method using a questionnaire was used to collect information, and the factor analysis model and the t-test statistical average test were used in the form of SPSS 22 software to measure the resilience of Ardabil city. The findings of the research showed that the highest mean is related to the physical dimension with a value of 3.57 and the lowest mean is related to the institutional dimension with a value of 2.94. Furthermore, the total mean of resilience of Ardabil city is 3.33, which is less than the average value of 4. Also, the results of the research indicate that from the combination of 30 variables, seven factors have been identified that explain 73.74% of the variance of the factors affecting the resilience of Ardabil city. Among these seven extracted factors, the factor of compliance with principles and laws was the most important and the first factor, which with a specific value of 8.87 was able to explain 29.59% of the research variance alone. Finally, the research has come to the conclusion that the physical dimension is very important in the resilience of Ardabil city. Because the factor of compliance with principles and laws is 39% and the factor of access to open and public space is 5.8% of the physical dimension. Together, these two factors interpret 44.8% of the total factors affecting the resilience of Ardabil city. Amaratunga and Haigh (2011) investigated flood resilience in Scandinavian countries. Accidents always cause serious changes in human settlements. These changes, which mainly occur in the form of tangible and intangible damages, harm a wide range of human settlement conditions. Resilient settlements, meanwhile, have the ability to absorb and return to equilibrium conditions and possibly better conditions than before the incident. If this capability and capacity does not exist in communities and settlements, activities related to disaster preparedness, coping, and reconstruction will face serious difficulties. One of the serious disorders is the relationship between people and their place of residence, which manifests in its subtle form as a factor of attachment to the place. Studies indicate the importance of spatial resilience in post-disaster management and reconstruction in the success of disaster-related activities. A study was carried out by Sui (2011) under the title of increasing physical resilience against floods, a case study of the Indus River and Punjab. This article aims to explain strategies for increasing physical resilience against the floods of Cheshme Kileh Shahr River. The research used the descriptive-analytical method. Therefore, before starting the steps of the SWOT model, using the study of previous researches in the theoretical foundations, variables and indicators were extracted and accordingly, the initial conceptual model was developed. In the following, using the content validity ratio (CVR) method, the necessary variables and indicators are identified and are the basis of the SWOT model. The method of this research is a combination of quantitative and qualitative methods that use GIS, AHP and SWOT software. Also, in order to zone the flood risk in the context, river flow simulation software (HEC_GEORAS) was used, based on which three flood risk zones were determined (river area, high risk zone, medium risk) then the indicators and applied variables in the research were prioritized after extracting them from different sources and determining the validity of the selected cases, and finally, practical strategies were presented to reduce the flood risk in the area around Cheshme River. Wang et al. (2019) in their paper, have presented a grid cell-based resilience metric to assess urban surface flood resilience at the scale of an urban drainage catchment. The method is illustrated using a case study in Dalian, China, which is divided into 31 urban drainage basins for flood resilience analysis. The results show that high-resolution resilience assessment identifies vulnerable watersheds and helps develop effective adaptation strategies to increase urban surface flood resilience. Comparing the new criteria with the existing criteria shows that the new criteria have the advantage of fully reflecting the changing process of system performance. This study provides a new way to describe urban flood resilience and an in-depth understanding of flood resilience for urban drainage basins with different characteristics, and contributes to the development of effective intervention strategies for sustainable sponge city development. Gao et al. (2022) investigated urban flood resilience: Insights from systematic and scientometric analysis. In this article, a complete review of urban flood resilience is presented using scientific and systematic analysis. Systematically summarized the urban flood resilience relationship, including co-citation analysis of keywords, authors, research institutions, countries, and research trends. Scientific results have shown that four stages can be distinguished to show the evolution of different keywords in urban flood management since 1999, and urban flood resilience has become a research focus since 2015 with a significant increase at the global level. Urban flood resilience research methods and progress are systematically analyzed in these four related fields, including climate change, urban planning, urban system adaptation, and urban flood simulation models. Climate change has been of interest in urban flood resilience research. Ebissa and Desta (2022) have studied urban agriculture as a solution to build a water-resistant city. The purpose of this study is to review the extensive literature on what and how UA can contribute to flood risk management in an effort to build water-resilient cities in various ways. UA plays a key role in changing the linear water economy to a circular one, thereby reducing the dependence of urban areas on rural areas to provide ecosystem services, including flood risk management. Flood risk and its management can be shared between the government and local bodies to make this system work. Urban managers and planners should make UA a pre-existing urban land use type because it enables water-resistant urban construction while responding to multiple policies and objectives relative to other urban land use types. Wang et al. (2023) investigated the relationship between urban flood risk and resilience at the scale of a high-resolution grid cell. The aim of this study is to investigate this relationship at the level of grid cells in urban areas. To evaluate flood resilience for high-resolution grid cells, this study proposed a performance-based flood resilience metric calculated using a system performance curve based on flood duration and magnitude. The results show that there is a complex relationship between flood risk and resilience, although a decrease in flood resilience generally leads to an increase in flood risk. High resilience, low risk versus low resilience, and low risk versus high resilience are important in identifying flood hotspots for intervention development. In conclusion, this study provides an in-depth understanding of the relationship between risk and resilience in urban flooding, which can help improve urban flood management. The proposed performance-based flood resilience measure and the findings of the Waterloo case study in London can be valuable to decision makers in developing effective flood management strategies in urban areas. According to above, while there is a growing body of literature on urban resilience and flood management, there exists a notable research gap in the specific context of analyzing the resilience of urban settlements in Qazvin City against floods using the Confirmatory Factor Analysis (CFA) method. The gap lies in the lack of comprehensive studies that apply advanced statistical techniques like CFA to assess the factors influencing urban resilience in Qazvin City specifically in the context of flood events. Key aspects of the research gap include: Existing studies often focus on qualitative assessments or basic quantitative analyses of urban resilience without utilizing advanced statistical methods like CFA. This research gap highlights the need for a more rigorous and systematic approach to analyzing the factors contributing to urban resilience against floods in Qazvin City. There is a lack of research that specifically addresses the resilience of urban settlements in Qazvin City against floods, despite the city being prone to flood events. This research gap underscores the importance of conducting a focused study that considers the unique characteristics and challenges of Qazvin City in the context of flood resilience. Limited empirical research exists on the application of CFA in assessing urban resilience to floods in the Middle Eastern context, particularly in cities like Qazvin. This gap highlights the need for empirical evidence and data-driven analysis to better understand the factors influencing urban resilience in the face of flood hazards. There is a lack of research that translates findings on urban resilience into actionable policy recommendations and urban planning strategies tailored to the specific needs of Qazvin City. Bridging this gap is essential for informing evidence-based decision-making and enhancing the city's preparedness and response to flood events. Addressing this research gap through a study that applies CFA to analyze urban settlements' resilience in Qazvin City against floods can provide valuable insights, fill existing knowledge voids, and contribute to the development of effective strategies for enhancing urban resilience in flood-prone areas. The present study aims to analyze the urban settlements resilience against floods in the Qazvin city mainly using Confirmatory Factor Analysis (CFA). Therefore the main objective of current study is as follow:

- Resilience analysis of urban settlements against floods,
- Investigating the impact of each of the mentioned indicators,
- Providing solutions to solve the problems in this area

2. Material and Methods

Based on the research method, this research is survey in terms of research classification. As in survey research, using questionnaires, which are our data collection tools, we want to bring the data from a qualitative level to a quantitative level, and in survey research, it is these numbers and values that turn a qualitative variable into a quantitative variable, and survey research seeks to discover the relationship between variables. Survey is a method to obtain information about views, beliefs, opinions, behaviors, motivations, or characteristics of a group of members of a society. This is a statistical method that is possible through scientific research. Also, survey can be considered as a scientific method in social research, which includes regular and standard methods to collect information about individuals, families, or larger groups of different groups of society. In fact, survey can be considered as both a tool used to collect data and the processes used when using that tool. This method is probably the best available for those social researchers who are interested in collecting primary data to describe large populations that cannot be directly observed. With accurate probability sampling, it is possible to provide a group of respondents whose characteristics reflect the characteristics of a larger population. Also, this method is a good tool for measuring attitudes and orientations. Surveys can be used for descriptive and exploratory purposes. The statistical population of this research consists of all the experts in the field of crisis management in different areas of Qazvin province in different categories. 384 people are selected as the sample. The tool for collecting information is a questionnaire. We collect our data by distributing this questionnaire among the statistical population. The stages of the research process and their relationship are shown in Fig. 1.

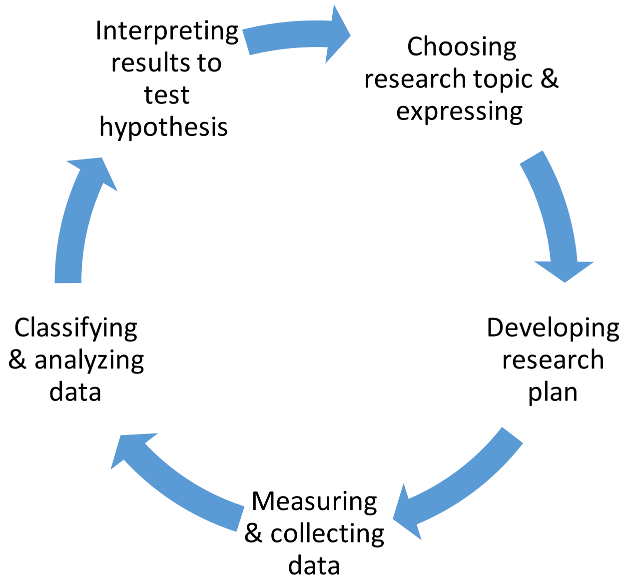

Fig. 1. Main stages of the research process

Each of the mentioned stages is related to theory. This means that the theory both affects them and is affected by them. Also, the mentioned stages are dependent on each other. The researcher should have knowledge in the research field to be able to state their hypothesis. Therefore, a general review of the writings related to the research is necessary. In addition, the researcher should complete each stage sufficiently and then start the next stage. The most important feature of the research stages is the operation flow. These stages begin with the research problem and end with the generalization of the result (preliminarily). The next round starts with the generalization. This process continues similarly to create a scientific system. If the said generality becomes negative, another generalization is formed and tested. During this re-formation of the generality, all research stages are re-evaluated. The research indicators may be directly measurable, and some others have a qualitative state. Regarding the first category of indicators that can be measured directly, data is collected from the system and indicators are calculated. The indicators of the second category are often not directly measurable. In these conditions, data is collected indirectly from people involved and facing the phenomenon. Naturally, in this case, personal perceptions and opinions affect the collected data. The implementation mechanism for this situation is such that these indicators are questioned in the form of a questionnaire. In these questionnaires, the evaluation of the identified indicators is the basis of the questions, and the summary of the results of the field operations of completing the questionnaires provide the scores related to the model in each dimension of the model.

2.1. Reliability and Validity of the Questionnaire

Validity measures the degree of compatibility of the measurement instrument with the research objectives, and in other words, validity addresses the issue that whether the measurement tool really measured what we intended, or in other words, whether the questionnaire and other measurement tools measure what they were actually designed to measure? As much as the conducted research has high validity, the validity of the research is increased. The measurement tools used are valid according to previous studies and the supervision of professors who have experience in this field. In this research, Cronbach's alpha is calculated using SPSS software. For this purpose, 30 questionnaires are distributed as a pre-test and then the data is analyzed using SPSS software. The reliability coefficient is calculated separately for each variable with Cronbach's method, and finally a Cronbach's alpha is calculated for all variables in general, given that the minimum reliability coefficient using Cronbach's alpha method is at least 0.7, the alpha coefficient obtained for each variable and for the entire questionnaire must be greater than 0.7 in Table 1 (Nezamfard and Pashazadeh, 2018).

Table 1. Results of Cronbach's alpha for different parts of the questionnaire

No.	Variable	Sub variables	Cronbach's alpha
1	Social factors	- Balanced attention to the net economic profit in the field of land exploitation - Forecasting during floods - Creating social partnerships in the field of flood crisis - Strengthening economic components in high-risk areas - Using the power and capacity of local communities - Having continuous and stable research in the field of floods - Having appropriate demographic information - Avoid inappropriate adaptive programs - Flexible weather decisions - Investing in nature Having applicable and updated rules and regulations - Creation of flood warning systems and notification of floods before they occur - Preparation of executive instructions for flood crisis management - Attention to public education - Continuous support of government organizations and charities - Having plans for a balanced intervention in nature	0.78
2	Environmental factors	- Attention to land use change - Paying attention to encroachment on the boundaries of rivers - Attention to the upstream drainages - Considering climate change - Creating protection facilities against floods - Scientific attention to the balanced use of forest capacity - No destruction of the pasture area - Absence of excessive road expansion in the forests - Lack of city development and incorrect land use - No construction along the rivers - Creating tunnels to channel flood water - Having solutions to guide the flood - Suitable street construction for flooding - Having routes to divert rivers - Raising the floor level and using flood resistant materials and any such action - Having waterproof buildings and creating underground insulation - Having reliable flood control structures - Creating reservoir dams - Creation of delayed reservoirs - Continuous and sustainable attention to vegetation - Reduction of impervious surfaces in cities - Attention to higher regional and continental scales and climate changes - Equipping research centers related to meteorology and climatology - Having a strong public information system against risks Building more bases in the city - Having long-term plans about the risk of floods	0.89
3	Technical factors	- Design and maintenance of engineering structures - Measuring the discharge of rivers in the country - Use of dams and protective walls in flood prone areas - Creating capacity and correct design of the river and floods - Creating a structure for the permeability of the ground and the rapid melting of snow - Having a capacity for heavenly descents and the capacity of the landing place - The capacity of rocks and streams for the passage of water in urban areas and the blocking of the river due to the collapse of the mountain	0.83
4	Managerial factors	- Using capabilities and turning threats into opportunities - Creation of division of labor between organizations to deal with floods - Full access of people to communication and information - Access to insurance services - Creating relief skills - Having a rehabilitation system after the accident	0.91

3. Results and discussion

In this research, the structural equation technique is used to analyze the data. The software used in this research is Lisrel. In this research, the confirmatory factor analysis technique is used in the first stage. Among the analysis methods used in management studies are the path analysis model and structural equation model. A complete structural equation model is a combination of a path diagram and confirmatory factor analysis. Structural equation modeling is a comprehensive statistical approach for testing hypotheses about the relationships between observable and latent variables, which is sometimes called structural analysis of covariance or causal modeling. A latent variable is a variable that is not directly measured but is measured using two or more observable variables in the role of a proxy. Structural equation models are usually a combination of measurement models and structural models. In this research, all dimensions of structural equations sub-set will be used. The desired technique in this research is the structural equations and the software Lisrel is used.

3.1. Demographic Characteristics of the Population

Descriptive statistics indicators are used to check the demographic characteristics of the respondents. Demographic characteristics, level of education, and work experience are investigated.

Gender: Total population is 260 people or approximately 67.7% of the respondents are male and 124 people or approximately 32.3% are female.

Education: Information on education is given in Table 2. Here, 128 respondents, i.e., 33.3%, have diploma and associate's degrees. 101 respondents, i.e., 26.3%, have bachelor's degrees, and 155 respondents, i.e., 40.4%, have master's or higher degrees.

Table 2. Frequency of respondents in terms of education

Education	Frequency	Percentage	Accumulated Frequency
Diploma & associate’s degree	128	33.3	33.3
Bachelor’s degree	101	26.3	59.6
Master’s & higher degrees	155	40.4	100.0
Total	384	100.0	---

Job Positon: The information on work experience is given in Table 3. In this table, 80 respondents, i.e., 20.8%, are students, and 109 respondents, i.e., 28.4%, are technical experts, and 55 respondents, i.e., 14.3%, are managers, and 106 respondents, i.e., 7.6% are universities teacher, 106 respondents, i.e., 27.6%. are environmental activists.

Table 3. Frequency distribution of respondents in terms of work experience

Job position	Frequency	Percentage	Accumulated frequency
Students	80	20.8	20.8
Technical experts	109	28.4	49.2
Managers	55	14.3	63.5
Universities teacher	106	7.3	70.8
Enviromental avtivists	6	27.6	100.0
	384	100.0	---

Given that the potential number of participants are experts and are effective in collecting data for this research to determine indicators. Therefore, the expertise of the participants is in determining the effective factors.

3.2. Inferential Analysis of the Data

Before using the statistical tests of the research, the normality test of the data should be performed first. Because before any test that takes place with the assumption of normality of the data, the data normality needs to be ensured. When checking the data normality based on the fact that the data distribution is normal, the null hypothesis is tested at the 5% error level. Therefore, if the significance value is equal to or greater than 1.96, then there will be no reason to reject the null hypothesis. In other words, the data distribution will be normal. The assumption of the data normality is tested at the significance level of 5% using the Kolmogorov-Smirnov technique. In order to test the data normality, the statistical assumptions are set as in Table 4. Since the studies based on the structural model are based on the assumption of the data normality, the normality test is carried out first. In confirmatory factor analysis and structural equation modeling, there is no need for all data to be normal, but the factors (structures) must be normal (Kline, 2010).

Table 4. Normality test description

Variables	Number	Sig. level	Test statistic	Status
Social factors	384	0.081	0.056	Normal
Environmental factors	384	0.062	0.045	Normal
Technical factors	384	0.082	0.036	Normal
Managerial factors	384	0.074	0.021	Normal

Based on the results listed in Table 5, in all cases, as the results show, the significance level for all variables is greater than 0.05. Therefore, it can be stated with 95% confidence that the data is normal in terms of distribution and the researcher can use the parametric method in the analysis. Thus, there is no reason to reject the null hypothesis, that is, the distribution of measurement data in each dimension is normal.

3.3. Partial Least Squares Technique and Research Hypothesis Testing

In this chapter, the theoretical foundations related to the partial least squares method will be presented in detail. The structural equations method with the partial least squares approach (PLS-SEM) was presented by Ringle et al. (2012). PLS-SEM is one of the second-generation approaches to structural equation modeling and it has advantages compared to the first-generation methods that were covariance-based. In this research, we used the second-generation component-based SEM techniques, whose name was later changed to the partial least squares (PLS) method, which was described by Ringle et al. (2012). The PLS method consists of two main steps:

- Examining the fit of measurement models, structural model.

-Testing the relationships between constructs.

3.4. Confirmatory Factor Analysis of the Research Variables

Before entering the stage of testing hypotheses and conceptual models of the research, it is necessary to ensure the accuracy of independent and dependent variable measurement models. Therefore, in the following, the measurement models of these two variables are presented in order using first-order confirmatory factor analysis. Confirmatory factor analysis is one of the oldest statistical methods used to investigate the relationship between latent variables (obtained factors) and observed variables (questions) and represents the measurement model. Fig. 2 and Fig. 3 show the confirmatory factor analysis of the research variables. The factor loadings of the model in non-standard and standard estimation mode show the effect of each variable or item in explaining the variance of the variable or main factor scores. In other words, the factor load indicates the correlation of each observed variable (questionnaire question) with the latent variable (factors). If the value of the variable's significance test statistic is higher than 1.96, it indicates that the considered item is significant, otherwise the item is eliminated.

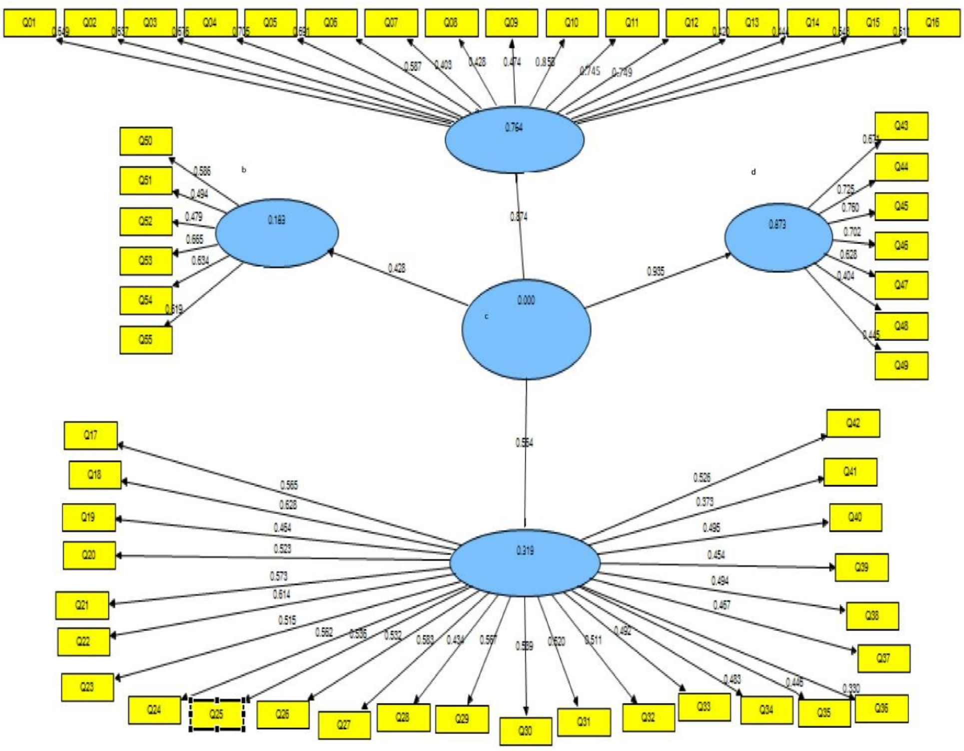

Fig. 2. Factor load coefficient of resilience analysis of urban settlements against floods (case study of Qazvin city)

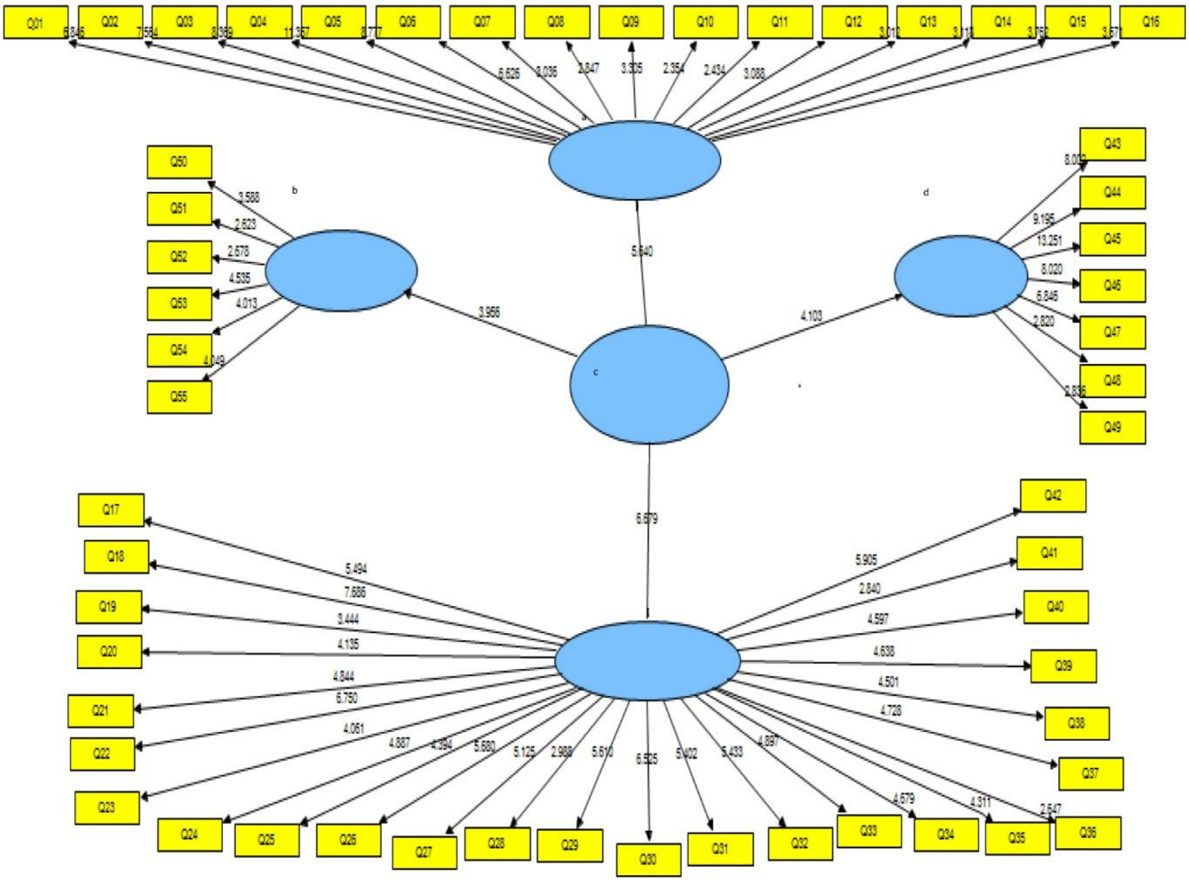

Fig. 3. t-value coefficient of resilience analysis of urban settlements against floods (case study of Qazvin city)

Table 5. Summary of confirmatory factor analysis results (measurement model) of the used scale

Item	Factor load coefficient	Sig.	Result	Item	Factor load coefficient	Sig.	Result
Q1	0.649	6.845	Acceptable	Q29	0.567	2.988	Acceptable
Q2	0.637	7.564	Acceptable	Q30	0.539	6.525	Acceptable
Q3	0.676	8.369	Acceptable	Q31	0.620	5.402	Acceptable
Q4	0.705	11.367	Acceptable	Q32	0.511	5.433	Acceptable
Q5	0.691	8.777	Acceptable	Q33	0.492	4.897	Acceptable
Q6	0.587	6.626	Acceptable	Q34	0.492	4.679	Acceptable
Q7	0.403	3.036	Acceptable	Q35	0.483	4.728	Acceptable
Q8	0.428	2.847	Acceptable	Q36	0.483	4.501	Acceptable
Q9	0.474	3.305	Acceptable	Q37	0.457	4.638	Acceptable
Q10	0.858	2.354	Acceptable	Q38	0.494	4.597	Acceptable
Q11	0.744	2.434	Acceptable	Q39	0.454	2.840	Acceptable
Q12	0.858	3.088	Acceptable	Q40	0.495	5.905	Acceptable
Q13	0.759	3.012	Acceptable	Q41	0.473	4.512	Acceptable
Q14	0.420	3.762	Acceptable	Q42	0.526	5.125	Acceptable
Q15	0.648	3.671	Acceptable	Q43	0.671	8.002	Acceptable
Q16	0.611	3.678	Acceptable	Q44	0.725	9.195	Acceptable
Q17	0.55	5.494	Acceptable	Q45	0.760	13.251	Acceptable
Q18	0.628	7.686	Acceptable	Q46	0.702	8.020	Acceptable
Q19	0.646	3.444	Acceptable	Q47	0.628	6.846	Acceptable
Q20	0.523	4.135	Acceptable	Q48	0.404	2.820	Acceptable
Q21	0.573	4.844	Acceptable	Q49	0.445	2.835	Acceptable
Q22	0.614	6.750	Acceptable	Q50	0.586	3.588	Acceptable
Q23	0.515	4.051	Acceptable	Q51	0.494	2.623	Acceptable
Q24	0.562	4.887	Acceptable	Q52	0.479	2.678	Acceptable
Q25	0.536	4.394	Acceptable	Q53	0.665	4.535	Acceptable
Q26	0.532	4.680	Acceptable	Q54	0.634	4.013	Acceptable
Q27	0.583	5.680	Acceptable	Q55	0.619	4.049	Acceptable
Q28	0.434	5.125	Acceptable				

The power of the factor's effect (laten variable) and the observable variable is shown by the factor load in Table 5. Factor load is a value between zero and one. If the factor load is less than 0.4, the relationship is considered weak and is ignored. A factor load between 0.4 and 0.6 is acceptable, and if it is greater than 0.6, it is very desirable. The power of the factor's effect (hidden variable) and the observable variable is shown by the factor load. Factor load is a value between zero and one. If the factor load is less than 0.4, the relationship is considered weak and is ignored. A factor load between 0.4 and 0.6 is acceptable, and if it is greater than 0.6, it is very desirable. When the correlation of the variables is identified, a significance test should be performed. To check the significance of observed correlations, bootstrapping or jackknife cross-validation methods are used. In this study, the bootstrapping method is used, which gives the t statistic. At the 5% error level, if the bootstrapping t-value is greater than 1.96, the observed correlations are significant.

3.5. Convergent Validity

The average variance extracted (AVE) criterion shows the average variance shared between each construct with its indicators. In simpler terms, AVE shows the degree of correlation of a construct with its indicators, and the higher the degree of correlation, the better the fit. In the case of AVE, the critical value is 0.5, which means that the AVE values above 0.5 show acceptable convergent validity (Table 6).

Table 6. Convergent validity of variables

Row	Variable	Value of convergent validity
1	Social factors	0.800722
2	Environmental factors	0.665395
3	Technical factors	0.740608
4	Managerial factors	0.594543

3.6. Structural Model: z Significance Value (t values)

The most basic criterion for measuring the relationship between constructs in the model (structural part) is the significant numbers of t. If the value of these numbers exceeds 1.96, it indicates the accuracy of the relationship between the constructs and as a result, the research hypotheses are confirmed at the 95% confidence level. The structural model is shown in Fig. 4 and Table 7.

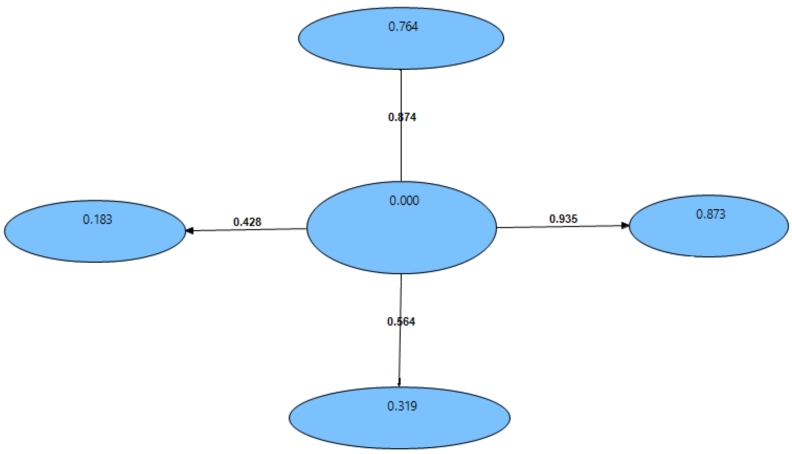

Fig. 4. Factor load coefficient of resilience analysis of urban settlements against floods (case study of Qazvin city)

Table 7. Summary of the results of confirmatory factor analysis (structural model) in the used scale

Hypotheses	Factor load	Significance	Conclusion
Social factors affect the resilience of urban settlements against floods in Qazvin city.	0.874	5.640	Confirmed
Environmental factors affect the resilience of urban settlements against floods in Qazvin city.	0.428	3.956	Confirmed
Technical factors affect the resilience of urban settlements against floods in Qazvin city.	0.564	6.679	Confirmed
Managerial factors affect the resilience of urban settlements against floods in Qazvin city.	0.935	4.103	Confirmed

3.7. Hypothesis testing

Hypothesis 1: Social factors affect the resilience of urban settlements against floods in Qazvin city.

According to Fig. 4 showing that social factors affect the resilience of urban settlements against floods in Qazvin, there is a significant relationship between these two variables with a value of 5.640 and also according to Figs 2-3, the intensity of the relationship between the factors is 0.874, which is confirmed and has a positive effect, and the result is that social factors affect the resilience of urban settlements against floods in Qazvin city.

Hypothesis 2: Environmental factors affect the resilience of urban settlements against floods in Qazvin city.

According to Fig. 4 showing that environmental factors affect the resilience of urban settlements against floods in Qazvin, there is a significant relationship between these two variables with a value of 3.956 and also according to Figs 2-3, the intensity of the relationship between the factors is 0.428, which is confirmed and has a positive effect, and the result is that environmental factors affect the resilience of urban settlements against floods in Qazvin city.

Hypothesis 3: Technical factors affect the resilience of urban settlements against floods in Qazvin city.

According to Fig. 4 showing that technical factors affect the resilience of urban settlements against floods in Qazvin, there is a significant relationship between these two variables with a value of 6.679 and also according to Figs 2-3, the intensity of the relationship between the factors is 0.564, which is confirmed and has a positive effect, and the result is that technical factors affect the resilience of urban settlements against floods in Qazvin city.

Hypothesis 4: Managerial factors affect the resilience of urban settlements against floods in Qazvin city.

According to Fig. 4 showing that managerial factors affect the resilience of urban settlements against floods in Qazvin, there is a significant relationship between these two variables with a value of 4.103 and also according to Figs 2-3, the intensity of the relationship between the factors is 0.935, which is confirmed and has a positive effect, and the result is that managerial factors affect the resilience of urban settlements against floods in Qazvin city.

3.8. Q^2 Criterion Method

This criterion was introduced by Stone Geyser (1975) and specifies the predictive power of a model; that is, models with an acceptable structural fit should have the ability to predict the model in order, the indicators related to the endogenous constructs of the model. The values of 0.19-0.33-0.67 indicate weak, medium, and strong predictability (it should be noted that this value is not given for exogenous variables). Given that the value of Q^2 for the endogenous variable in Table 8 is higher than 0.33, it can be said that the structural model has the necessary predictive power and is acceptable.

Table 8. Q^2 criterion for the structural model of the research

Item	SSO	SSE	Q^2=(1-SSE/SSO)
Social factors	362.000	113.125	0.845
Environmental factors	362.000	156.123	0.864
Technical factors	362.000	143.076	0.954
Managerial factors	362.000	107.085	0.859

3.9. General Fit of the Model (GOF Criterion)

This criterion applies to the general part of structural equation models. That is to say, by this criterion, the researcher can also control the general fit of the research after examining the fitting of the measurement section and the structural part of the general model of his research. The goodness of fit (GOF) criterion was developed by Tenenhaus et al. (2005) and is calculated according to Eq. 1:

(1)

$$GOF = \sqrt{Communalities \times R^2}$$

Wetzels et al. (2009) reported three values of 0.01-0.025-0.36 as weak, medium, and strong values for GOF.

$$communalities = \frac{0.340 + 0.265 + 0.400 + 0.280}{4} = 0.319$$

Social factors R^2 =0.183

$$GOF(\text{General model fit}) = \sqrt{0.746 \times 0.319} = 0.626$$

Environmental factors R^2= 0.764

$$GOF(\text{General model fit}) = \sqrt{0.183 \times 0.319} = 0.626$$

Technical factors R^2=0.873

$$GOF(\text{General model fit}) = \sqrt{0.936 \times 0.319} = 0.626$$

Managerial factors R^2= 0.319

$$GOF(\text{General model fit}) = \sqrt{0.319 \times 0.319} = 0.317$$

And the obtained GOF value of the model design indicators for analyzing the resilience of urban settlements against floods (case study of

Qazvin city) shows the strength and accuracy of the structural model and measurement in the model validation.

4. Conclusion

Natural disasters are a set of harmful incidents with natural origins, and sometimes human factors affect their aggravation. In this regard, strengthening social and economic components and subsequently increasing resilience can play an important and effective role in reducing flood damage. According to the statistics provided by the United Nations, among the natural disasters, floods and storms have caused the most casualties and damages to human societies, such that in just one decade, the amount of damages caused by floods and storms was billions of dollars of the damages caused by earthquakes, this is also true in Iran, and in most of the past years, a significant amount in unexpected events has been spent to compensate for the damages caused by floods. In addition, it should be noted that due to the improvement of construction methods and compliance with the rules and regulations, the safety of structures and facilities against risks such as earthquakes will increase. However, unfortunately, the natural development process in countries like Iran has caused the destruction of the environment and 25% of the country's flood damage, and the damage caused by floods is constantly increasing. The growth of the last decade proves this claim. In this research, the indicators were first identified and hypotheses were developed based on these indicators, and finally, all the hypotheses were confirmed using statistical techniques and the following results were extracted.

Hypothesis 1: Social factors affect the resilience of urban settlements against floods in Qazvin city.

According to the results, social factors affect the resilience of urban settlements against floods in Qazvin and there is a significant relationship between these two variables with a value of 5.640 and also according to the results, the intensity of the relationship between the factors is 0.874, which is confirmed and has a positive effect, and the result is that social factors affect the resilience of urban settlements against floods in Qazvin city.

Hypothesis 2: Environmental factors affect the resilience of urban settlements against floods in Qazvin city.

According to the results, environmental factors affect the resilience of urban settlements against floods in Qazvin, there is a significant relationship between these two variables with a value of 3.956 and also according to the results, the intensity of the relationship between the factors is 0.428, which is confirmed and has a positive effect, and the result is that environmental factors affect the resilience of urban settlements against floods in Qazvin city.

Hypothesis 3: Technical factors affect the resilience of urban settlements against floods in Qazvin city.

According to the results, technical factors affect the resilience of urban settlements against floods in Qazvin, there is a significant relationship between these two variables with a value of 6.679 and also according to the results, the intensity of the relationship between the factors is 0.564, which is confirmed and has a positive effect, and the result is that technical factors affect the resilience of urban settlements against floods in Qazvin city.

Hypothesis 4: Managerial factors affect the resilience of urban settlements against floods in Qazvin city.

According to the results, managerial factors affect the resilience of urban settlements against floods in Qazvin, there is a significant relationship between these two variables with a value of 4.103 and also according to the results, the intensity of the relationship between the factors is 0.935, which is confirmed and has a positive effect, and the result is that managerial factors affect the resilience of urban settlements against floods in Qazvin city. Accordingly, it is of great importance to plan and take comprehensive measures to prevent and reduce flood damage in the form of study and executive plans. The climatic conditions of Iran and the non-uniformity of the temporal and spatial distribution of precipitations in the country cause destructive floods in different seasons of the year and cause a lot of damage in different regions of the country. The location of Iran in a subtropical region has led to the issue that the precipitations often happen suddenly and in a short period of time. Given the climatic and geographical conditions of the country and the arid and semi-arid climate, the optimal use of these atmospheric precipitations is very important. In most areas, unprincipled constructions and indiscriminate use of nature have caused most of the rain to flow on the surface of the earth, causing financial and human losses and underground aquifers to be out of reach without any use because of not recharging. Flooding is possible in any part of the country and almost all parts of the country are sometimes affected by this phenomenon Floods, as one of the natural disasters occurring in the form of overflowing rivers, unlike before, also have human causes. Consequently, for several years, floods have occurred one after the other, and according to experts, much earlier than the natural return periods. Although the biggest floods in the history of the world in the last millennium have a wide extent and include many countries in Northern Europe to Eastern China, the point is that in the last one hundred years, most of the devastating floods in the world has occurred in third world or developing countries, especially in Asia, and have killed thousands of people. What is shared in all these countries is the lack of development and widespread destruction of land and vegetation, which is one of the causes of floods. Rivers as one of the structural elements of cities and natural corridors play an effective role in providing environmental resources. Therefore, investing in adjacent lands and building and developing recreational parks around them, besides having many environmental effects, paying attention to vegetation and not destroying it is one of its basic solutions. Human interventions have caused many problems in this area and caused many floods. Some of the human interventions in this field include the construction in the floodplain of rivers, which requires the occupation of parts of it and reduces the natural capacity of the river. Thus, the area of the floodplain that goes under water during the flood becomes wider. Urban development and removal of plants reduce the amount of infiltration water and increase the surface water. On the one hand, the large volume of water increases the magnitude of the flood, and on the other hand, with the increase in erosion, it creates sediments, which, when left behind, reduce the capacity of the main river bed. Sudden and catastrophic floods are often caused by the destruction of dams, creating a type of coping and adjustment of flood damages. Despite the spread of floods due to natural and human causes, it depends on the necessary infrastructure in urban and rural areas. In this regard, crisis management and increasing resilience indicators can play an important and effective role in reducing the damages caused by floods. Flood resilience consists of indicators that are measured in this conceptual model. In this regard, since any plan will not be completed without social and economic attachments, the role of the mentioned factors on increasing resilience and finally reducing the damages caused by floods is investigated in the present research. Using the capacities of public participation, voluntary associations, economic strengthening of public institutions, empowering the local community, and increasing their awareness and responsibility can be effective in reducing the damage caused by floods. People's participation is in the flood management cycle. The economic and social participation of citizens in managing flood incidents greatly increases the city's resilience to reduce flood damage. Given the situation that Qazvin city experiences after every flood, it should be said that economic and social components play an important role in reducing the damages of the mentioned disasters. Plans to empower local communities to deal with natural hazards and incidents are among the policies that countries are seeking to increase the strength and capacity of regions against disasters. Downstream flooding is one of the risks causing a lot of damage in Qazvin city in recent years due to various reasons, including lack of empowerment of the society, locality of public participation, the lack of economic structure, and lack of support from government bodies. Given that it is not possible to prevent the occurrence of floods, but it is possible to reduce the effects of floods to a great extent. Vegetation can be considered effective in preventing floods and it can be stated that the vegetation of an area plays a very important role in preventing floods, as plants do not allow raindrops to directly hit the soil, as a result, their speed is reduced and the water gets enough time to penetrate the soil. And Qazvin gardens are very important and fundamental covers in this area and it is possible to use the capacity of this cover by not destroying it and paying attention to it. Flood management should be considered effective in delaying and reducing the speed of flood flow, storage through the creation of natural and artificial reservoirs on the ground, and recharging underground aquifers (alluvium and rock layers with high permeability), as well as protecting the lands along the rivers and restoration and recycling of such lands that have been destroyed.

- Strengthening cultural, sports, and educational institutions to guide the population towards a sustainable lifestyle and resilience against natural hazards

- Increasing the level of residents' awareness of the cultural impact and social relations of residents on reducing vulnerability through the formation of associations
- Increasing coordination and obliging the responsible organizations in the matter of crisis management
- Using knowledge, innovation, and education to create a resilient society

The managerial factors identified in the study can have significant implications for enhancing flood resilience in urban planning and policy-making in Qazvin City. Here are some key implications:

- **Strategic Decision-Making:** Understanding and addressing managerial factors such as leadership commitment, resource allocation, and coordination among stakeholders can help in making strategic decisions to enhance flood resilience in urban planning. This includes prioritizing investments in infrastructure, early warning systems, and community engagement initiatives.
- **Risk Assessment and Mitigation:** By considering managerial factors, urban planners and policymakers can conduct comprehensive risk assessments, identify vulnerable areas, and implement targeted mitigation measures to reduce the impact of floods in Qazvin City. This may involve zoning regulations, green infrastructure development, and land-use planning strategies.
- **Capacity Building:** Enhancing managerial factors like training programs for emergency response teams, public awareness campaigns, and inter-agency collaboration can strengthen the capacity of local authorities to effectively respond to flood events. This can improve coordination, communication, and resource mobilization during emergencies.
- **Policy Integration:** Integrating managerial factors into urban planning policies can ensure that flood resilience considerations are mainstreamed across various sectors, including housing, transportation, and water management. This holistic approach can lead to more sustainable and resilient urban development in Qazvin City.
- **Community Engagement:** Involving local communities in decision-making processes and incorporating their perspectives on flood resilience can enhance the effectiveness of urban planning initiatives. Managerial factors related to community participation, empowerment, and social cohesion can foster a sense of ownership and resilience among residents.
- **Monitoring and Evaluation:** By focusing on managerial factors such as performance monitoring, data collection, and evaluation mechanisms, policymakers can assess the effectiveness of flood resilience interventions over time. This iterative process allows for adaptive management and continuous improvement in urban planning strategies.
- **Public-Private Partnerships:** Leveraging managerial factors to foster partnerships between the public and private sectors can enhance the implementation of innovative solutions for flood resilience. Collaborative efforts can lead to shared resources, expertise, and technology adoption to address complex urban challenges.

By considering and addressing the managerial factors identified in the study, urban planners and policymakers in Qazvin City can develop informed strategies, policies, and interventions to enhance flood resilience, build adaptive capacity, and create sustainable urban environments that are better prepared to withstand and recover from flood events.

There are potential biases and limitations that researchers should be aware of them is following as:

- Experts who choose to participate in the survey may not be representative of the entire population of crisis management professionals. This could lead to a biased sample, where certain perspectives or experiences are overrepresented or underrepresented.
- Experts who voluntarily participate in the survey may have specific motivations or interests that differ from those who choose not to participate. This self-selection bias can skew the results and limit the generalizability of the findings.
- Respondents may provide inaccurate or biased responses due to social desirability bias, where they may feel pressured to give socially acceptable answers, or acquiescence bias, where they tend to agree with statements regardless of their true beliefs.
- Experts may have difficulty accurately recalling past events, experiences, or decisions related to crisis management, leading to inaccuracies in their responses. This can affect the reliability and validity of the data collected through the survey method.

- The presence of social dynamics within expert groups, such as hierarchies, power dynamics, or groupthink, can influence how respondents interact with the survey questions and each other. This social bias can impact the quality and depth of the data collected.
- Surveys may not allow for in-depth exploration of complex issues or nuanced perspectives in crisis management. The structured nature of survey questions may restrict experts from providing detailed explanations or context for their responses.
- Surveys may lack the ability to capture the full context or situational factors that influence expert opinions and decision-making in crisis management. This limitation can hinder the researchers' understanding of the complexities involved in managing crises effectively.
- Without the opportunity for clarification or follow-up questions, there is a risk of misinterpreting respondents' answers or misrepresenting their views, leading to errors in data analysis and interpretation.

Acknowledgment

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the authors.

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