Urban Vulnerability Assessment in Earthquake Using AHP, Crisis Management Point of View

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ABSTRACT

One of the most important issues of today's world is increasing of physical expansion of urban areas and cities which emanate from the rapid urbanization process. Modern cities, that are samples of development, are subjected to most severe natural disasters such as earthquakes.

Iran, due to its location and geotechnical conditions, is located on earthquake belt and frequently exposed to destructive earthquakes. Undoubtedly, irreparable damages were caused by lack of plan ahead in order to deal with earthquake risks. Lack of preparation to deal with the adverse complications of the issue is very important. Therefore, efforts against these problems in the world today have created a topic called crisis management. Crisis management provides community for prevention, preparedness, disaster relief and recovery by planning an appropriate program.

In this study, it was tried to discuss and evaluate the principle processes of crisis management against earthquake. On the other hand, with regard to the implementation of crisis management programs through data analysis and possible data, the methods of Multi Criteria for Earthquake crisis management of the Analytic Hierarchy Process (AHP) was introduced and its application was fully described. An attempt has been made to the principles of crisis management discussed in the earthquake. Qazvin was selected as a case study, and the analytical methods for assessing the

vulnerability of 19 urban areas were performed. Analytic Hierarchy Process evaluation method was used to assess the vulnerability of the city, by classifying vulnerability of Qazvin against the earthquake crisis in 3 criteria: (I) Physical dimensions and physical resistance texture, (II) The amount of urban texture responsibility in order to aid after crisis, (III) Possibility of city's reversibility after the crisis and divide these criteria into 20 sub-criteria. The priority of sub-criteria was evaluated by questionnaire survey that distributed through related experts. Based on the findings of research, it was concluded that from 19 areas of city, 2 areas had high vulnerability, 6 areas had medium and 11 areas had a little high potential of damage vulnerability. High population density, urban texture of old and repairable buildings, lack of relief and medical services, a few organic texture area, sidewalk length with less than 6 meters width in the region and lack of open spaces in the area were the most important reasons that caused the high vulnerability of urban texture of Qazvin city in areas 10 and 18.

Keywords: Crisis Management, Analytic Hierarchy Process, Urban, Vulnerability Assessment, Earthquake

ÖZ

Hızlı kentleşme sürecinin bir sonucu olarak, kentsel alanların ve şehirlerin fiziksel olarak hızla genişlemesi, bugün dünyanın en önemli sorunlarından biri haline gelmiştir. Gelişmelerin bir örneği olarak görülen modern şehirler, deprem gibi doğal felaketlere daha çok hedef olmaktadırlar.

İran, konumu ve geoteknik koşullarına bağlı olarak deprem kuşağında bulunmaktadır ve birçok yıkıcı depreme maruz kalmaktadır. Deprem risklerini önleme ve baş etme ile ilgili planlamanın eksik olmasından dolayı ise birçok geri dönülmez zarar yaşanmaktadır. Bu konuyla ilgili olumsuz zorluklarla baş etmekten yoksun olmak önemli bir sorundur. Buna bağlı olarak, bu tür sorunlarla ilgili çabalar kriz yönetimi adlı bir alanın doğmasına neden olmuştur. Kriz yönetimi, uygun programlar planlayarak topluma, önlemler, hazırlıklar, afet yardımları ve iyileştirme kazandırmaktadır.

Bu çalışmada, depremle ilgili kriz yönetim süreçleri tartışılmış ve değerlendirilmiştir. Bir diğer yandan, data analizi ve veri yoluyla kriz yönetim programlarının uygulanması ve Analitik Hierarşi Proses'in (AHP) deprem kriz yönetimi için çok kriter yöntemlerinden bahsedilmiş ve uygulanması anlatılmıştır. Araştırma, deprem bağlamında kriz yönetimi prensipleri tartışılmayı amaçlamaktadır. Vaka çalışması olarak Qazvin seçilmiştir ve analitik yöntemlerle 19 kentsel alanın hasar görebilirliği değerlendirilmiştir. Qazvin'in depremlere karşı hasar görebilirliğini

ölçümlemek amacıyla Analitik Hierarşi Proses değerlendirme yöntemi kullanılmıştır. Hasar görebilirlik, (I) Fiziksel boyutlar ve fiziksel dayanıklılık yapısı, (II) Kriz sonrası yardım için kentsel yapının yeterliliği, (III) Krizden sonra kentin geri döndürülebilirliği olmak üzere 3 temel kriterde ölçümlenmiştir ve 20 alt kritere bölünmüştür. Alt kriterlerin önceliği, uzmanlara dağıtılan anketler ile değerlendirilmiştir. Çalışmadan elde edilen sonuçlar doğrultusunda, kentin 19 alanından 2'si yüksek derecede hasar görebilirliğe, 6'sı orta derecede hasar görebilirliğe ve 11 alanı ise düşük derecede hasar görebilirliğe sahip olduğu gözlemlenmiştir. Yüksek nüfus yoğunluğu, açık alanların yetersizliği, yardım uygulamalarının yetersiz olması, 6 metreden dar olan geçitler, eski ev ve binaların dokusu, Qazvin şehrinin 10 ve 18 numaralı alanlarında yüksek hasar görebilirliğe neden olan en önemli etkenler arasında görülmüştür.

Anahtar Kelimeler: Kriz Yönetimi, Analitik Hierarşi Proses, Kentsel, Hasar Görebilirlik Değerlendirme, Deprem

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INTRODUCTION

1.1 Problem Statement

Urban sprawl, urbanization and the gradual increase in the number of cities, especially in the developing countries, including Turkey, Iran, Kazakhstan (in mid-east) and etc. is an important issue nowadays. Growth of cities, population density, and increasing the economic and environmental loadings force us to pay more attention to roles and functions of cities. Natural disasters are one of the most important issues that cities extensively face with today. Due to the unexpected nature of these events and the need to take quick and correct decisions and operations, the theoretical basis of these decisions has created knowledge as disaster management. Applying the principles and criteria contained in the urban planning and explaining the concepts such as the structure of the city, urban land use, connection network and urban infrastructures, will greatly reduce the effects and consequences of natural disasters.

Natural disasters, including earthquakes are often considered as one of the most destructive elements harmful to human societies. Meanwhile, one of the important and common events of the modern world is expansion of urban units and intensive physical growth of cities. It’s the result of intensity urbanization trend, life facilities and possibilities in the environments. In this

regard, it has always been a great deal of research to find methods and ways that can act as reducing damages and effects of such crisis. All officials have been paying particular attention to these practices. Today, due to natural disasters and complex aspects of human construction, for crisis management of such disasters, the researchers have paid more attention to the combination of methods. Those methods cover various aspects of natural disasters, and they are on the path of organizing systems able to manage such crisis side effects.

Crisis management is a key part of dealing with any crisis arising from natural disasters such as earthquakes. In the research it has been attempted to evaluate the crisis management after occurrence of contingent earthquake in this region through case study in the Qazvin area using an Analytic Hierarchy Process (AHP).

Therefore, it has been tried to fully evaluate the concepts of crisis and its management. And relatively a complete set of criteria was proposed for the management of natural crisis such as earthquakes. Then it was tried to evaluate application of Multimedia Analysis and Data Mining (MADM) techniques for managing crisis such as AHP.

1.2 The Importance and Necessity of Research

Natural disasters have always existed and will exist throughout the planet as a natural phenomenon. The occurrence of natural disasters such as floods, earthquakes, hurricanes, and so on most often have a devastating impact on human settlements and heavy casualties against their inhabitants. Besides,

they have destroyed buildings and infrastructures in these areas and have imposed economic and social effects on the extensive societies and countries.

Today’s urban needs, lack of attention to the correct placement of cities, urban growth, and lack of necessary detailed plans to prevent this unbridled growth have caused many problems in terms of cities' protection. This trend has led major cities spread over the river fault zone or in rivers and floodways. This could exacerbate city vulnerabilities and increase financial and human losses caused by these events. The truth is that the reflection of human settlements creates disaster in the face of natural disasters.

Iran is in a very vulnerable position against the phenomenon due to its location on the seismicity and earthquake belt. Many other major cities, including Tehran, Shiraz, Qazvin and etc. are on active faults. So they have always been subject to many risks. Therefore, the general weakness of the city and lack of proper planning in this regard, the high population density and poor distribution of population in urban locals during an earthquake cause an increase in the frequency of financial and human losses. One of the Iranian cities that has been exposed to such risks and the problem is city of Qazvin. According to Qazvin area, its different regions and locals take various reactions in terms of risk taking from the earthquake. The city has high vulnerability facing natural disasters such as earthquake because it is located among the Alborz range of mountains and existence of floodways inside it on the one hand and being located on the abundant faults on the other hand. Obviously, it is impossible to prevent earthquakes because it is

impossible to predict its time, so the important issue is to establish an appropriate crisis management before occurrence.

1.3 Scope and Objectives of the Study

The strategic research in the crisis management in the urban planning has an effective influence on the urban vulnerability reduction. So in this study a general glance on concepts, different types and literature descriptions of crisis has been done. Then indexes, approaches, crisis stages and crisis management have been argued. A major and comprehensive cycle of crisis management has been reviewed. After that an applicable method of crisis management was established to set a model for vulnerability assessment. In the next step Qazvin city was selected as a case study. In addition, properties of its 19 districts was collected and divided according to various parameters of vulnerability. One of the best and latest methods in multi-criteria methods in order to determine the crisis caused by various factors and their management in an urban area is AHP. To make a binary comparison through sub criteria a questionnaire survey has done. Finally, a mathematical model created to analyze and evaluate numbers of vulnerability for each region of the city.

There were some limitations. First of all collecting data of case study, and secondly finding a group of well experienced related experts in questionnaire survey were two of the main study limitations.

In general the main objectives in the thesis could be divided into 3 categories such as general, especial and practical purposes as following:

- General objective

The overall aim of the thesis is to study and present the crisis and its management against natural disasters especially earthquakes. Therefore in the research it has been tried to investigate coordination for rehabilitation and returning to the ex-condition in the critical earthquake situations. Also needs, problems, functionalities and specific local possibilities were expressed for Qazvin administrators introducing exactly the crisis and its concept. Then management factors were illustrated via AHP in order to take them into account in planning, preparedness and relief efforts for the development and reconstruction. In other words, it can be said that the overall objective of the research is to achieve a kind of spatial organization to adapt itself to critical condition with lowest burden of and most flexibility with coherent, regular and integrated reaction of Qazvin's components during the earthquake.

- Especial objectives

- Review and investigation of the factors influencing the crisis occurrence and explaining the strategic backgrounds to manage it with special attention to earthquake crisis

- Interpretation and explanation regarding the regulation of social, political, economic, skeletal and spatial organization for flexible operation and rapid response in order to return to normal conditions after the earthquake crisis.

- A case study in Qazvin area for review and assessment in management of crisis caused by potential earthquake in the city

- Using hierarchical analysis method to estimate the action and reaction of various sites and 19 districts of Qazvin during an earthquake

➢ Practical objectives

According to a survey carried out in the context of the Analytic Hierarchy Process (AHP) in earthquake crisis management in the country, it seems that the following relevant organizations are as contingent productive agents of thesis results. Such as:

- Management and Planning Organization of Iran
- Prevention and crisis management organizations (national)
- Transportation and Traffic department
- Consulting Engineering Companies active in construction and tunneling
- Major construction companies in the country
- Universities and research centers active in the field of construction
- Municipalities
- Ministry of Housing and Urban Development, etc.

According to the discussions of crisis management and vulnerability assessment of the earthquake, the aim of the research is:

- To define a new structure of crisis management cycle by doing a general study on the field

- To find comprehensive urban characteristics and main criteria of a city to analyze the vulnerability in a crisis like earthquake

- To know when is the most vital time to make a decision about managing a crisis.

- To assess the vulnerability of 19 urban areas of case study and determine which regions are vulnerable in a crisis using AHP.

- To find the criteria of a city that should strengthen in order to better resistance against a crisis

1.4 Works Carried Out

In the study it has been tried - using the analytical method - to analyze Qazvin's context of vulnerability in the form of 19 metropolitan areas based on different criteria. It can be explained that the goal of research is to use hierarchy analysis method. So a case study was performed in Qazvin after collecting the required information about the city texture and various factors needed for its process. To obtain importance and priority of different elements in a city, a questionnaire prepared and distributed to some urban design experts, companies and consulting engineers in order to make the result more practical and applicable to use analytic hierarchy process. In order to meet goals, the following steps were followed:

- A general investigation and literature review performed to lighten definition and concept of crisis and crisis management.

- An analytic process was done. The criteria and elements are related to three main decision time of pre, during and after crisis to know when is the most important time to manage a disaster.

- After collecting proper data about case study, a questionnaire survey has been done to make raw information applicable for analysis. By the analytic hierarchy process, the priority of vulnerability was calculated for each region of the city in each criterion.

- As the result of vulnerability assessment, weakness of each 19 municipality regions was determined based on 3 main categories.

1.5 Achievements

One of the mail achievements of this research was to categorize and to talk deeply about what had been done, should and can be done in the field of risk mitigation and crisis management; especially facing earthquake. Then the best ways of AHP in ranking the risks for risk assessment and management were done (the hierarchical analysis method and its application in earthquake crisis management). Furthermore, in this study by a case study in the area of the city of Qazvin (which described before), the amount of vulnerabilities in pre-crisis levels were identified and assessed to identify the failures and to prioritize the planning and resource allocation where experts points of view helps us in questionnaire result. In other words, in this study the evaluation method of multivariate hierarchical analysis was used to evaluate the vulnerability amount of Qazvin's 19 districts with classification

of vulnerability to 3 main categories physical resistance factors of texture, responsiveness and relief impossibility and reversibility of city after crisis;

- A comprehensive study about crisis and crisis management cycle has been done. All specification and policies which help to make an applicable analysis was described. The achievement was the way that vulnerability criteria categorized. By doing this, the urban characteristics have been found and partitioned under three main categories of vulnerability due to the city condition.

- By doing an analytic hierarchy process on three time steps on crisis management decision making; pre-crisis, during crisis and post-crisis; it have been calculated that the most important time to make a decision when a disaster occurs is “during crisis”. The second is pre-crisis to take any managing and mitigation action in the city.

- The vulnerability assessment in 19 regions of the Qazvin city has been done in 20 sub criteria and under three main categories. The results show that regions 18 and 10 have more cumulative vulnerability and regions 11, 2 and 18 have high vulnerability in each criteria after a crisis. More over the results showed the vulnerability of each region under the properties of each 20 sub criteria.

- The results also showed that the worst condition was related to “population density” and “reparable building” criteria in those high risk regions. Detailed results of assessment are discussed in chapter five.

1.6 Thesis Outline

In chapter two, a comprehensive literature review on the meaning, different types and dimensions of crisis have been done. Then different parts of crisis management cycle were described, to identify existing hazards and disasters in the region. Then prioritizations of the likelihood have explained, according to the history, scientific studies and the risk area. Finally principles of Analytical Hierarchy Process were mentioned to know why this method was selected.

Chapter three; in methodology chapter at first, tried to describe and find principles of crisis management planning to make it applicable. Basic requirements to deal with the crisis have been mentioned. Afterwards different criteria of vulnerability have been established to make a proper model to assess risks caused by earthquake.

Chapter four, in this section, first of all general data about Qazvin city are brought. It is continued with urban texture, socio-economic, population density and building condition of the city. In addition trend of gathering data by designing a questionnaire is described. At the end, method of process data in an analytical hierarchy in order to evaluate vulnerability and other management abilities was introduced then the results have shown.

Chapter five; in this chapter results based on elements which are mentions and described in previous chapters, are illustrated. Final results of questionnaire are shown as charts, afterward vulnerability assessment - partitioned by three effective aspects - one by one, aggregative and

comparative figures are mentioned. Finally overall priorities of each element guide us to find a solution or recommendation for municipality officials.

Chapter six; this chapter is a brief review on what have been done in this study. The process of doing the study, aims, works done and the achievements will be reviewed briefly. Finally some recommendations about the study and for further research have been presented.

Chapter 2

REVIEW ON PRINCIPLES OF CRISIS MANAGEMENT

2.1 Introduction

Challenges of today's cities are not compacted only in social, economic, political and cultural issues but there are also influential environmental factors that constitute urban context. This issue has a particular importance in our country due to many different natural characteristics. Many cities due to close relationship with environmental factors such as sea, river, roughs and faults etc. are always vulnerable. So simple it can be to get that proper planning has particular importance to prevent or reduce harmful effects and to increase the reversibility of city during a natural disaster. Recent Earthquake experiences suggest that the main parts of damages were happen due to poor urban planning, failure in complying principles and criteria based on weakness in identification the factors which are affecting vulnerability of cities; while the probable earthquake happens. To reach that at first, the relative risks priority should be determined. In order to further activities the hazards and disasters throughout the region should be identify to determine what types of risk faced by the region using measures such as probability, extent, scope and side effects. (Smith, 2008)

In this part, a comprehensive literature review on the meaning, different types and dimensions of crisis have been done. Then different parts of crisis

management cycle were described, to identify existing hazards and disasters in the region. Then prioritizations of the likelihood have explained, according to the history, scientific studies and the risk area. Finally principles of Analytical Hierarchy Process were mentioned to know why this method was selected.

2.2 Definition of Crisis and Crisis Management

Crisis is a phenomenon created by natural and human events and operations suddenly which exerts hardness, losses and damages to a group of human beings and its removal needs some emergency and extraordinary operations. (Aysan & Davis, 2004)

Thus, given the definition of the concept of crisis, it is obvious that the crisis management involves a continuous and dynamic actions And in general it is solidly based on the classical management function consists of planning, organizing organization, leadership and control.

In effect the various organizations involved in crisis management for several tasks that must act with complete harmony towards crisis prevention, reduction and with required preparedness. Also relevant organizations should take appropriate and necessary measures to improve the situation after the crisis.

the Planning process and actions of public officials and agencies, state, municipal and public officials' integrated, comprehensive, and coordinated observation and critical analysis using existing tools are to prevent the crisis or if they occur they should attempt in order to reduce the effects, to get

preparedness, to react, to relieve rapidly and to recover in order to achieve normalcy and reconstruction. (Aysan & Davis, 2004)

In the Studies in the field of natural disasters, there are several approaches. The latest approach is the reversible cities approach that was presented at the World Summit on Sustainable Development in 2002 in Johannesburg, South Africa in the second phase of Local Agenda 21. (WSSD, 2002)

The most important part of crisis management measures should be focused on preventing crisis caused by natural disasters to reduce the risks and vulnerabilities. If we are to consider the crisis management with a broader concept than that of operations after the accident, it includes concepts such as risks reduction, particular permanent readiness and meeting specific needs of the accident, including emergency in short-term or long term. Since the comprehensive planning for city needs so much time and costs, it is required to clarify the suburban in terms of vulnerability rate and priority in obvious measures and planning. (Abdollahi, 2004)

Assessment of hazards and related disasters throughout a region and prioritizing the probability of happening perfume according to the historical records and scientific studies; and regional risk probability is evaluating. In other words, in the first to identify the hazards and disasters in the region and to determine the kinds of risk, the relative priority area of risks should be determined toward performance of further activities by using measures such as probability, extent, scope, side effects, etc. (Smith, 2008)

2.3 Threat Posed by Natural Crisis

Natural disaster has always existed and will be as a natural phenomenon of the Earth's life. Natural disasters such as floods, earthquakes, hurricanes, and so on often leave devastating effects on human settlements And made heavy casualties upon their inhabitants also they have destroyed the buildings and infrastructure of the areas and imposed far-reaching economic and social effects on the human communities and the world.

Via study of natural crisis, it was observed that a bulk of threats from the natural crisis still exists. And perhaps still some work shave not been done on reducing the risks of the crisis. Most problems in this regard are already existed too and always threaten human societies. Natural phenomenon such as earthquakes, tornadoes, volcanoes, tides and sea level rise, natural fires, flooding rivers, earth fission and drought are still entail potential risks.

These disasters as one that are caused by humans cause human casualties, economic and social losses and in this regard they’re making significant damages to the environment. Over the years Humans somewhat have learned how to deal with natural crisis But the crisis and dangers threaten the human population and impose major damage on the communities. The Reviews on the crisis shows that some dangers caused by the crisis are further even during the last years. Because if we go back to the history of 1920s, we will see that the danger caused by an air crisis occurrence is too little, or it has been no crisis at all because of the small number of aircrafts all around the world. Even in the case of an air crash, a few people are

killed. But nowadays and in the late twentieth century, the dangers arising from an air disaster have risen dramatically. (Abdollahi, 2004) Every day more aircrafts enter into the airway system of countries; air traffic has been growing and it causes compact air traffic in some major cities or capital of countries. It is obvious that in such situation the event of a plane crash would lead to a huge disaster.

2.4 Effects and Crisis Properties

In General the effects and characteristics of crisis can be classified in three categories as follows:

- Globally
- Nationally
- In actual crisis management

2.4.1 Globally

When there is no necessary and common prevention against the crisis occurrence and reduction of its devastating effects globally the effects of crisis affect the human beings and communities' lives. At the moment, the world is faced with some serious environmental and feeding problems and therefore the reduction of damaging effects of the crisis should be taken into consideration and it should have a major role in the struggle against all the problems of current era. Stable political, economic and social systems in the world are correlated with the gap between developed and developing countries significantly. Thus to reduce the damaging effects caused by various crisis in developing countries, it will be crucial factor in resolving this gap and the stability of the global system. In this regard the role of

international aid and increasing the aid is also noticeable when a crisis occurs. (Aysan & Davis, 2004)

2.4.2 Nationally

Overall effects of crisis are normally shown in the following two ways:

- The loss of national assets in different ways
- Allocation of national resources and determination to recover and rebuild the situation and circumstances after a crisis rather than allocating resources and national commitment to national economic development.

Indeed, countries have special needs of master plan prepared for crisis management in the framework of crisis management system to address any risks posed by various disasters. In effect under shadow of having had such a project we can hope to deal efficiently and effectively with any crisis. Naturally the comprehensive crisis management plan is effective and sufficient if not only it involves all issues related to a defined cycle of crisis management but should also include kind of balance and coordination among different sections of crisis management cycle including prevention, reduction of effects, preparedness, relief, recovery and reconstruction. (Aysan & Davis, 2004)

2.4.3 In Actual Crisis Management

Overall, actual crisis management focuses on the existing resources and actual needs of implementation of actual crisis management in crisis conditions and at various levels of government and due to resource constraints and also to prevent the additional organization; it provides the

best possible solutions. In this regard, the following should be investigated fully and much basically. (Aysan & Davis, 2004)

- Likelihood of crisis happening and dangers caused by it
- Existing resources
- Organizational logistics
- Planning shortcoming
- Measures required in each cycle of crisis management
- Training

2.5 Basic Cycle of Crisis Management

The basic cycle of crisis management is often plotted via a variety of different forms and sometimes different words are used to call it.

The basic cycle of crisis management is any way called or plotted It should be indicated that the most important principle in it i.e. the principle that crisis and crisis management consists a series of continuous and constant activities.

In effect the basic cycle of crisis management involves not a series of activities that can be terminated at any time with the onset of the crisis. (Alexander, 2012)

2.5.1 The Basic Shape of Crisis Management Cycle

In reviewing the basic framework for crisis management, at first identification of two important principles are of particular importance.

A. The provided figure for different sectors of higher management cycle is based on graphical considerations. And this figure does not specify the time required and the relative importance of different sectors considered in the crisis management cycle because the time required for operations referred to the section “Recovery and Reconstruction” can vary depending on the type of crisis.

B. Drawing a fundamental cycle of crisis management and identifying different operational sections is in fact a means of separating these parts separately and apart from each other. Instead, it should be considered that generally marked parts may interact with other or have to be enforced as combinational. It should be mentioned that as an example some of the provisions relating to the “responsibility and relief” can be taken care before the crisis and in the section “Preparation”. And so, the recovery and reconstruction process often begins when the emergency response and relief efforts are still ongoing. For example, a technical advice team generally- immediately after the crisis - begins to gather information that is used in each of areas “relief, responsibility, recovery and reconstruction”.

2.5.1.1 Different Steps

- Preparation step
- Responsibility and relief Step
- Recovery and Reconstruction step

2.5.2 Combination of Main Activities in the Crisis Management Cycle

Generally start in each of the sections, or all sections related to the management cycle are dependent on four main factors as defined below. These four factors may even have influences on the desirable limit between the activities or the priorities assigned to each activity. The four factors mentioned bellow:

2.5.2.1 Post-Crisis Reviews

Post-crisis Reviews should be done as soon as possible and in the recovery and reconstruction period. Conducted extensive studies will help to find shortcomings and weaknesses of plans For example, the results of these studies may suggest recommendations to improve the quality of the courses level or responsibility and relief.

2.5.2.2 The Results Obtained from Exercises and Simulation of Crisis

Crisis simulation and exercises can contribute greatly to the authorities and those involved in crisis management. It can be used to accurately identify and define the relevant shortcomings and suggest solutions or actions necessary to perform these exercises and scenes simulations by evaluating the results. The results of such studies, exercises and simulations have effects like post-crisis investigations and sometimes they act even more effective than the results of studies of post-crisis for the following reasons.

2.5.2.3 Crisis Scenes of Simulation and Exercises

Usually these activities are done on each cycle of crisis management in particular, as an example it could be mentioned of practice exercises as to coordinated resource usage.

2.5.2.4 Results of Lessons Learned from Exercises

This knowledge can be reviewed and explained with great precision. About review of post-crisis it is very likely that some of the critical necessary information due to the condition emerged from the bigger crisis is ignored at all.

2.5.3 The "Prevention" in Crisis Management Cycle

Activities related to the management fundamental cycle is designed to prevent crisis and to prevent or curb the effects caused by the crisis on people and key facilities.

The following steps are usually taken as preventive measures:

- ✓ Measures to build dam or flood wall that can be done to prevent and control floodwater and cause no harm, and damage to the public, buildings and other facilities,

- ✓ some kind of legislations can also be considered as preventive measures As an examples it can be mentioned of rules of land usage that specify how the towns will be expanded and causes non-expanding the cities in vulnerable sites. Some countries have incorporated activities related to the prevention and mitigation of the effects and they simultaneously introduce a new chapter named the prevention and reduction of effects.

2.5.4 The "Decline" in the Crisis Management Cycle

Activities related to this part of the basic cycle of crisis management normally takes as a program to reduce the effects of the crisis in a country or city. For example, some countries consider the preparation and application of building regulations as part of measures to reduce the effects of the crisis

(to reduce damages and losses caused by earthquake and hurricane). If other countries regard the building regulations as preventive measures, new Practices and innovations in the construction of buildings resistant to earthquake is itself proof of this.

The term “reducing the effects of the crisis” generally refers to the principle although some of the effects of the crisis can be prevented, but there are still other effects of the crisis. It can change or mitigate the effects in such a way by doing proper operation. Thus, given the nature of the measures to prevent and reduce the effects of the crisis, it seems that under certain conditions the phrase “prevention-reducing the effects” of crisis combined with some countries is better than using two words, “Prevention” and “reduce the impact” as two distinct parts with different concepts and measures. Measures and programs to reduce the effects of the crisis are usually as follows:

- Implementation of building regulations;
- Setting the laws related to land use;
- Implementation of safety rules in tall buildings, hazardous materials control, etc.
- Programs associated to reduce the risks on the products of agriculture;
- Programs related to the protection of public service of key systems, including protection of, power supply and telecommunications systems;

- Programs and actions related to the development of network infrastructure, including the construction of freeways away from vulnerable areas.

2.5.5 The “Preparation” in the Crisis Management Cycle

The term “preparation” to deal with the crisis usually refers to all measures which enable the governments, organizations, communities and individuals to demonstrate the required response in critical situations correctly and efficiently. The preparation measures usually are as follows:

- Having a timely and comprehensive anti-crisis program that can be performed immediately in an emergency;
- Setting the regulations and limitations for emergency operations such as temporary evacuation of population to the safe areas;
- Setting the special regulations and restrictions for information and warning;
- Emergency contacts;
- Public education and promotion of public awareness;
- Training program includes exercises and quizzes.

One of the important things that are not usually much of a priority in the “preparation” is individual and family readiness. In most cases, the emergency services of governments are faced with resource constraints, individual or family readiness has a critical role in survival.

In general, in the basic cycle of crisis management, the preparation section includes two other subsections are as follows:

2.5.5.1 Warning Updates

It is a time of crisis or a period in which the risk detected, but the time is not specified in a specific location yet.

2.5.5.2 Risk Threat

It is a time or a period of time that the risk is diagnosed and its occurrence has also been identified in a specific location. Some of the enclosed drawings to show the different parts of the basic cycle of crisis, sometimes suggest a further subdivision and It consists of the "precautionary" which in the stage after being informed of the notice announcing the risk of a crisis to the public usually runs a number of precautions to reduce the detrimental effects caused by the crisis, some of the measures include:

- Closure of all offices, schools, etc.
- Preparation of emergency power generation units;
- Preparation of public transport for emergency evacuation of the population;
- Doing some precautionary measures by households, including storing water.

2.5.6 The “Crisis Occurrence” in Crisis Management Cycle

This part is actually indicating the time and stage the crisis occurs in. Thus creating a variety of different crisis causes some of the kinds of effects which some of them areas follow:

- An earthquake occurrence is usually not coupled with a warning and time of its effectiveness may be short, and but the results are very hard and suffering.

- Tornado event may have occurred with longer time notice, but its continuity is not high.

2.5.7 The "Responsibility and Relief" in Crisis Management Cycle

The Measures in this sector usually refers to the measures that will be implemented immediately after crisis and its effective time. This part of the cycle of crisis management measures are planned primarily to save lives and protect public property and also to deal with other effects that are caused by the crisis. Typical actions that are performed in this section are as follows:

- Pre-designed programs;
- Activating anti- crisis systems;
- Search and rescue operations;
- Emergency Measures for food, shelter and medical assistance, etc.
- Review, evaluation and assessment;
- Measures to evacuate the people and places.

This is the most iconic part of the management cycle called emergency period, (typically 2 to 3 weeks after the crisis) because after the crisis, governments commonly have stated that emergency and planned actions are implemented to deal with the effects of crisis.

2.5.8 The "Recovery and Reconstruction" in Crisis Management Cycle

This section is all actions that according to them can restore normal conditions and communities to the normal condition after the occurrence of any crisis. Recovery and reconstruction process may be lengthy and sometimes may take even 5 to 10 also.

Major operations that typically arise at this stage of the cycle of crisis management are separable to three subsections, which are the “reintegration”, “reconstruction” and “modernization” respectively.

Examples of activities that occur in these three subsections are as follows:

- Restoring the services and essential services;
- Reintegration of repairable homes and other buildings and facilities;
- Providing the temporary housing;
- Actions that are done to help the body and mind of suffering people;
- Long-term Measures of reconstruction, including replacement of infrastructure and buildings that have been destroyed by the crisis.

In the recovery and reconstruction section, it is necessary to add also a subsection “review and revise” because the investigation of all actions and operations done in this stage of crisis management cycle will appear in the first possible chance the strengths and weaknesses of provided programs and performed actions. The results of this investigation will be useful to revise the anti-crisis program and to make them much richer.

2.5.9 The “National Development” in Crisis Management Cycle

This part of the crisis management cycle illustrates the relationship between the activities and actions related to the crisis in national development. Including this section to the basic cycle of crisis management more shows the coming crisis effects on the future national development policies. For example, the effects of the crisis will lead to policy making and or following operations in the future country development programs:

- Introducing the modern systems of building construction and retrofit applications;
- Optimum use of international assistance to the crisis;
- Using the experiences gained from the crisis in future research and development programs.

2.5.10 Practical Application in Crisis Management Cycle

Crisis management cycle is depicted by different countries with respect to their internal needs in addition to contribute the understanding of the objective crisis and the different sectors considered critical in crisis management, it is of practical applications for the interested individuals as following:

2.5.10.1 Training Programs and Internship

It is usually most useful section on preparedness, response, relief, recovery and reconstruction. The purpose of the internship and training programs which are implemented using a cycle of crisis management is to be more helpful to understand the relationships between the three basic parts and their relationships with other activities and actions related to the crisis.

2.5.10.2 Basic Education Programs and Promotion of Public Awareness

In this respect, the crisis management cycle could be used such as training and internship programs. Risk education in schools as well as increasing the level of public information through posters and television programs are perceived practical applications including practical applications of crisis management cycle.

2.5.10.3 The Reference Agent and Controllability

The basic cycle of crisis management can be used as a reference agent because the authorities using it would be able to control all activities and operations related to the management of the crisis constantly or they attempt to describe the existing deficiencies and corrections needed in various sectors.

2.6 National Crisis Management Policy Making

National Policy on crisis Management has an important and special place to deal with threats from various crises in different countries. Regard to this clear policy, countries and the competent authorities in crisis management will be able to perform the necessary operations.

National policymaking in fact consists of all organizational different levels and national systems and it should cover the highest state systematic through the lowest level. It is obvious that if such a policy is not defined clearly in the national level, arrangements and procedures for dealing with the crisis will be faced with some problems. As a result increased human and financial losses will be appeared and in general the country will be affected by losses.

A clear national policy that is defined in an appropriate manner in the crisis context, it should contain the following: (Seeger, Sellnow, & Ulmer, 2003)

- ✓ It determines the critical leadership role of the state in all matters pertaining to the crisis.
- ✓ It shows a place for legislation and guidelines.

- ✓ It defines an optimal and efficient organizational structure and principle division of labor.
- ✓ It defines a specific orientation in order to allocate and use the existing resources optimally in order to deal with the risk of crisis.
- ✓ It defines national power to deal with the crisis and its position and it provides the right amount of international aid in times needed.

2.6.1 Steps to Define and Describe the National Policy of Crisis Management

In order to get a national policy as harmonious and appropriate, it is necessary to pay attention to several key factors which the most important ones are as follows:

- ✓ Exact crisis threatening risk definition;
- ✓ Full Understanding the impact of the crisis;
- ✓ Determining the resources to confront and deal with the crisis;
- ✓ Understanding the suitable organizational structures should be prepared to respond quickly and improving the situation a crisis;
- ✓ Defining the relationship between national policies on crisis management with national policies considered in other sections especially the relationship between national policy for crisis management policies for national development and environmental protection.

2.6.2 Risk Threatening the Crisis and Its Associated Effects

According to national and regional conditions, consideration of dangers stemmed from crisis and its effects, the statistics and information and exploration of similar crisis exactly is of important. Meanwhile in stating the

national policy of crisis management it should make the proper relationship caused by crisis and its mutual effects on the one side and policy making on the other side vivid and According to the reflection, different policies should be defined and described and each priorities should be verified in National Policy.

2.6.2.1 Determination of the Available Resources

Policy making at the national level (for crisis management) should be provided according to the national available resources and in this context, an appropriate combination is investigated from the resources including staff, facilities and supplies. In the estimation of the resources, public and private scrutiny of available resources is essential and is funded by international resources.

2.6.2.2 Suitable Organizational Structure

In some countries, the government's primary responsibility is to deal with the crisis. In addition, the bulk of the resources available in each country are under the governments And optimal use of the resources should be under state supervision. Thus, organizational and institutional arrangements for dealing with the crisis (whether occurring before, during and after the crisis taking place) should be formed based on the structure of government. And experience has shown that establishing a specific institutional structure and arrangements for crisis management; in addition it did not work alone, but has not a required performance. Of course, as mentioned before, this is only true for some countries are on the proper administration of government.

2.6.2.3 Relationship between National Policies on Crisis Management with other National Policies

Governments are generally responsible for all economic sectors and social policy which is defined as a collection of national policies in every economic and social sector such as Policy making in areas like health and education etc. that usually governments give special priority to the health and education sectors. Attention and priority to the Crisis management is dependent on the formulation and supply Authorities of national policies Crisis Management which logically they will be able to adjust their policies given the interaction between crisis management and other economic and social sectors. National policies of the countries have general interfaces and the inter-relationship between the national policy of crisis management in national development and environmental protection sectors because the crisis and national development are associated with each other perfectly. All planning should be provided for national development (given the crisis occurrence danger and also the effects of it on the programs and different plans).

Crisis management and environment protection are common and closely related with together and a bulk of the actions the taken place as to crisis which is included on the environmental cases and thus is important for coordination between environmental policies. Recently some countries have attempted to formulation and to supply the national policies of environmental and crisis management uniquely. They have implemented the unique and national policies on the crisis and environment.

Competent authorities in the crisis management should consider the two policy making areas in the contexts of national development and the environment. They should clarify a relationship between the two sectors and the crisis management sector as a key factor in policymaking for all sections in order to address the specific priority in crisis management.

2.7 Essential Elements of the National Crisis Management Policy

2.7.1 Existing Options

In Understanding the available options as essential elements of a national policymaking to manage the crisis, it is better to review the crisis management cycle because it considers all of cycles of crisis management as a key element in the policymaking. Different parts of the crisis management cycle are comprised of prevention, effects reduction, preparation, relief, recovery and development. Each of these sections of crisis management cycle shall be examined fully according to the government's priorities in national policymaking. (Hosseini, 2009)

2.7.1.1 Crisis Prevention

All Measures which have evaluated the risky level of society aim to prevent accidents or mitigate their harmful effects and it reduces its level to an acceptable limit with necessary studies and measures.

2.7.2 Reducing the Devastating Effects of Crisis

Long-term and short-term activities are those that eliminate or reduce the likelihood of an accident in order to mitigate potential and actual incidents effects. In some cases it is impossible to remove an event, but one can reduce its effects by some actions.

2.7.3 Selection of Desired Options

Exploration of different parts of crisis management cycle is corroborated by the fact that the choice of three options (including preparation, outreach and improvement, and finally normalization) there is not any option for the countries. In fact, these three major options should be considered by the authorities and in national policy-making level, 1 to 3 priorities should be respectively, “preparation”, “improvement” and “normalization” And priorities 4, 5 and 6, respectively are for options “development projects”, “effects reduction” and “crisis prevention”.

In the context of national policies, specific system is introduced to monitor and review the policies defined. This responsibility is assigned usually to related ministries who assign this responsibility to the crisis management supreme council.

The consideration and control of policies and actions after occurrence of crisis will reflect the worthiness, correction and review in the mentioned policies very well.

2.8 Basic Requirements to Deal with Crisis

Although the basic needs to deal with a crisis may be different in minor principles and But they are quite common in the principles defined below. These basic principles are as follows: (Aysan & Davis, 2004)

- Organizational systems of crisis management
- Planning
- Optimal use of resources

- The use of multidisciplinary
- Training

In the necessary studies to determine the necessary requirements to cope with the crisis, it is better to specify the entire volume of the crisis. Therefore, the description and scope of duties to deal with the crisis are listed as follows:

- The rules and how to declare warning of the crisis risk
- Search and rescue operations
- Measurement and report of the crisis effect
- Maintenance and treatment of victims
- Environmental cleanup and recovery operations of roads, airports, rail networks, ports and all other key issues
- Criteria and mode of catering
- Criteria for shelter construction
- Unloading the individuals, groups, cities and also cattle
- Criteria for healthy operation
- Resettlement of populations and establishing communication systems, water and electricity
- Direction and coordination of all the anti-crisis affairs
- Providing the information and guidance with people
- Immediate financial assistance to the victims and their appointed
- Control and Distribution of Essential Ingredients
- Rehabilitation and reconstruction of issues related to food production
- Emergency housing programs

- To conducting the long-term improvements and normalization of conditions
- The use of emergency regulations

Given the different operations and tasks as above mentioned, systematic and organized method should be defined and used toward the crisis management and case measures should be avoided even if they are based on the old and traditional experience.

2.8.1 Philosophy of Dealing with Crisis

In general, every crisis has an extensive effect on the countries, governments and their people. So the primary responsibility for dealing with the crisis is of the government's functions. And thus the states have a direct responsibility to cater the needs caused by the crisis, as well as their other responsibilities in terms of facilities and National Development. (Lindell, Prater, & Perry, 2007)

Although governments often require full assistance from non-governmental organizations (NGO), private and public sectors, and in some cases even international aids. However, the overall and primary responsibility to deal with the crisis is of governments' responsibility. And in effect state systems and their resources are determined to perform anti-crisis actions and operations. When the Crisis occurs, various government departments and agencies, especially those units that provide emergency services must act in coordination with other departments and agencies more common than being in difficult situations. Sometimes in critical condition, needs arisen that different state agencies and departments are not obliged to provide them

under normal circumstances And such needs happen with regard to the specific effects of the crisis. In this particular example the catering can be mentioned. For this reason it is that there is an urgent need for crisis management system to deal with the crisis. We should always consider the facts about the crisis management system:

- ✓ Crisis Management System cannot always control the state departments.
- ✓ Crisis Management system does not dictate how to do activities of state agencies.
- ✓ The main task of crisis management is to ensure coordination among government agencies and operational resources And if necessary non-state agencies provide the best anti-crisis measures at all times to the best possible manner.

As well as the basic principles described in the previous section, these principles to deal with the crisis is an accurate understanding of the concept of crisis at all levels and classes of state administration, determination of the dangers of a crisis and a right & efficient policy to deal with the crisis and also other needs, which may include organizational systems, planning, optimization and application of educational systems and the use of special expertise.

2.8.2 Organizational System of the Crisis Management

Organizational system of the crisis management has special features that are sometimes different interpretations of it. Here it is necessary to provide a brief description of the organizational system of crisis management and features that are not included in this system:

- Organizational systems of crisis management, simulation, and it do not cause the system of governmental organizations twice.
- The system does not act independently of the government.
- The system does not control the agencies and public institutions.
- The system does not work outside of the Charter or description of services regulated by the government. (except in very special circumstances and emergencies)
- The organizational and institutional crisis management system is an auxiliary system and regulated by state common system which it is necessary in order to enable the public system to provide better services needed in crisis periods.

2.8.3 Important Considerations in Designing the Crisis Management

2.8.3.1 Organizational System Structure

As was mentioned before, crisis management system is not a more specialized or superior to the existing governmental system and vice versa, it uses the government organizations' resources to deal with the crisis For example, the Supreme Council of crisis management is not necessarily composed of certain officials, who are active in the field of crisis management. The Council is formed naturally of high ranking government's officials such as Ministers and as well as representatives of non-governmental organizations. The officials are elected more because they are the best people who actually know the resources at the best. They are also familiar enough to use resources within their areas of activity and also with management principles and systems. However, even members of the Supreme Council for Crisis Management applies to the acquisition of

knowledge obtained in the crisis through training and experience and so they do their duties in the best way in the crisis periods.

2.8.3.2 The Usage of the State Structure

Organizational and crisis management system uses the state organization both over in width and length completely and it covers the system from the national and provincial levels as well as to the city and town level. And since organizational and institutional system of the state is essentially a permanent organizational system, so founding an organizational system of crisis management based on it would be perfectly logical and reasonable. According to The experience gained, an organization system separate or specific from the state system is not appropriate under any circumstances to deal with the crisis.

2.8.3.3 The usage of Non-Governmental Resources in Crisis Management Organizational System

NGOs resources are easily integrated and coordinated in the crisis management system. Management and coordination of tasks related to non-government resources is done through the Supreme Council for risk Management and Central administration of crisis management (through a systematic relationship with non-governmental organizations) and operational control group and technical consultation team which has a representative from non-governmental organizations in that company as shown in Fig 2.1.

2.8.3.4 Involvement of Towns and Villages

Crisis occurs in towns and villages and when it affects even on the several cities and villages once simultaneously. Therefore, any system of crisis

management should pay attention to all matters relating to the involvement of cities and how to participate in critical situations. And it is to make the necessary arrangements in 3 sections of the activities related to crisis management cycle consists of “preparation”, “responsibility and outreach” and “improvement and normalization”.

In fact, the crisis management system design and evaluation of system performance, it is recommended that you first need urgent measures should be considered in urban and rural areas. And then arrangements will be adjusted in the upper level so that they can provide all emerging needs of the city and countryside or in other words the crisis forefront line.

2.8.3.5 Specialized Systems and Facilities

Crisis management system is a dynamic system in which all of the basic cycle of crisis management essentially participate and do some operations , in effect the performance of various sectors of basic cycles are to enlist relatively wide range of specialized systems and different features that are included:

- Orientation and coordination between the operational issues related to the crisis
- Activities related to the Emergency Operations Center
- Preparing and activating the crisis management system when necessary
- Dialog and communication settlement
- Warning
- Review and determination of the amount of damages

- Information Management
- Emergency servicing

Overall consideration of needs in the crisis management demonstrates a fact that limited determination and understanding the set of systems and specialized facilities needed to deal with a series of special events are among critical matters in the crisis management. Also, it can be stated clearly that the harmonious and efficient organizational system is considered one of the major keys to any successful crisis management plan which ultimately makes the final presentation of results or to say a final product called “operational coordination” in responsibility and outreach operations.

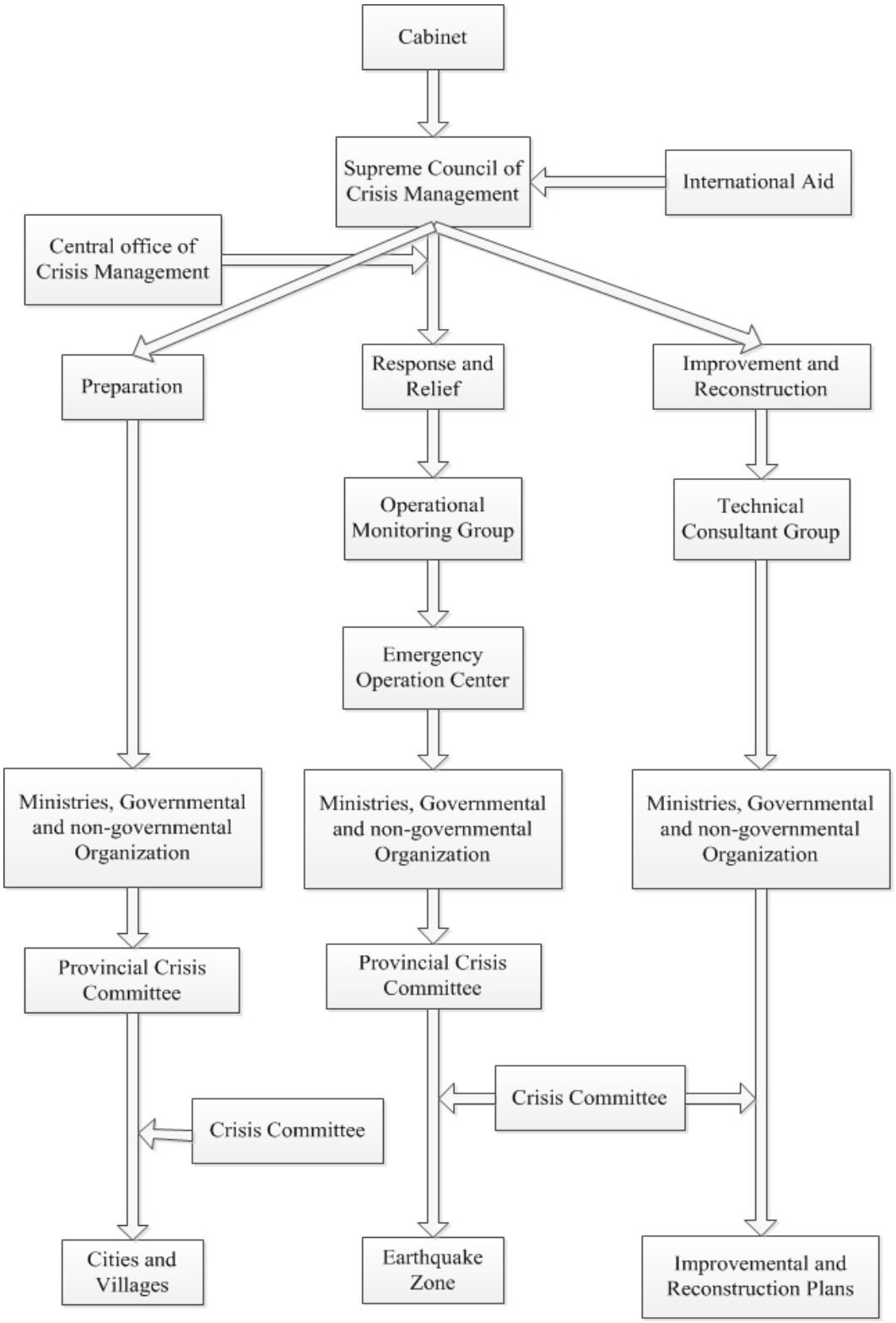

Figure 2.1: Sample of Organizational and Operational system in Crisis management

Coordination is an Operation means that the authorities (the government) have given a clear picture of the operational model to meet the needs for guidance and coordination of the crisis because the absence of such

coordination of operations - even for a short time - may also cause to a reverse swirl response and outreach operations and ultimately create more serious problems.

2.8.4 Planning

Requirement to preparation anti-crisis programs is sometimes criticized by people And in effect these people are arguing that natural crisis will happen anyway And therefore it is better to let nature to do its job and then to mobilize all available resources to perform all upgrades and renovations. However, most international experiences confirm this fact: In the event that there was (no) specific plan or has had the defects to deal with the crisis. The Effects ratio of the crisis is worse in the crisis-stricken country and its people than when there is a specific plan to deal with the crisis.

Planning to deal with the crisis which is characterized as follows:

- It defines a clear and coordinated approach to deal with the crisis;
- It provides a general reference for all departments, executive agencies and authorities involved in crisis management;
- It is a basis for coordinating the operations;
- It clarifies the division of work and responsibilities clearly;
- It clarifies the instructions relating to the crisis;
- It is a framework for the review and revision of the current and future needs in crisis management.

Planning is essential to deal with the crisis and however, it should be noted that some programs need to be reviewed and they should be adapted to the

realities of the day. Otherwise, unrevised programs may cause problems and those programs will likely remove the same problems

2.8.5 Optimum Use of Resources

One of the major problems in the Crisis management is optimal use of available resources. Resource allocation problems often occur for the following reasons:

- Anti-crisis Planning has not been done comprehensively and has weaknesses and shortcomings.
- All potential sources are not fully identified in the programming.
- Base organizations have not been defined as resource in terms of capacities, availability and continuity correctly;
- Division of tasks in the based organizations as resource is not a fit and proper;
- Because of impact of the crisis, some resources may disappear or be excluded from the operation;
- Delays that may cause the crisis of lack of access and use of resources;
- Lack of coordination between the operations of resources agencies due to lack of adequate training on tasks related to the crisis;
- Incomplete Information may cause incorrect and suboptimal adoption and use of resources;
- Poor management of resources may cause rework or create gaps in responsibility and outreach operations in crisis.

Resources that are used to deal with the crisis may have come from various sectors, including the following:

- Ministries and state agencies (sometimes including the Armed Forces)
- NGOs;
- People from different social groups;
- International groups and organizations;

Due to the diversity of sources of supply areas, it is evident that in the planning process, there is probability that some sources are not estimated correctly from different places such as an accurate estimation of resource for international groups and organizations in which case the guidance and coordination of crisis management authorities may encounter difficulties in the use of resources to optimize responsibility and outreach operations.

In the overall management of resources, it is important to note that in fact each enterprise resource management system should have correct management system in order to enable the Authorities to conduct the overall crisis management coordination to the best and also officials for directing and coordinating the crisis management should not interfere in the internal resources agencies For example, it can be noted that the authorities should provide guidance and coordination to manage tasks and priorities of the tasks set for each organization, and communicated to the organization. But they should never dictate the organization how to do the tasks assigned to different organizations because this was of a technical issue related to the

internal management of their organizations. If this management note is fully respected, the following problems will not appear:

- ✓ There will be No confusion and uncertainty in the management role of officials for directing and coordinating agencies and resource managers;
- ✓ There will be no management conflict between agencies officials for directing and coordinating crisis management and resource managers;
- ✓ Tasks assigned will be performed correctly and with full functionality;
- ✓ Responsibility and outreach operations will be carried out with high efficiency and goodness;

In general, due to management problems that were mentioned and to mention them for management of how to best manage the crisis, it can be concluded that the optimal management of resources, in fact, is based on the four principles:

- There is a strong Emergency Operations Center
- A good information system
- Communication and closely conversation between coordinating bilateral and international authorities and resource agencies
- Responsibility resource agencies for operational duties with regard to their capabilities

2.8.5.1 The Use of Multidisciplinary

In different sectors of Crisis management, different skills are needed for different operations and optimal use of all expertise available or needed to

increase the efficiency of crisis management - With regard to the scale and effect of the crisis - is one of the major bottlenecks in crisis management. Because It is likely that there are not enough multidisciplinary in the crisis occurrence period in the respective organizations or professional requirements, but still do not possess the necessary qualities.

The main areas of expertise are needed to address the crisis management in some way are as follows:

- Search and rescue operations
- Evaluation, assessment and preparation of relevant reports
- First Aid
- The mobile medical teams
- Evacuations
- Emergency Welfare (General Nutrition Program)
- Emergency housing and shelter (immediate tents Construction, emergency repairs of buildings)
- Providing the emergency services
- Dedicated staff of emergency operations centers
- Information Management

In this regard, it is essential to pay particular attention to the special supervision or team group or mission and in this context; necessary education should be provided by educational facilities with intended people.

2.8.5.2 Training

Trained and experienced personnel are the key component of a successful and effective crisis management and instead inexperienced and untrained personnel may cause many problems for themselves and for the people. So the issue of how to provide education and training with personnel involved in crisis management is one of the basic requirements in each country. International experience suggests that countries need to implement particular policies as to require training crisis management that those are of importance stated as follows:

- ✓ According to the local and geographical features, the countries should determine the training needs and they do it based on their own policy. The use of training programs in other countries, or the best example of scientific literatures may not have the desired result.
- ✓ Training responsibilities should be defined and explained in a clear manner in the context of government policies and anti-crisis programs.

2.8.5.3 Volume of Training Activities

One of the first essential steps for policy and educational planning is to investigate and identify the volume of training activities that are required are as follows:

- Review of the National Policy as to Crisis Management
- Review of the organizational structure in the crisis management in all related levels
- Review of all relevant programs, including ministries' programs and state agencies and also non-governmental organizations and agencies

- Review of the education requirements and public information in order to create coordination with educational programs in crisis management
- Review of the crisis management information resources in other countries (for programs comparison)

2.9 Approach to Reversible Cities

Reversibility indicates to an issue that one location is able to keep itself against huge natural disasters stable without being suffered of devastating harms and losses, reduction of productivity or life quality and being needless of others' aids outside the community. (Milet, 1999) (Trim, 2004)

Reversible City is a sustainable network of physical systems and human communities. Physical systems of a city's body that make up the arteries, bones and muscles in it. At the time of disasters, physical systems have been able to maintain its life and keep its performance against extreme stresses. If their weak level is enough high to be repaired, the damage can be very severe and reversibility process will be slow. Hence, in the absence of a reversible physical system a city would be highly vulnerable to disasters.

This strategy is aimed at further development of reversibility not only in the infrastructure but also in institutions and social and economic life of cities across the world. Comprehensive attention to the spatial organization of cities and reducing vulnerability by planners and city managers can be an effective step towards the concept of reversible city. (Thomas et al., 2005) (Perry, 2003)

2.10 Vulnerability

Vulnerability is a phrase that is applied in order to show the scope and amount damage and losses exerted likely over the communities, buildings and geographical regions caused by natural catastrophes etc. In UNESCO's definition, the environmental sensitivity against the occurrence of a natural disaster is to determine the vulnerability of the environment. More rates of environmental reaction, response and resistance to the actions of natural phenomena causes less degradation, vulnerability and magnitude of the disaster. The Vulnerability can be considered as destruction and lack of outreach and reversibility of the city aftermath the crisis. The effect of natural disaster like earthquake on the man-made environment can bring negative and wide scopes, so as all human beings' lives would be affected in a district, city and even a country in different economic, political and social dimensions etc. (Nateghallahi, 1998)

Earthquake recent experiences show that structural measures alone will not suffice to secure the city against earthquakes. The city is not just a collection of buildings, but it is a phenomenon beyond it. It is a phenomenon of human, social, cultural, economic and physical phenomenon. Physical aspect is only one facet of the city and the buildings are just a part of the physical elements of the city, therefore it cannot be solely attributed to the collection of buildings. Then providing the security with a city against the earthquake cannot look only at the concept of earthquake resistant buildings. Because this view only considers the city as a building mass while the reality is otherwise and the various elements make up the fabric of city space.

On the other hand, adoption and implementation of construction and retrofitting the buildings against earthquakes is a difficult task. And such arrangements in many cases remain only on paper and their operation is so difficult. This would be due to costly implementation of structural measures and their lack of complete enforcement guarantee. (Abdollahi, 2004)

The most important section of crisis management measures should be led to prevent the occurrence caused by natural in order to mitigate damages and vulnerabilities. If we consider the crisis management in a broader sense than operation after event occurrence (like the matters were discussed in the second chapter completely), it will be led to reduce the dangers, to get special preparation permanently and to meet necessary needs after occurrence including emergency, short-term and long-term operations. Since a comprehensive planning for a city needs enough time and abundant costs, then it is required to clarify the vulnerability rate and priority in the planning and actions in the suburban ex-occurrence. (Abdollahi, 2004)

2.11 Effective Aspects of Vulnerability in Earthquake

The effective aspects of a city can be divided into three general sections against earthquakes according to what was stated in the previous section: (Motohiko, 2004)

- Physical aspects and physical strength of the site
- Site responsiveness to the possibility of outreach after the crisis
- Possible reversibility of city after the crisis

2.11.1 Urban Texture Physical Strength

The city contains several elements that are organized through integrated planning and urban design.in general it can be said that some vulnerability criteria of a city are related to its natural bed specifications and some of them related to the artificial factors in that city.

2.11.1.1 Environmental Factors

Studies confirmed that the fault lines, soil quality and its impact on liquefaction, and slope of the region and existence of streams and rivers in the area, effect on the amount of damage caused by the earthquake in a city. Closeness to the limits with potential risk (e.g., city closeness to the faults, rivers, existing large slopes, etc.) has a major role in increasing the vulnerability of urban sites. In addition, in the discussion it should be paid attention to the existing environmental factors in a city with analysis and identification of situations in which the vulnerability potential is high due to secondary environmental effects. (Hosseini, 2009)

2.11.1.2 Physical Factors

Perhaps the physical dimensions can be perceived the most tangible dimension as to the role of urban planning and urbanization in reducing earthquake effect. Generally physical dimensions affecting on the level of vulnerability of a city in an earthquake can be divided as follows:

A. City's Structure and Site

The city's structure means the spatial distribution of elements, how to get together and combine elements and functions of the city. The Most fundamental doctrine in the city planning to reduce vulnerability is to prevent development of the city toward the lands situated in risk areas. other

examples including city physical divisions and city Uni/Multi centrality are counted as other facets of a city's structure for example, it can be said that the multi-central structure more than Uni-central one in a city is resistant against natural disasters. (Habib, Vulnerability Concepts, 1995)

Any urban fabric shows a certain resistance to the disaster. Shape, size, and how to combine the smallest components specify the overall urban fabric of a city. For example, regular fabrics are more resistant to the natural disasters than irregular one. In addition, the safety degree of discrete site in a city is more than that of continuous site against natural disasters. The more segmentation model is regular (square and rectangular) and the less obtuse angles exist, the city will be less vulnerable. (Amini, 2006)

It is necessary to mention that some factors will be a lot effective such as lot area, lot width and length appropriation related to the land use and kind of ownership (private or joint) in the vulnerability rate or site efficiency. On the other hand, the profile of structural building, buildings quality and buildings life (the useful life of the building in Iran is estimated at 30 years), the number of separate building blocks within each lot, type of construction material, the occupation surface and such information are of importance and impact the degree of vulnerability to damage and casualties in the cities and in the site and structure of a city. (Hamidi, 2006)

B. Urban Land Use

Optimal planning of urban land uses has an important role in reducing the vulnerability to natural disasters in a city. If in designing the land uses, the

neighborhoods issue has been observed very well and incompatible land uses shall not put together, rapid evacuation sites can be provided comfortably after an accident such as an earthquake. In addition, if the uses are distributed in a manner that may cause of non-concentration, it can be expected that urban vulnerability greatly will be reduced to the natural disasters. Some land uses in the city have a crucial role in the city's vulnerability to natural disasters. These uses are known as special usages and include schools, universities, hospitals, outreach centers, urban management centers, factories, fuel tanks, etc. which have been studied extensively in the previous chapters. It is evident that damage to facilities such as schools and universities due to being overcrowded, plants and fuel tanks (due to being dangerous for surrounding areas), urban management centers (due to their sensitive performance during natural disasters) are extremely important and It is necessary to locate accurately such usages extensively. (Bahrainy, Urban planning and design in a seismic-prone region (the case of Rasht in northen Iran), 1998)

C. Facilities and Infrastructures of the City

Damage to the infrastructures such as water, electricity and gas networks can increase the severity of the damage caused by the earthquake in a city. Urban gas tanks must be dispersed reasonably throughout the city. If a part of the city gas system damaged, the amount of gas leaks naturally. So, all necessary equipment should be prepared, such as gas-blocking switch, foam, Hydrant valves and other equipment for firefighting and rescue. (JICA, 2000)

Urban sites organization should be in such a way that in case of a power outage caused by an accident; it is possible to replace parallel connections. Its water supply and distribution should be controllable throughout the city and also sewage network should be controlled via a central system. City network infrastructure securization against natural disasters such as earthquakes has a major role in increasing the resistance against these disasters. The less length of the network infrastructure exists, the less they will be damaged.

2.11.2 Site Responsiveness after the Crisis and Relief Possibility

2.11.2.1 Social-Population Related Factors

Different areas work differently in times of crisis vulnerability according to the demographic-social texture living in the community. The less population density exists in one of city's regions and density has been distributed as balanced throughout the city, the less vulnerability will occur against natural disasters. high density in the population leads to an increase in the death rate of people due to falling debris and it could mean a lack of space to escape and temporary accommodation which led to the less possibility of evading dangerous situations, access to the safe places and difficult unloading the victims and the vulnerabilities will be augmented. The relation between with natural disasters traces is such that the population density has no role in the demolition severity, but it is of importance after demolition occurrence.

In robust and safe parts of the city, increase of densities responsible to any capacity in any size does not affect the level of vulnerability. Experiences show that social context residing in the area will affect the vulnerability tremendously. (Sphere, 2004)

2.11.3 Physical Factors

The city's communication network has a very critical role in vulnerabilities of a city. If a network has not exerted any major losses and then it survives, it is possible to do outreach operations and population transfer to the safe regions quickly and as a Result, mortality rate will be reduced considerably. The most important issues should be paid attention about communication network and access in a city is as follows: (Abdollahi, 2004)

- Access hierarchy
- Width, length and slope of crossings and their height Fitness with walls
- Number of intersections and distance between them
- Location of airport, stations, railway, subway lines and etc.

Urban open spaces and how they are distributed in the city has a very important role when disasters happen. in relation to the urban open space role it can be said that the most major performance of open spaces during an earthquake is to separate a region with danger potential from other sites, to prevent centralization of devastating forces, to expand the events chains and to settle the affected population. (Ghadiri, 2003) Access to services and outreach centers in the region - which have not been seriously affected by the earthquake - in the least time possible will reduce the amount of physical damage and human casualties in the event of an earthquake significantly.

2.11.4 City Reversibility

2.11.4.1 Economic Factors

Major economic sectors in the region are the economic centers in the area if an event occurs, broad effects on the local economy will be vivid and so

they should receive special attention. Hence it is necessary to carry out next pre-emptive measures; economic centers should be identified in high-risk areas before the accident. In this section, careers at risk have been identified and prevention programs can be developed to reduce the impact of disasters on the economy of families living in the area. (Partovi, 2006)

2.11.4.2 Social Factors

City Social reversibility is due to the local culture and traditions (including the experience of adaptation with past crisis), political and social organizations and NGOs. The more urban resident's participation and social involvement will result more ability for a city to return to normal situation after a crisis. Moreover, resident immigrants and literacy rates are important things that need to be examined in this context. (Partovi, 2006)

2.12 Analytic Hierarchy Process (AHP)

In The science of decision making in which the choice of one solution among the solutions or solutions prioritization is important, during several years decision-making methods with multiple criteria "MADM" have opened wide their place in engineering systems. Of these methods, analytic hierarchy process (AHP) has been used more than other methods in management science. AHP is one of the most versatile decision-making techniques that it was first developed by Thomas Saati in the 1970s. AHP reflect the natural behavior and human thought. This technique is the study of complex problems based on their mutual effects and converts them to a simple form and solves them.

AHP can be used when faced with competing multiple-choice or multi-criteria decision making. The criteria can be considered quantitatively and qualitatively. This decision making method is based on latent paired comparisons. The decision-maker begins providing a hierarchical tree. The decision hierarchical tree shows the comparable factors and evaluates the competing alternatives in a decision then a series of paired comparisons is carried out. The comparisons show the weight of each factor toward competing alternatives to evaluate in a decision. Finally the hierarchical analysis process logic integrates matrices of pair wise comparisons together in a way to make a better decision.

2.12.1 Principles of AHP

The founder of this method has reported the following four principles as principles of AHP and founded all calculations, laws and regulations based on the principles. The principles include: (Ghodsipour, 2003)

- ✓ Reverse conditions:

If preference of A to B is equal to “n”, then preference of B to A is equal to “1/n”.

- ✓ Principle of homogeneity:

Element A should be homogeneous and comparable with B. In the other word, preference of A to B cannot be infinite or zero.

- ✓ Dependence:

Each hierarchy element can be related to its own superior level element and the dependence can be continued up to the highest level linearly.

- ✓ Expectations:

Whenever a change occurs in the hierarchical structure, the evaluation process should be performed again.

2.12.2 AHP Model for Earthquake Crisis Management

Application of this method requires the following four basic steps:

2.12.2.1 Modeling

At this stage, decisions Problem and aim are Hierarchical from decision elements which are connected together. Design elements include “decision criteria” and “decision alternative” AHP requires to break a problem via multiple levels in the hierarchy of levels. The high level indicates the main goal of decision-making process. The second is to represent the major fundamental factors which may be broken down into more detailed sub-indices in the next level and the last also offers options for decision. Figure 2.2 has shown the hierarchical structure of a decision problem. (Mehregan, 2005) In this diagram, there is a hierarchy of four levels consists goals, criteria, sub criteria and alternatives.

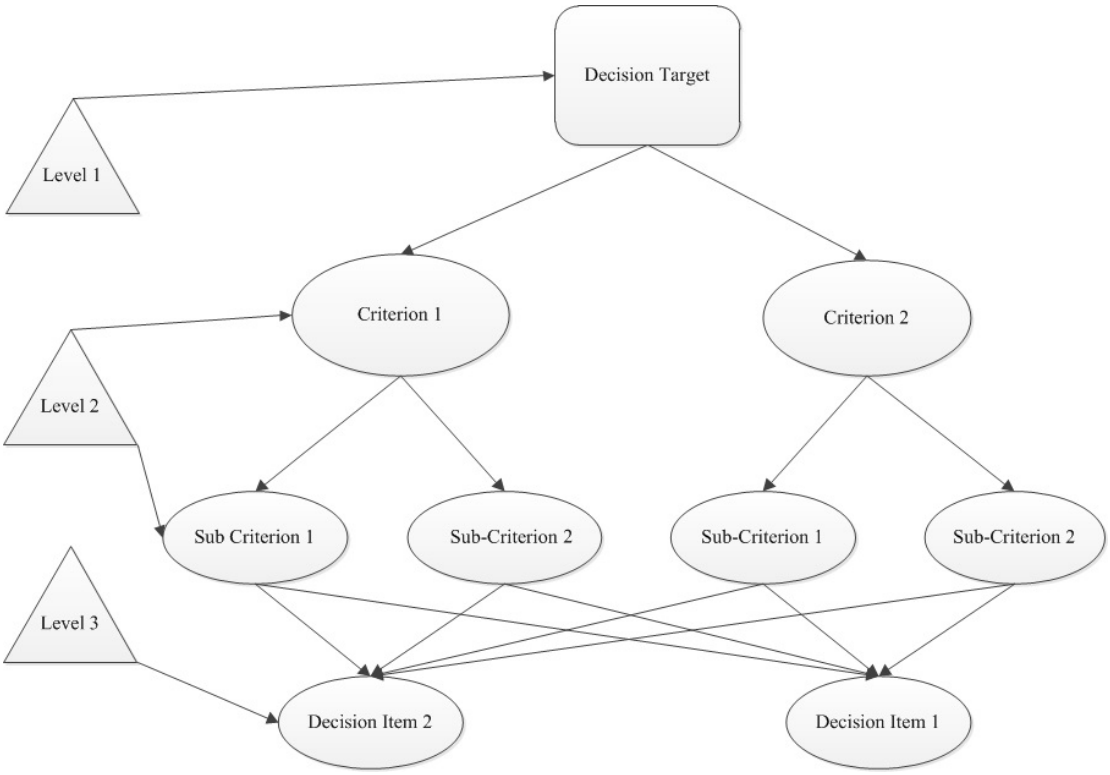

Figure 2.2: A decision hierarchy illustration

Converting the issue and considered problem into a hierarchical structure is the most important part of analytic hierarchy process because in this part analyzing complex and difficult issues, the process explains them simply to be consistent with the human's mind and nature. In other words the hierarchical process converts the complicated issues in to a simple form analyzing them in the detailed elements and connection is the main goal of an issue with the lowest level of hierarchy. In order to explain AHP used in the study, 3 different steps of crisis have been clear include pre, during and post crisis as intended options to choose an optimal step of the crisis management; which is fully describe in chapter 3.

2.12.2.2 Calculating the Coefficient of Criteria and Sub-criteria Priority to Determine the Preference Severity in the Paired Comparison

Performing comparisons between different decision options is made on the basis of judgment about the importance of each decision via paired

comparisons. After designing the hierarchy of decision, decision maker should be able to measure a series of matrixes that evaluate the numerical importance or priority of indexes together and it provides each decision option compared to other options according to the criteria. This trend is done with pair wise comparisons between elements of decisions (Binary comparison) and assigning numerical scores which indicate the priority or importance between the decision elements. (Stein & Norita, 2009)

To do this, usually comparison of alternatives is used with indices “i” proportion to options or indices “j” which the valuation of indices as compared with together has been shown in Table 2.1. (Ghodsipour, 2003)

Table 2.1: Preference intensity Evaluation by binary comparison relatively between criterions in AHP

Preference Intensity	Comparison status of "i" relative to "j"	Description
1	**Equally preferred**	**Item i has equal priority with "j" or there is no preference.**
3	**Moderately preferred**	**Item "i" is slightly more important than "j".**
5	**Strongly preferred**	**Item "i" is important than "j".**
7	**Very strongly preferred**	**Item "i" is more important than "j".**
9	**Extremely preferred**	**Item "i" is absolutely important than "j" and is not comparable to "j".**
10	**Especial importance**	**Item "i" is absolutely more important than "j" and has very special importance.**
2, 4, 6 and 8	**Median preference**	**Show the median values over preferred values. For example 8 express greater importance over 7 and less than 9 for "i" in compare to "j".**

Pairwise comparisons are recorded in a matrix "n*n" and the matrix is called binary comparison of criteria A = $[a_{ij}]$ n*n. All elements of this matrix are positive and calculated according to the reverse principle in the analytic hierarchy process. [If the importance of element "i" compared to "j" was equal to "k", the importance of element "j" compared to "i" would be equal to 1/k. (Saaty, 1998)] Since determination of importance degree and prioritization of indices is an important issue; also all calculations about AHP are performed based on pair wise comparisons; it is a reasonable manner to determine the importance degree and prioritizations of indices according to experts in different urban fields. Therefore in this section a

questionnaire designed to gather importance of each urban criterion based on engineering experience and using the credible resources.

2.12.2.3 Local Priority Calculations

The geometric mean is used because it is more accurate to calculate the criterion index (local priority). In this method to calculate the coefficient of criteria at first the geometric mean in the rows of matrix A was obtained and then normalized, and were. As it can be seen in Table 4.12) in chapter 4, sum of the coefficients of multiple criteria is equal to 1 and it is an indication of the relative importance of the criteria.

2.12.2.4 Integration of Local Priority Weights

Determination of decision alternatives weight via set of numerical calculations relative together is the next step in AHP to do necessary calculations for determination of preference of each decision elements using pair wise comparisons matrixes. Mathematical operations are summarized in the following steps.

Sum numbers for each column is calculated of pairwise comparisons matrix, then each element of the column is divided by the sum of the numbers in the column. A new matrix is obtained in this way, is called “normalized comparison matrix”. Then the average numbers in each row is calculated from the normalized comparison matrix. This mean relative weight provides decision elements with matrix rows. The final score of alternatives will be achieved by combining the weights.

In other words the relative weight each element should be multiplied by high weight elements to get the final weight in order to rank the decision options.

By doing this step for each option, the final score will be calculated according to the following equation. (Stein & Norita, 2009)

The final score (preference) of criterion “j”:

$$pr. = \sum_{k=1}^{n} \sum_{i=1}^{m} W_k W_i(g_{ij})$$

In which $\mathbf{W_k}$ is a preference coefficient of the criterion $\mathbf{W_i}$, “k” is the preference coefficient of sub-criterion “i” and $\mathbf{g_{ij}}$ is criterion score related to sub-criterion “i”.

Nearly all calculations as to AHP are performed based on the primary judgment of decision maker in the form of pair wise comparisons matrixes and it removes all incompatibilities and errors in the comparison and determination of the importance between options and indices of final results obtained from calculations.

2.12.3 Consistency in Judgments

Nearly all calculations as to AHP are performed based on the primary judgment of decision maker in the form of pair wise comparisons matrixes and it removes all incompatibilities and errors in the comparison and determination of the importance between options and indices of final results obtained from calculations.

Inconsistency rate (IR), which is presented in the following calculation method, it is a device that determines the consistency and show how it can be trusted to priorities made of comparisons. For example, if option A is important than B (preference value of 5) and B is relatively more important

(preference value of 3), then we should expect that A to C ratio is very important (preference value of 7 or higher) or if preference value of A relative to B is 2, and B relative to C, 3. Then the present value of the preferred value of A relative to C is 4. Perhaps the Comparison of two options is probably something simple at first, but when the number of comparisons increases, the consistency could not be trustable and we should achieve the trust using inconsistency rate. Experience has shown that if the inconsistency rate is less than 0.10, the consistency will be reasonable otherwise should be revised. It is worth noting that in the model described above, the inconsistency rate is also equal to 0.07, and it indicates that the data are consistent.

In general, the following steps are used to compute the inconsistency rate:

- Step 1) Calculating the weighted sum vector

Matrix has multiplies the Pairwise comparisons by the column vector "local priority" and a new vector that is obtained in this way is called the Weighted Sum Vector (WSV).

- Step 2) Calculating the inconsistency vector

The elements of weighted sum vector are divided by relative priority vector and the result is Inconsistency Vector (IV).

- Step 3) Obtaining λ_{max}

Mean of inconsistency vector elements gives the value of λ_{max}.

- Step 4) Calculating the inconsistency index

Inconsistency Index is defined as follows:

$$C.I. = \frac{\lambda_{max} - n}{n - 1}$$

In this equation, “n” is the number of options in the problem.

- Step 5) Calculation of inconsistency ratio or incompatibility test

A mechanism which has been determined to consider the consistency in the analyses is calculating inconsistency ratio (CR) obtained from dividing inconsistency index divided by random index as following:

$$C.R. = \frac{C.I.}{I.I.R.}$$

If this ratio is less than or equal to 0.1, the consistency is accepted in judgments. Otherwise it should be reconsidered in judgment. (Mehregan, 2005) It should be noted that the random index is derived based on the Table 2.2.

Table 2.2: Determination the random index (criteria)

N	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
RI	**0**	**0**	**0.58**	**0.9**	**1.12**	**1.24**	**1.32**	**1.41**	**1.45**	**1.51**

Chapter 3

CRISIS MANAGEMENT METHODOLOGY AND VULNERABILITY ASSESSMENT MODEL

3.1 Introduction

In methodology chapter at first, tried to describe and find principles of crisis management planning to make it applicable. Basic requirements to deal with the crisis have been mentioned. Afterwards different criteria of vulnerability have been established to make a proper model to assess risks.

3.2 Research Methodology

Besides many sciences introduced in order to reduce injuries and deaths from the earthquake, knowledge of urban planning can be effective in this regard. Crisis management is done in three stages: pre-crisis, during crisis and post-crisis. The vulnerability assessment in phase of pre-crisis has to identify the failures and to prioritize the planning and resource allocation. It's very important issues in reducing injuries after disasters occurrence. The important thing is that there is a fundamental difference between the two concepts of risk probability and vulnerability against the natural hazards. In fact, the vulnerability is beyond taking a risk or hazard zonation and comes from the synthesis of various information layers. The Vulnerability can be considered the sum of three factors: physical strength of site, lack of relief possibility and reversibility of city after crisis. There are several methods to

evaluate multiple-criteria and multi-variable for this purpose, among which we can mention the Analytical Hierarchy Process Model (AHP).

In this study, it is attempted to assess the vulnerability of 19 urban districts of Qazvin defining the criteria and using AHP. Therefore, after a thorough study of the geographical location of the city of Qazvin and then classifying and identifying the most important criteria in order to manage the crisis before the earthquake in the hierarchical analysis, using this method has been attempted in analyzing the vulnerability of Qazvin; thereby it can divide 19 districts of Qazvin urban areas into the highest and lowest levels of vulnerability and The next steps are proposed in order to manage the crisis in the region.

So at first using methods and library studies have shown how the exact identification of crisis and extant risks in a city (with old and deteriorated site) like Qazvin can help to reduce the abundant damage caused by contingent earthquake. Therefore, the most important principles and basics of crisis management and related standards originally have been studied thoroughly. And then the crisis management procedures have been described to deal with natural disasters such as earthquakes as fully descriptive and library studies. Following the multi-criteria ranking or clustering method in the evaluation and management of the earthquake crisis i.e. the method of AHP has been presented and the procedure fully has been trained and moreover, how to use this method in the crisis management projects has been studied. Finally, it has been tried to asses and manages the crisis caused

by the earthquake in different areas of the city, using the method with a case study in the context of the city of Qazvin.

In this part of defining methodology of crisis management approach, first of all policy making should be define, different sections and definitions. National policymaking in fact consists of all organizational different levels and national systems and it should cover the highest state systematic through the lowest level. After that in understanding the available options as essential elements of a national policymaking to manage the crisis, it is better to review the crisis management cycle because it considers all of cycles of crisis management as a key element in the policymaking. Different parts of the crisis management cycle are comprised of prevention, effects reduction, preparation, relief, recovery and development. Also basic requirements to deal with the crisis and planning to achieve a comprehensive system of crisis management have been mentioned. At the rest, steps of crisis planning and the planning model to deal with the crisis caused by the earthquake are completely described.

3.3 Planning to Achieve a Comprehensive System of Crisis Management

Undoubtedly intense earthquakes will have a lot of failures in addition to the primary killings because of a lot of destructions and being ruined of many people - add the severity of the incident. Earthquake is a natural event and we should be prepared to deal with the related risks and be proactive in constructions, as well as prevention programs. One of the first steps in crisis management planning is to have a coherent and effective program.

Planning is considered as the basis for management and in the crisis management cycle it is the main process. With proper planning, we can access to the organization objectives and executive areas in the process of crisis management using the maximum power and minimum wastage of resources.

Urban and operational planning is the key to successful crisis management plan, provided that the plan is within the framework of the Strategic Plan of Crisis Management and it is planned to determine the necessary management and micro-managements, policy implementation, and ultimately actions needed to achieve a coherent system of organization.

According to the executive policies and in the crisis management strategic plan, design of a documented preparedness scheme against the earthquake should be provided that includes the following three steps: (Aysan & Davis, 2004)

- First stage: introduction to various planning steps
- Second stage: plan design
- Third stage: plan Implementation

Different and detailed data of city and its vulnerability is necessary for the success of a comprehensive urban and preparedness program. Meanwhile, the city administration’s commitment to prevention and preparedness is also important; perhaps a very thorough and comprehensive plan - with no legal backing and support from state and municipal authorities - has no efficiency. In this respect it should be noted that the education or training is the

complementary of preparedness plan especially in cities and continuing education as well. The supplementary case for this plan includes public education for the public and individuals.

But it should be said that a comprehensive and effective program has been designed based on detailed studies of the status and potential seismicity and if possible, it will also include warning and notification systems. In this section three stages are referred to the preparation plan.

3.4 Steps to Crisis Planning

3.4.1 First Step: Introduction to Different Stages of the Plan

We can use a ten-step list below to obtain a documented plan for preparedness and management. In Step 1 a logical category presented in the list, although these steps are not necessary to be followed according to the above sequence, but the experience has shown that removal of one of the stages makes it difficult to plan at the time provision. These steps include:

- Arousing attention to the quake in the zone
- Determination of the economic and political restrictions in the city.
- Setting a City Council committee.
- Review of vulnerability and assessing the different city zones risk
- Vulnerability assessment and risk assessment of different areas.
- Review of existing urban programs and support activities in emergency urban situation
- Building some key assumptions concerning the city
- Accepting the goals and needs
- Setting some Working Committees

- Providing an organizational chart
- Division of labor and task allocation

As mentioned in the above list to them each of these factors will have a substantial role to provide a final plan. For example, if the authorities do not support the necessity and favorable legitimacy of the law to run the program, they will fail to do planning successfully. City officials, on the other hand, should - before any action - investigate the economic and political conditions in the region and have a prepared report.

Economic and political conditions may have a direct impact on the comprehensive plan or even prevent it and this important point must be considered. Setting of The city council committee or the council of city crisis is one of the most basic steps. It should be formed predominantly by the highest authority in town. The committee is mostly made up of senior managers and heads of security forces in the city. According to the formation of City Disaster Council, reviewing the organization and identifying the organs involved and effective in the city - it could have a role in supporting preparedness plan - should be done by the Council. In this respect, the study is to evaluate seismic vulnerability and risk assessment which is important in several areas of the city that should be evaluated and calculated by officials.

After that, a key point is the key assumptions and scenarios prepared for earthquakes of city and its performance against possible earthquakes. For example, we can mention the assumptions of secondary crisis such as fires,

earthquakes or flooding after a dam failure. These hypotheses help remarkably to actualize a business plan and to estimate the prerequisite requirements.

With regard to the above, the objectives intended to be considered by the Committee. These objectives should cover all stages of earthquake mitigation, preparedness, responsibility and recovery in the form of a comprehensive crisis management system. The goals should be included all organs and ultimately - in terms of resources - be coordinated with other efforts and programs in other parts of the country and certain provinces.

At this stage, the committee existence is necessary to determine the exact process and to prepare detailed specifications. Then according to the general plan, an organizational chart is prepared for preparedness and crisis management and eventually tasks are determined in terms of codified planning and organization.

3.4.2 Second Step: Plan Design

This step is to design a final plan and to develop it programmatically to coordinate the plan with city needs we can use the following to achieve this important point:

- Planning Committee setting
- Review of the required content and previous works
- Phasing and timing the plans
- Determination of required actions
- Review of job description and services

- Preparation of program content and implementation recommendations
- Providing the above conditions is needed to prepare action plan. This is begun first with the planning committee. At this point, an elected Chairman and members of the planning committee are appointed based on their experiences and organ functions. It is very important that prior to the preparation of plans all committee members have a common understanding of the various materials which are formed by the coordination group. It is very important and necessary to review the contents of the previous proposals.

Here it is necessary that all members of the planning committee should be aware of the vulnerability analysis and assessment results of seismic risk. If there is not a common understanding of risk and the extent of its meaning, the Committee would not be able to provide effective programs.

The plan Timing and phasing is the next action that specifies the process of plan. It is necessary to ascertain the activities in terms of time at different stages of the crisis plan. Frequently 4 stages of the crisis are defined as follows:

- Before the crisis, including short-term and long-term preparedness
- Onset of the crisis, including rapid and emergency measures
- During the crisis, including rapid responsibility, rescue and outreach
- After the crisis, including the improvement, reconstruction and redevelopment

For each step, actions and description of the services should be specific. This should be considered by urban planners to the desired program. This type of activity is often different for different regions. Therefore, it is recommended that given the vulnerability identification and detailed understanding of the city or region, these activities are reviewed constantly to include all the items required in four stages of crisis. In Review of the activities and responsibilities required, it is necessary to note the following points carefully:

Review the activities and responsibilities required at the time of the determination; it is necessary to note the following points carefully:

- ✓ What actions should be done?
- ✓ When the activity is completed?
- ✓ Who has the responsibility to do this work?
- ✓ What is the relationship between a responsible person and the other authorities?
- ✓ What is the next action required?

Given the above mentioned points in this part, the content and recommendations prepared by the Planning Committee should be provided with a full description of activities formally. Providing a micro-management and organizational charts will be very useful in the design template as provided as well. The Return of the committee is a final plan in a form of a multi-year program. It and positive evidence will be used later as a long-term guidance for preparedness and effects reduction and activities necessary for during and after the crisis.

3.4.3 Third Step: Plan Implementation

The third part of the comprehensive plan to reduce and manage the earthquake is related to its effective implementation. This step should always be seen as a continuous and long term process. To achieve an effective implementation of preparedness plan, we can note the following:

- Phasing and accepting the multi-year plan for achieving the project goals
- Assigning the powers and responsibilities to the individuals involved in the plan
- Emphasizing on the education, training and practice
- Continuous monitoring the plan implementation

Because some or many proposals are required to be included in multi-year research plans in the management processes to reduce the effects caused by the earthquake and Crisis Management, so it should be recognized that achieving a complete design is not accessible in a short time. Plans of Earthquake preparedness and mitigation of adverse effects often requires a multi-year and exact planning that the authorities should pay special attention to this important task.

In this regard, continuation of the city authorities' sensitivity should be considered. The next and important matter in the process of research and practices certainly will be legal powers assignment. Perhaps, if for determining the vulnerability of municipal bridges, the preparation and study of their maps are inaccessible to the reading devices, the discretion in this regard must be given to the government authorities before implementing the

plan of preparedness and mitigation of the earthquakes effects by creating some effective rules. Table 3.1 shows all the items mentioned in 3 stages of planning and provision of earthquake preparedness plan as summary.

3.5 Planning Model to Deal with Crisis Caused by an Earthquake

A Suitable model in Programming for dealing with the crisis caused by the earthquake in a city generally is included in the following four steps: (Drabek & Hoetmer, 2009)

- Determining the overall purpose and of tackling operational objectives
- Understanding the current state for Responsible organizations
- Understanding the organizational and environmental obstacles and assistance to cope
- Determining the necessary measures and operational goals

Table 3.1: Different theoretical step of planning for comprehensive preparation and management plan of earthquake

First Step	Second Step	Third Step
Introducing different steps of planning	**Designing the program**	**Implementing the program**
• Provoking and awareness of authorities about the dangers of earthquake in region. • Specify economics and political limits in the city • Forming the committee of city council • Review current program of the city and backup programs • Estimation of damageability and evaluating earthquake dangers • Creating basics hypothesizes about city and earthquake in it • Accepting goals and necessities • Establish goals and necessities • Establish working committees • Creating organizational chart • Dividing workload and assigning responsibilities	• Establish planning committee • Review necessary studies and previous works • Staging and timing the plan • Specifying activity and necessary action • Review the explanation of responsibilities and services, providing plan specification and execution recommendations	• Divide the plan into steps and accepting long time planning • Designating authorities and necessary responsibilities to people in charge in the plan • Emphasizing the need for education and training • Constant control and monitoring on plan execution

In determination of overall goals to achieve the desired goals, four fundamental issues should always be considered. First, the city should be given of immunity against the risks posed by earthquakes that this includes the peripheral immunity against damaging elements that originated from the agents vulnerable to earthquakes. Second, the control of existing status after

earthquake, for example it can be pointed to the healthy measures that lead to prevention of physical and mental damages and death or providing the life facilities for the injured and secondary vulnerabilities. Then the issue of security in the community and organizing social and economic status of the survivors should be considered. And finally, we have to pay especial attention to create the appropriate fields for the post-crisis phase, which are included improvement, rehabilitation, expansion and work creation and production.

The next step is to identify the current status of the organizations responsible for the seismic problems in all critical processes. Here, all organizations must be identified and available resources should be distributed to them in order to properly enjoy in the time required.

In The process of determining the appropriate model, environmental aids and barrier issues have also contributed in to planning. Environmental and organizational - to cope with - should be paid attention and explored in two categories a) Deleteriousness and b) vulnerabilities and the aids titled as struggle facilities and finally in the model the necessary measures should be determined to achieve the goals. And in each case, method, time and location of the work and the person, performing department or agency and the necessary resources should be anticipated.

Measures that are designed to achieve the goals should have maximum flexibility to cope with possible events and situations that may arise. Therefore, it is recommended that cities have to attempt to cater different

scenarios and find all possible positions by these scenarios and plan for them.

In general the required actions to get the pre-determined goals should have an urban management plan with a suitable model in the work schedule and for every operation. It clarifies the necessary micro-activities and gives the programs to city's officials formally. Tables (3-2) and (3-3) provides an overview of some of the measures in relation to the pattern of urban planning.

Table 3.2: Pre-specified theoretical management actions in a city to provide immunity

Immunity type	**Establish immunity against earthquake dangers during the earthquake**
	Actions
Soul	**Getaway people from places, evacuate dangerous regions and refuge to safe places and regions, first aid to injured people.**
Control vulnerability and causing factors	**Cut the electricity, water and gas in affected regions and central places, determine unsafe structures, take away all unstructured objects from the region and start cleanup.**

Table 3.3: Management actions to control spread of crisis hazards

Control Type	**Control domain of crisis**
	Actions
Preventing physical and mental damages and dying	**Search, rescue injured, first aid, evacuate injured, partition injured among medical centers, remedy and take care of injured, social support.**
Providing healthcare of survivors	**Emergency feeding the survivors, building WC for public use, taking care of corpses, social support, disinfection the region, public vaccination against epidemic illnesses, distribute healthcare stuff, distribute medicine.**

Provide the minimum life facilities for survivors	**Emergency shelter, providing foods and general needs, provide basic life stuff, provide healthy water and emergency electricity**
Preventing physical and social harms of aftershocks	**Public announcement, control harmful factors, decrease the crisis time, displacement of people in emergency case, control and monitor the time during the crisis, move the damaged structural and not-structural objects from region**
Providing safety in society	**Protecting the damaged region, set emergency rules for the region, protecting soul's property, quick punishment for criminals, fight with criminals.**
Organizing dead bodies situation and resuscitation of survivors	**Recognition and identifying dead, survivors and injured people, public announcement, collecting and uniting people and survivors of a family.**
Provide development needs after the crisis	**Careful evaluation of crisis, public announcement, improvement, retrofitting and reconstruction, development and going back to normal state, review current plans, revise current plans, social support and creating jobs.**

3.6 The Process of Planning to Achieve a Comprehensive Crisis Management Plan

As it was stated, for reaching a comprehensive crisis management system, firstly we should identify the crisis management cycle exactly and then make policy for different stages of this planning cycle. Various phases of crisis management cycle include the preparation, responsibility, outreach, reconstruction, and finally improvement. Each of these steps is divided into different micro-activities and completes the main steps above. (Coppola, 2011) In addition, it should be noted that each of the activities relates to a period of time. Thus, the time stages should be considered for before the crisis, onset of the crisis, during the crisis and after the crisis. The chart of

different time steps is shown in Figure 3.1. In addition, micro-activities and actions needed are given for each step in Table 3.4.

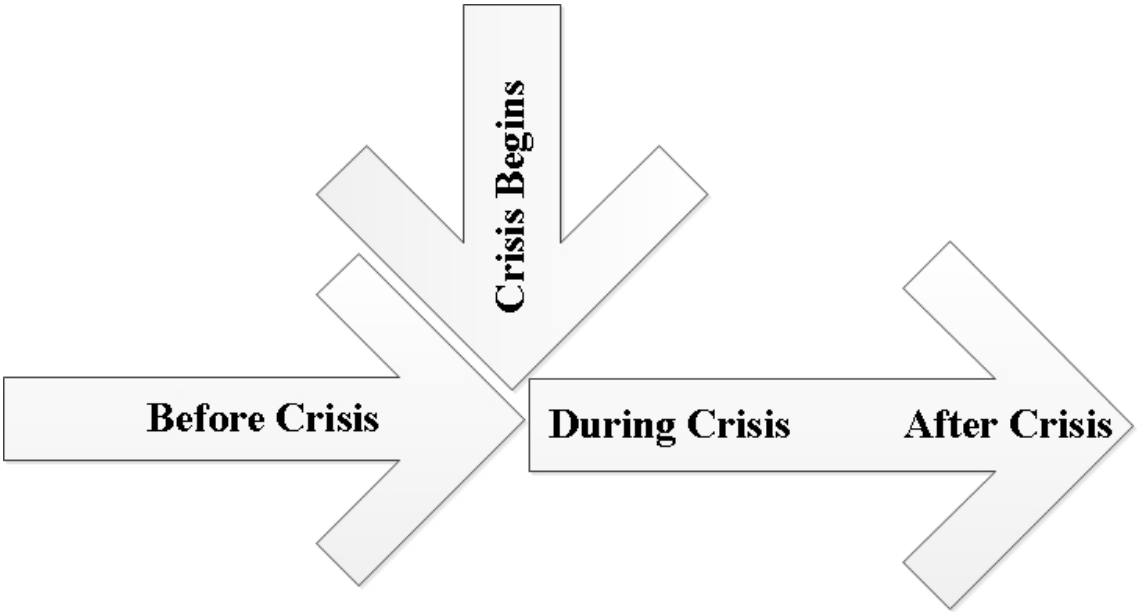

Figure 3.1: Figure of different timing stages of crisis

As it has been shown in the table 3.4, the pre-crisis actions are those via which the citizen, officials and public become aware of the crisis onset during a concise program. And generally from the perspective of the operational program, it is commonly a very important and significant time. Perhaps at this stage it is possible to reduce attention during times of crisis. During the crisis phase, activities and micro-activities are done, hoping to reduce the scope of the crisis to an acceptable level.

Then after the crisis is a long-term process of restoring the situation to a normal. Of course we have to mention that this step has been faced with a lot of serious problems for a long time. And always life, economic and psychological bothers this step. However, after a suitable period of time, the situation is led to the initial state and the cycle is ready to deal with another

crisis. Review and evaluation of policies, laws and management plans are important at this stage of the crisis management process and the ability to control the effects of future crisis. Those countries that do not use the optimal stage almost are the same countries that don't possess any success in a sustainable development in no time and via the next earthquake, economy and community power will be lost and they are always in a cycle of sustainable development.

Table 3.4: Management activities in different stages in crisis management lifecycle

Stage of Crisis	Activities and Actions
Pre Crisis	• Legislation and following laws • Planning • Approximation, evaluation of earthquake potential • Approximation and estimate danger • Prevention • Vulnerability determination and decrease effects • Being prepared • Raising alarms and warnings • Research and study

Beginning of Crisis **During Crisis**	• Announcement and warning • Preliminary evaluation of incident size and dimension • Mobilization • Rescue and search • Rescue and first aid • Activate crisis management plan • Activate of confronting plan officially • Search, help and rescue • Living facilities • Healthcare facilities and observation • Region health condition, injured and survivors • Evacuating people from unsafe regions to safe zones • Exact evaluation of crisis • Announcement
Post Crisis	• Retrofitting and establishing emergency services again • Reconstruction • Create temporary shelter • Demolition of unsafe places and cleanup damaged places • Healthcare • Establishment normal status • Social support • Evaluating and reviewing rules and regulations and crisis management plans • Development • Research and study

Another important issue to achieve an appropriate organizational structure - to manage the crisis in the country or city - is to pay a particular attention to the special organizational characteristics of the crisis management:

- ✓ The structure should not simulate and create an organizational system of crisis management and a state administration system again.
- ✓ The system should not act independently of the government.
- ✓ The system should not control public agencies and institutions.
- ✓ The system cannot operate outside of the Charter or description of services regulated by the government, except in a very special circumstances and emergencies.

Therefore, given the proper structure of a crisis management plan - taking into account the different stages of the crisis - the definition and management activities are needed to achieve the crisis management micro-plan. It is offered fully in the next section.

3.7 Model Development to Assess Vulnerability of Urban Areas in Earthquake Crisis

It is not only confined to a single building. As previously stated, the most important crisis management measures should be led to damage reduction and vulnerabilities in getting preparedness and prevention of crisis caused by natural disaster. Preparation against the events is dependent to recognition of vulnerabilities and planning priorities in a city. given that the city is a big whole and an integrated system, then analysis of vulnerabilities and securisation should be zonational and in the urban texture in order to reduce

the effects stemmed from an earthquake in a city and it should not only limited to a building.

In this section, vulnerability analysis of the urban textures in Qazvin has been introduced in the frame of 19 urban districts and based on 3 main criteria; 1.Qazvin physical resistance, 2.Texture responsiveness after crisis and outreach possibility and 3.City reversibility after crisis and 20 sub-criteria in the following sections have been studied and evaluated (using Analytical Hierarchy Process, AHP) that the procedure was assessed accurately in the previous sections and an example of crisis management were analyzed using this method.

3.7.1 Evaluation Criteria and Indicators Used to Assess the Vulnerability of Qazvin's Urban Texture

In general to achieve the expected results in Qazvin urban vulnerability assessment 3 principles have been considered in the selection of criteria:

- First principle: any criteria covering a particular aspect of the concept of urban texture vulnerability against earthquakes.
- Second principle: the criteria have taken into account - as far as possible - all cases affecting vulnerable urban textures.
- Third principle: the criteria have been chosen so as they are measurable and their statistics and information are existed and can be used.

3.7.1.1 Physical Resistance Criterion of the Qazvin City

- Average area slope:

The greater slope of the area, the greater the degree of vulnerability of the area.

- Distance Reverse of faults from the region:

Closeness to the fault in a region will play an important role in increasing the vulnerability of the area.

- Average distance Reverse of industrial, chemical, nuclear areas:

Industrial, chemical and nuclear centers have played a major role in creating secondary hazards after an earthquake. The greater a distance from the center, the more vulnerability of the area will be reduced.

- Distance Reverse of region from the river and watercourse:

The watercourse and rivers have an important role on the vulnerability rate of the region due to secondary dangers after an earthquake. The more distance of area from the phenomenon, the less vulnerability in the area.

- For repair and destruction buildings area in the region:

More occupied area for repair and destruction buildings in the region causes more vulnerable region.

- Lots less than 200 square meters in the region:

More finely considered region and lots area is less than 200 square meters, the more vulnerability of the intended texture.

- Average number of units in buildings of the region:

Increasing the number of units in buildings due to the increasing number of families living in the building as well as increasing the likelihood of the impossibility of escape from the building, it will increase the amount of potential losses in the event of falling debris.

- Average number of floors:

Increasing the number of floors and height of the building, the probability of blockage of its adjacent crossing will be more due to falling debris (on average one-third the height of the building collapsed on the crossing) and also the mortality rate increases due to increasing population residing in the building.

- Especial land uses area in the region:

The area of fuel storage tanks, industrial and workshop centers, and storages containing flammable materials, schools and universities is calculated to obtain the special land uses. The applications due to being dangerous or existence of a massive crowd inside these will increase the vulnerability after the earthquake.

3.7.1.2 The Texture Responsiveness Criterion after the Crisis and Relief Possibility

- Population density in the region:

The lower population density in the region means the fewer amounts of casualties caused by falling debris and the more possibility of escape from dangerous situations.

- Vulnerable populations in the region:

To vulnerable populations in the region is total population over 65 years (elderly), population under 10 years (children) and the number of disabled people living in the region?

- Sex ratio reverse:

Women are more vulnerable during natural disasters than men. In a region if the sex ratio is much higher (men are more than women in the region) the less vulnerability of the region.

- Length of crossings with less than 6 meters in width in the region:

Possible escape from dangerous situations and outreach effect on the vulnerability tremendously. The greater the width of the street, the more possibility of the Stunt street network and outreach and thus it will decrease the vulnerability.

- Organic texture surface of the region:

The possibility in the chess access and outreach would be far more than organic textures with the maze of narrow streets. Therefore, increased levels of organic textures in the region the vulnerability of the region will increase.

- Reverse access to outreach services in the region:

The amount of outreach applications reduces significantly the rate of vulnerability. Area of hospitals, clinics and large regional fire stations is considered to calculate this indicator. However, it should be noted that before the earthquake the applications should be retrofitted (during the crisis), the harm to the uses won't increase the catastrophe.

- Reverse area of open spaces with an area over 500 square meters in the region:

Open spaces is an area with green spaces, public buildings and schools, courtyard with over 500 square meters. The higher open spaces area in the region is equal to less vulnerable region.

3.7.1.3 Reversibility Criterion after the Crisis

- Area of major activity centers in the region:

Economic centers when damaged in times of crisis leave widespread effects on the local economy. More area of this land use means the vulnerability of the region is much more. Therefore, it should be special attention to these regions to revitalize the city

- Employment rate in the region:

In this section jobs at risk are identified. The more employment rate is the region, the more vulnerability of the region.

- Immigrants settled in the region:

Often increase of the number of immigrants residing in a region effects on the social and economic level of the region. As previously stated, more number of immigrants from the city dwelling in a region causes the little number of the regions' vulnerability.

- Illiterate population in the region:

Literate population will often be better prepared to deal with natural disasters. The more illiterate population in the region is equal to more vulnerability.

It should be noted that in evaluations conducted in an analytic hierarchy process it is essential that all criteria and sub criteria should be consistent. Sub-criteria of fault distance from the region, the average distance of industrial, chemical and nuclear centers from the region, distance from the river and watercourse areas, sex ratio, area of open space over 500 square meters in the region and access to outreach services are not aligned with other sub-criteria. So in order to align the sub criteria in this study, the reverse of these criteria has been studied.

Chapter 4

CASE STUDY (QAZVIN CITY) DATA COLLECTION AND ANALYSIS

4.1 Introduction

In this section, first of all general data about Qazvin city are brought. It is continued with urban texture, socio-economic, population density and building condition of the city. In addition trend of gathering data by designing a questionnaire is described. At the end, method of process data in an analytical hierarchy in order to evaluate vulnerability and other management abilities was introduced then the results have shown.

4.2 Generalities

Qazvin is recognized as a major city, according to the criteria and definitions of urban planning and sociology. In addition, the city is close to Tehran and it has a particular political, social and cultural position. It can be used as a resource area in a national disaster. Over the past 1,300 years, it has traveled a long journey of development from a small village to a major city. The development has caused the emergence of a lot of facilities for the citizens but its uncontrolled growth has led to some heterogeneous sites in the city and finally it has transferred various vulnerabilities into the city. On the other hand this city had many earthquake experiences and as a historic texture it can be a model for other states in the region.

The city is much more vulnerable against natural disasters such as earthquake due to its geographical situation and being located between Alborz range of mountains and existence of floodways and rivers inside the city on the one hand and being placed on the abundant faults. One of the other hand cases that cause the intensive vulnerability of different sites of the city is existence of old and uneven sites in the city's core which have been built next to each other as aggregated. The houses are not mostly resistant and do not conform to technical standards against earthquakes. Another problem with these sites is limited access, which makes it difficult for the citizens to get the relief aids after the occurrence of natural disasters like earthquakes, and can cause a human tragedy in critical condition.

4.3 Geographical Location of the Study Area

Qazvin Township is the center of Qazvin province; it is the largest township in Qazvin province in terms of area and population. The city is situated on the southern slopes of the Alborz Mountains, part of the Iranian Plateau and on the route from Tehran to Rasht, Hamedan and Zanjan. It is shown separately in Figure 4.1 entire area of Qazvin province as well as Figures 4.2 show 3 regions of municipality and 19 districts of the Qazvin city.

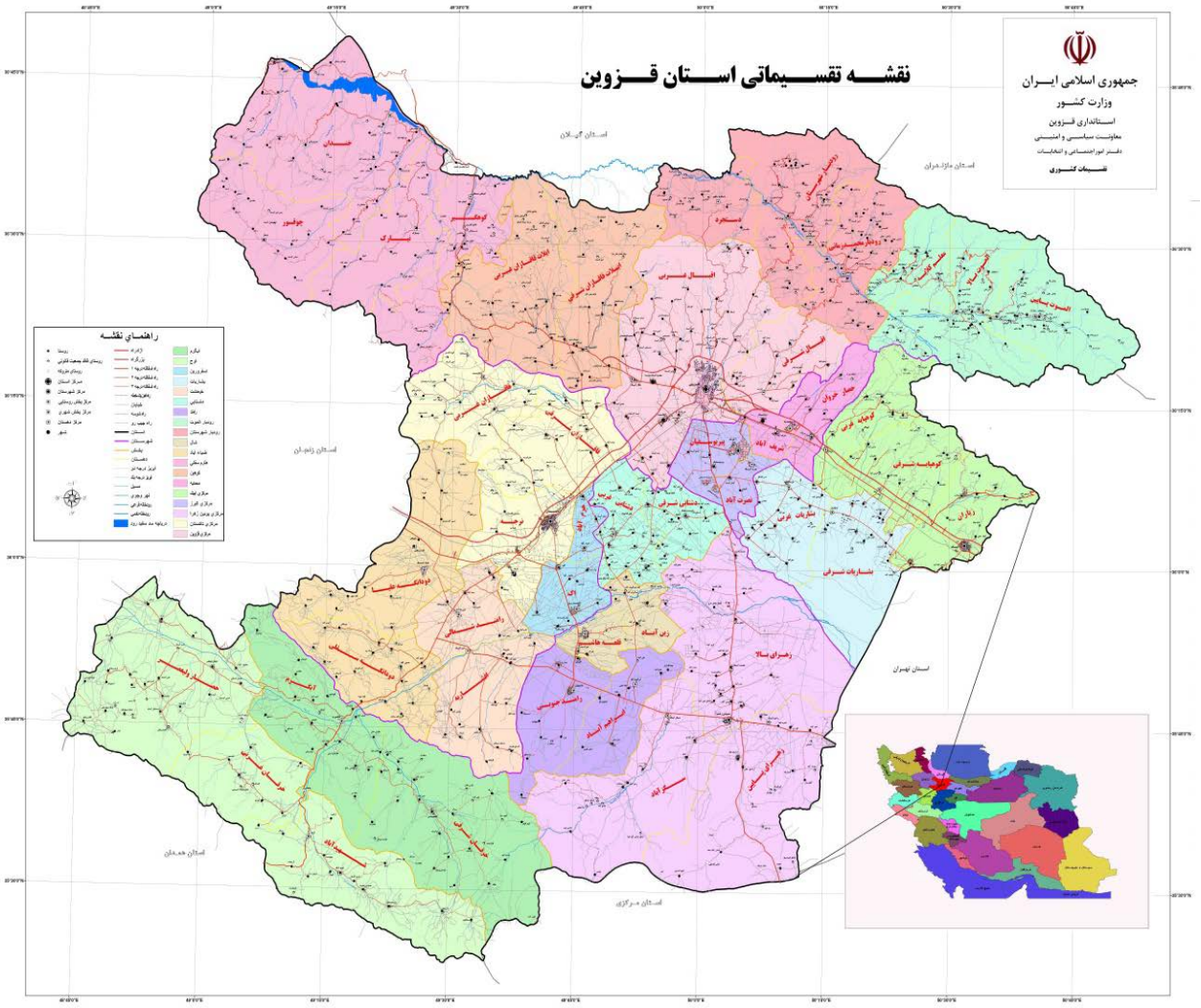

Figure 4.1: Map of Qazvin province divisions (Comprehensive Plan of Qazvin, 2010)

Figure 4.2: Trilogy regions of Municipality and 19 study districts of Qazvin (Comprehensive Plan of Qazvin, 2010)

Geographical coordinates of the city are 49.58.22 to 50.01.38 degree eastern longitude and 36.14.20 to 32.20.00 northern latitude. The study area (Qazvin city) leads to Zanjan Ring Road from north and Railway Station from South.

This area is about 55 square kilometers. In Downtown, the city of Qazvin height is 1298 meters above sea level and given the topography position of the city, public land sloping is from north to south and less than 1%. The city is the lack of slope in the east-west direction and surface water comes in through the main North-South and East-West channels. In the old part of the city, with an area of approximately 44 hectares, there are historical and

cultural collections. In Figure 4.3 land-slope map of Qazvin province is shown.

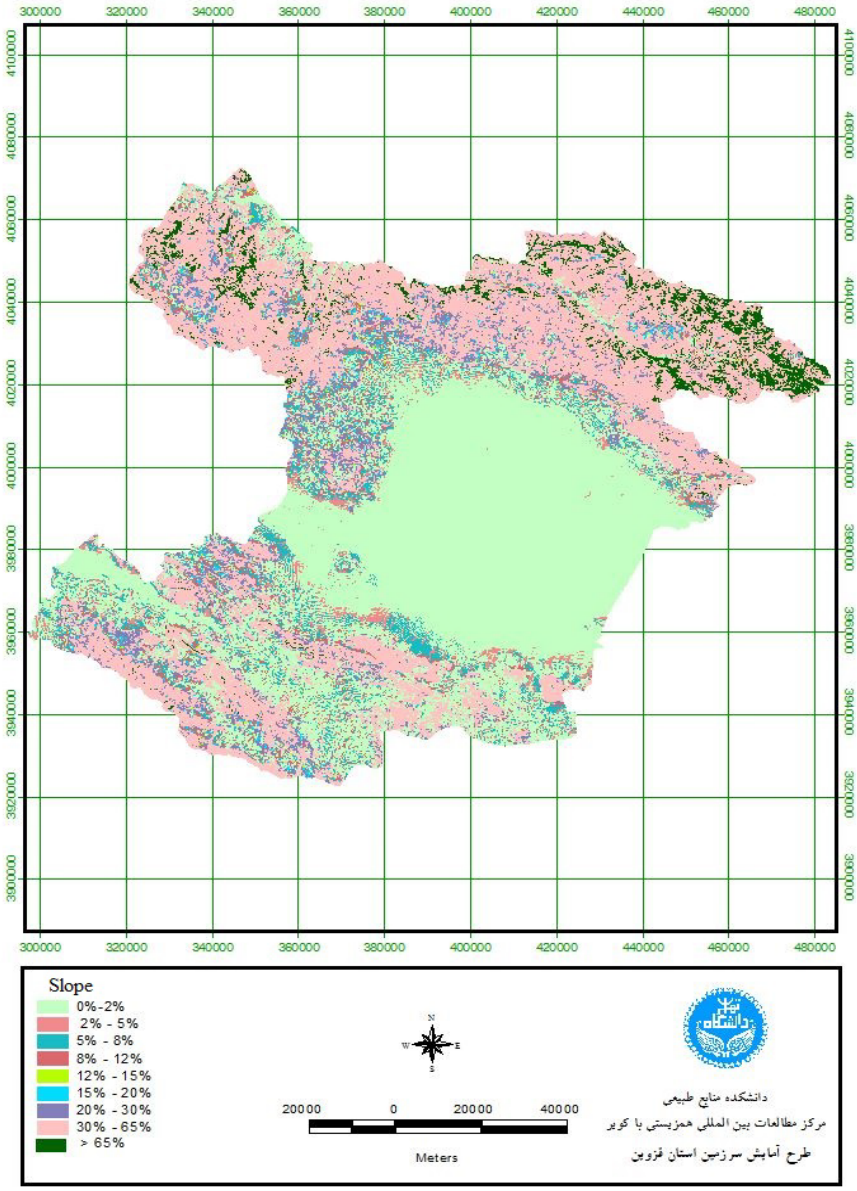

Figure 4.3: Land Slope map of Qazvin (Spatial Planning of Qazvin Province, 2010)

4.4 The Social Ecology of the City of Qazvin

According to the studies done in the site of city and taking economic, social and cultural characteristics in to account, the city can be segregated into four distinct areas:

A. Southern and central region
B. Eastern and North Eastern Region
C. Western and North Western Region
D. North of the city

A. Southern and central region

1. Heartland (downtown)

This place has formed the city's economic center and controls the region's economy from the distant past. It is a distributor of goods and services in the city and province. The core is located between the streets Molavi and Imam Khomeini. The Major features of the area include:

- ✓ High volume levels of clients to meet the individual needs during the afternoon and evening, and a relatively high traffic in the area
- ✓ Narrow and tall buildings, shrines and mosques, In addition, old warehouses and baths of the city are also located in this area
- ✓ Focus of the cultural and entertainment venues (theaters and cinemas) in this area
- ✓ Population density is high in this part of the city during the day and decreases at night
- ✓ Markets and caravanserais are concentrated in this area and were considered as the economic and commercial center from the distant past

The most changes in the central part view are the construction of new streets, mostly luxury shops located around the city streets.

2. Southern Region

It is a Southern limit of the area and the western part of the city and has the following features:

Dominant livelihood in this area relies on income from labor in industries, farms, fields and gardens around city.

- ✓ This area is located in the extremely low levels in terms of material kind and form.
- ✓ Reduction of building the infrastructure along the narrow and winding streets, it has made difficult to establish services and urban facilities. This especially in view of outreach after the earthquake is very important.
- ✓ This is the location of rural migrants and the lowest social strata.

B. Eastern and North Eastern Region

The Characteristics of this area include:

- ✓ This is a location of the best buildings in the city both in terms of design, materials and building height and type of services.
- ✓ There is a highest land value in comparison to other metropolitan areas.
- ✓ The region's population density is low because of the loss of family.
- ✓ Most organizations are located in this area, including the governor's office, governorship, municipality etc.
- ✓ Due to the urban convenience and amenities as well as having better weather than other areas of the city, this area is the settlement location of the upper strata of society and their activities.

C. Western and north western region

Features in this area include:

- ✓ There are problematic areas in this part of city frequented such as Hadi-abad that are not considered to be acceptable due to its construction in the present study.
- ✓ Focus on the bottom social groups in the area of the city due to cheaper land and rent
- ✓ High population
- ✓ Low average per capita in urban residential area
- ✓ Limited facilities and amenities in the residential part of the city have resulted in lower value, and is a factor to attract low-income people
- ✓ Promoting the social anomalous phenomena such as crime, drugs, corruption, profligacy, alcoholism and etc.

D. Northern city of Qazvin

This area is very new compared to other urban areas, primarily urban standards have been implemented and Minoodar City is the perfect example. In general, the social site is identified by the middle working class community in north of Qazvin. Above average of infrastructure level is often represents the cheap land on the one side and their being biased toward Housing and Urban Development Goals on the other side.

The most important factors determining the location of human settlements in the city of Qazvin are as follows:

- ✓ Quality of climate and appropriate weather
- ✓ Ability and economic status of the areas' residents

- ✓ Social and cultural residents' base
- ✓ Kind of job
- ✓ Variety of leisure facilities
- ✓ Easy access and road development
- ✓ The gardens and urban spaces

4.5 Surveying the Properties of Qazvin Region in Terms of Population and Building Conditions

4.5.1 Region One

This area leads to the streets of Abuali-Sina and Ayatollah Taleghani Ave from north and Railway Station from south. Zone A with total area of approximately 76,980 hectares is comprised of historic buildings and business centers and in some cases administrative buildings (which in the study of historic buildings are not included) and due to the special significance of cultural heritage, their vulnerability case assessment has been conducted. Based on triangulation, the area is divided into 15 districts and Residential area in the district is 29,224 hectares which is per capita residential infrastructure for 23.5 m^2. Population based on statistics 2001 is estimated about 110,000.

The results obtained from statistics have shown that the residential density in the areas and the locals varies 80.4% to 119% and the average building density is 85.2% in this region.

In general 13% of the buildings are average less than 10 years old and 43% is between “10” to “20” and remaining 46% is more than 20 years old.

4.5.2 Region Two

This is the area between the Moalem Street from north and the streets of Abuali-Sina and Ayatollah Taleghani Boulevard from south. The region has a total area of approximately 1078.46 acres, which is divided into 17 zones based on district division. The residential area is 352.52 acres, which per capita residential infrastructure available is equal to 20 square meters. Population based on 2001 statistics has been estimated 120,000 peoples.

The results show that structural density in the neighborhoods and areas in the region is 81% to 127.7% variable. And average building density in this area is 101%.

Generally, 40.7% of the buildings in this area are less than 10 years old and 46.5% between “10” to “20” and 15.8% have more than 20 years old. (Comprehensive Plan of Qazvin, 2010) (Spatial Planning of Qazvin Province, 2010)

4.5.3 Region Three

This is the area between the Qazvin-Zanjan freeway from north and Moalem Boulevard from south. Region three has 10 districts and the total area is about 2933.4 acres. The inhabited area is 159.12 acres and per capita residential infrastructure available is 16.39 m^2. Population based on 2001 statistics has been estimated as 90049 peoples.

4.6 Geology of Geotechnical Characteristics and Seismicity in Qazvin

4.6.1 Geology of Qazvin

In terms of the geo-status, Qazvin range can be divided into three sub-units:

- ✓ Mountainous area
- ✓ Foothills area
- ✓ North subsidence zone of Central Iran (Qazvin plain)

According to the above, more specifically the city of Qazvin geological conditions are as follows:

Qazvin in the northern part has topography and in the southern part has almost flat and uniform topography. Topography lines are in the southern-central city of Qazvin has almost a directly east-west process. In terms of Division of geological conditions, the northern parts of the range are located on the foothills northern zone and the southern parts on the foothills of the southern zone. The highest part of the city is located in the north with 1370 meters and its lowest part in the south less than 1277 meters lower than sea level. Therefore, the maximum difference in the height is about 93 meters. General slope of the land is to the south and is on average equal to 1%. Moving from the north to the south in this area, slopes will be reduced, which is a characteristic of an alluvial fan zone, in Qazvin region.

In the past, most floods and rivers that entering sediments caused by erosion from the northern region of Qazvin area, there were rivers Amir-Abad, Barajin and a few other small floods which are now the only river Amir-

Abad crossing from Qazvin and continues its rout. Sedimentary cover in the northern plains - which is a unit of the foothills - are sandy, gravely and cobble stone and in the South - which is part of the Qazvin plain - is from clay and silt and. in Figure 4.4 is shown the map of altitude classifications within the Qazvin plain.

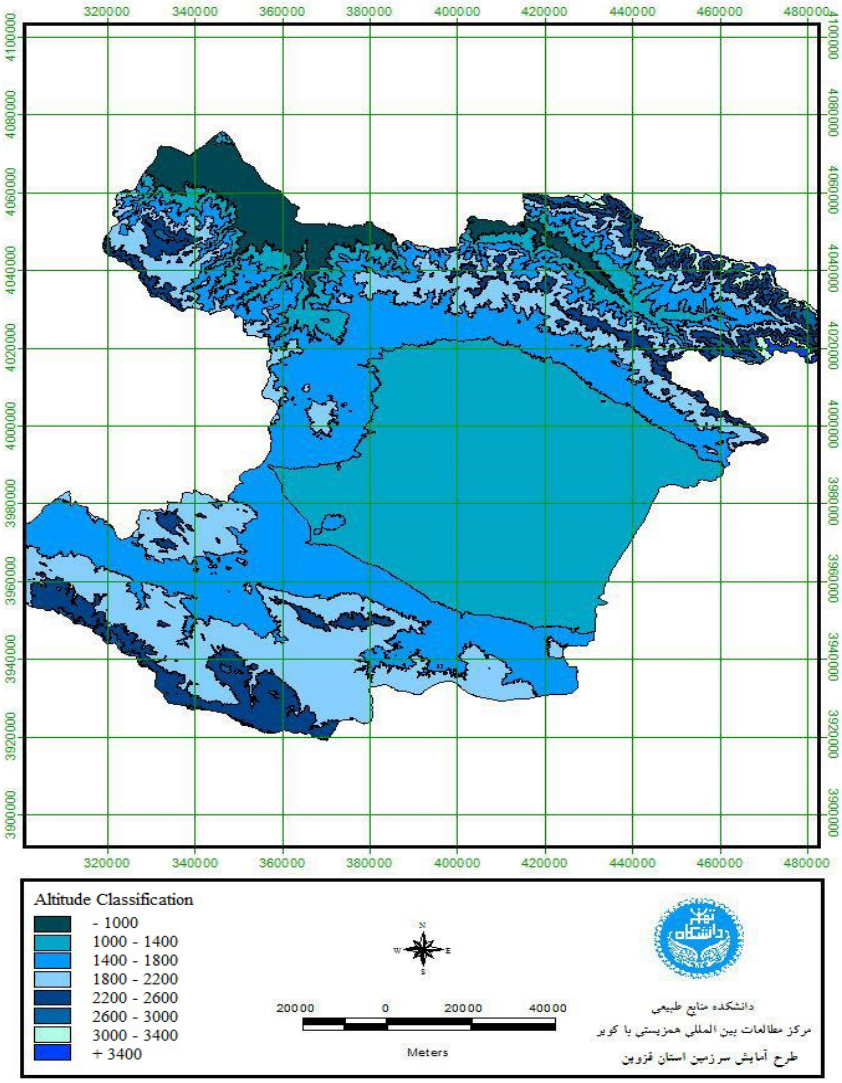

Figure 4.4: Altitude classification map of Qazvin (Spatial Planning of Qazvin Province, 2010)

4.6.2 Underground Water Situation of Qazvin Range

In general, in the Qazvin Plain, groundwater depth is around 60 meters range to less than 2 meters in the central plain. Based on co-depth lines map scaled

1:100,000 of groundwater, the curve pass 50 meters through Qazvin. The Depth of the groundwater level is lower toward the center of the Qazvin plain that reaches to 2 meters in the central plain.

Due to the specific morphology conditions and terrain, different areas within the city of Qazvin have a different situation in terms of groundwater aquifers. Based on studies have been conducted in the city of Qazvin using borehole data and field observations In the northern city due to the high conglomerate layer of Hezar Darre with low permeability in some parts (due to clay lenses in the low depths) it is composed of small local aquifers. It was felt in some parts of town, including the Phase II Janbazan, Mahdiyeh and Minoodar perfectly. So that the depth of groundwater levels in these areas varies from 1.5 m to 4 m.

In addition to small aquifers which are seen more in the northern Qazvin, there is a main aquifer in the city of Qazvin that is counted a section of Qazvin plain aquifer.

Based on 1:100,000 scale maps of underground water depth, and log of deep wells drilled within the limits of the city of Qazvin; Underground water depth is varies in different parts of the range. For example, the depth of groundwater in the street Heydari is 60 meters, 57 meters in Boulevard Falakeh (round about), 55 m on the south side of Oloom-pezeshki, 55 m Vali-Asr 50 m in vegetables center, 47 m in Qazvin slaughterhouse, 43 m in glass Factory, 43 m in the airport, 35 m in south of the railway near the village of Jamal Abad. In region 1 in the northern plains, alluvial sediments

are coarse -type with higher permeability. Infiltrated waters flow easily and move to the south. But in the south sections because of fine grains and low permeability of alluvial, the flow is slow and the level of ground water is high and the groundwater table is a free table. It is worth noting that confined groundwater aquifers have been observed in some areas.

4.6.3 Seismicity at Qazvin Range

One of the basic data to evaluate the risk of earthquake and introduction to seismicity history of a region is to survey the past earthquakes in the region. During the past history various earthquakes have occurred in Qazvin caused by one of seismic faults. Table 4.1 has provided few details of some earthquakes occurred in the range of Qazvin.

In the terms of structure, the study area is the part of the southern slopes of the Alborz. Major regional geological structures and tectonic forces are affected by the main structures of the Alborz. There are various faults from the city center with high seismicity power in a radius 65 kilometers which the name and specifications of some of them have been mentioned in Tables 4.2 and 4.3. The role of work and seismic fault lines in the scope of Qazvin is illustrated in Figure 4.5.

Table 4.1: Specification of some great earthquake happened in Qazvin area

Earthquake year (A.C.)	Magnitude of earthquake according to Richter scale	Level of damage
864	**5.2**	**Happened in Rey and sensed strongly in Qazvin.**
958	**7.7**	**Happened in Taleghan and sensed up to almost 400 KM from the zero point of the earthquake**

1119	**6.5**	**Happened in Qazvin city, killed many and caused great destruction**
1226	**7.2**	**Happened in the region between Ray to Qazvin, destroyed this region and killed many souls**
1608	**7.6**	**Destroyed the area of Alamoot and Taleghan**
1808	**5.9**	**Destroyed the whole west arena of Mazandaran and Taleghan and also some buildings in Qazvin City**
1901	**5.4**	**Happened in Qazvin Region**
1962	**7.2**	**Destroyed the Boein-Zahra region in the south-side of Qazvin**
1990	**7.7**	**It shook a vast area in the west part of Alborz and caused full destruction of Roodbar, Manjil, Loshan and about 300 villages**

4.6.3.1 Major and Seismic faults

These groups are young faults found with a length of over 10 km wide in the alluvial plain of Qazvin. The faults are seismic and dangerous.

4.6.3.2 Middle Faults

This section of the fault has length from 2 to 10 km, and is not seismic in it. However, this group may be able to have a slip and displacement caused by large earthquakes.

Table 4.2: Medium faults in Qazvin city area

No.	Fault	Length (km)	Fault direction
1	Najm abad	6	E-W
2	Akbar abad	5	E-W

Table 4.3: Some seismic faults in Qazvin city area

No.	Fault name	Fault length (km)	Fault direction	Fault distance from the center of Qazvin city (km)	Location	Size	Horizontal acceleration
1	Qazvin North fault	60	E-W	10	North	7.2	0.350 g
2	Abyek	85	E-W	62	South	7.4	0.168 g
3		63	E-W	62	South	7.3	0.171 g
4	Gheshlagh	33	WNS-ESE	33	South-East	6.9	0.243 g
5	Taleghan	60	E-W	50	South-East	7.2	0.203 g
6		62	WNW-ESE	55	North	7.3	0.198 g
7	Shahroud	60	NW-SE	31	North	7.2	0.327 g
8	Sotroom	55	NW-SE	35	North-East	7.2	0.293 g
9	Masha	200	E-W	62	South-East	7.6	0.281 g

4.6.3.3 Velocity of Bed Rock in Qazvin

The seismic motion of the bed rock in Qazvin is in the range of modeling, based on seismic studies Barbariaan et al (1992) in this model - for a 50 and 100 year return period - the bedrock velocity of Qazvin is 0.22 g and 0.28 g respectively. It seems that these values are much lower than its true value. At risk zonation map of earthquakes in Iran, the study area is in relatively high risk and bylaws of buildings design against earthquakes (Iran seismic standard 2800) has suggested the velocity 0.25 g as the velocity of the design basis. Figure 4.5 has shown Qazvin's earthquake’s hazard zoning map and a range of Qazvin plain is divided into five regions with high earthquake to low earthquake risks.

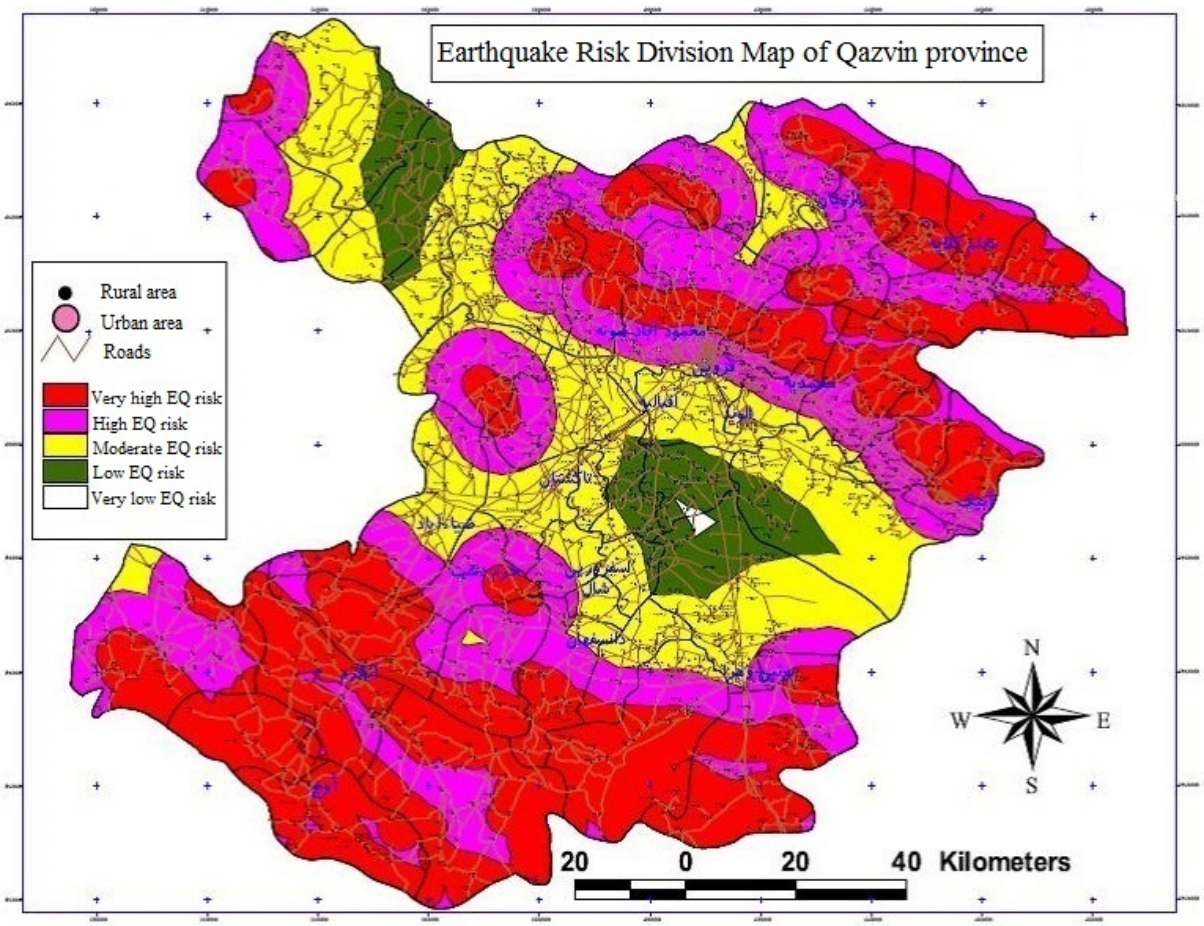

Figure 4.5: Earthquake hazard zoning map in Qazvin province

4.7 Data Collection

Collecting data in this study contains two parts as row data and a questionnaire survey. Row data is a group of numbers about different aspects of the case study conditions (Qazvin city) like people, urban construction and other city properties. This information is categorized under 20 sub criteria and it has taken from Tehran Disaster Mitigation and Management Organization (TDMMO) which is derived from Population and Housing Census (2012) statistics, The Comprehensive Plan of Qazvin (2010) and Spatial Planning of Qazvin Province (2010). As a glance maximum and minimum numbers are illustrated in Table 4.4. The process of designing the questionnaire is described below.

Table 4.4: Vulnerability sub-criteria data

Criteria	Minimum	Maximum
Population density in the region	**16.99431 (region 17)**	**264.0121 (region 12)**
Immigrants settled in the area	**94 (region 1)**	**10285 (region 19)**
Illiterate population in the region	**117 (region 17)**	**4852 (region 12)**
Vulnerable populations in the region	**311 (region 17)**	**11335 (region 19)**
Reverse of Sex ratio	**0.113992 (region 17)**	**1.126783 (region 10)**
Sidewalk length with less than 6 meters in width in the region	**236.89 (region 17)**	**52280.51 (region 2)**
Area of old and Repairable buildings in the region	**0.7166 (region 19)**	**54.93 (region 2)**
Building segments less than 200 square meters in the region	**135 (region 11)**	**4156 (region 12)**
Average number of units in the building of the region	**1.18 (region 14)**	**4.2 (region 19)**
Reverse no. area of open spaces with an area over 500 square meters in the region	**0.0000007 (region 19)**	**0.0000502 (region 4)**
Especial land uses area in the region	**133.66 (region 4)**	**164679.41 (region 9)**
Organic texture surface of the region	**Without organic texture region (regions 9, 11, 13, 1615, 19)**	**1307842.55 (region 18)**
The average number of floors	**1.18 (region 14)**	**2.86 (region 19)**
Reverse no. of access to relief services in the region	**Without service (regions 1, 2, 5, 147)**	**0.02359 (region 13)**
Area of major activity centers in the region	**821.87 (region 17)**	**1891177.54 (region 14)**
Employment rate in the region	**525 (region 18)**	**7328 (region 4)**

Average area slope	**0.52 (region 16)**	**2.3 (region 18)**
Reverse no. distance to faults from the region	**0.0000727 (region 8)**	**0.0001580 (region 19)**
Reverse no. average distance to industrial, chemical, nuclear areas	**0.00009 (region 7)**	**0.00033 (region 9)**
Reverse no. region distance to the river and watercourse	**0.000772368 (region 9)**	**0.015994882 (region 12)**

4.7.1 Questionnaire Survey

To apply hierarchical analyze a binary comparison between criteria is needed. As mentioned before, a questionnaire was designed to distribute through a group of construction and related industries experts. Then the level of importance of 20 vulnerability sub-criteria was derived; where sub-criteria were evaluated as the result of model development in third chapter. This questionnaire distributed to a group of consulting and contractor engineers, project managers, urban facilities managers, university masters and some municipality related experts.

The total number of questionnaire form was 50, and 35 forms were returned. The number 70 percent of filled forms is acceptable. Some information about participants is brought as follows. In the Table 4.5 age range of participants are shown. Table 4.6 is about work experience by year and Table 4.7 shows the level of academic education about participants in this questionnaire survey.

Table 4.5: Participants age distribution

Age range (year)	25-34	35-44	45-54	55 and more
No.	8	9	13	5

Table 4.6: Participants work experience distribution

Work experience (year)	6 and less	6-12	12-18	18-24	24 and more
No.	2	6	9	10	8

Table 4.7: Participants academic education distribution

Academic education	Bachelor	Master of science	Ph.D.	Post doctorate
No.	8	13	11	3

Below there are the tables which illustrate result of the questionnaire survey by the degree of importance for each three main criteria as; Qazvin physical strength in Table 4.8, responsiveness of urban texture after the crisis and the possibility of relief in Table 4.9 and Qazvin reversibility criterion after the crisis in Table 4.10 have been shown. In other words, each sub-criterion is attributed to the severity of the initial preference for paired comparisons in the next step.

Table 4.8: Questionnaire survey result - Importance level of sub-criteria of physical resistance of Qazvin city

	No.	Sub criteria	Not importance	Very low importance	Partly not importance	Low importance	Below avg. importance	Average importance	Above avg. importance	Partly High importance	High importance	Very high importance	Special importance
Physical resistance criteria of the Qazvin city	1	Average area slope (A)	0	1	**2**	3	4	5	6	7	8	9	10
	2	(Reverse no.) Distance to faults from the region (B)	0	1	2	3	4	5	**6**	7	8	9	10
	3	(Reverse no.) Average distance to industrial, chemical, nuclear areas (C)	0	1	2	3	4	**5**	6	7	8	9	10
	4	(Reverse no.) Region distance to river and watercourse (D)	0	1	2	3	4	5	6	**7**	8	9	10
	5	Area of old and Repairable buildings in the region (E)	0	1	2	3	**4**	5	6	7	8	9	10
	6	Building segments less than 200 square meters in the region (F)	0	**1**	2	3	4	5	6	7	8	9	10
	7	Average number of units in the buildings of the region (G)	0	1	2	**3**	4	5	6	7	8	9	10
	8	The average number of floors (H)	0	1	**2**	3	4	5	6	7	8	9	10
	9	Especial land uses area in the region (I)	0	1	2	3	4	5	6	7	**8**	9	10

Table 4.9: Questionnaire survey result - Importance level of sub criteria of urban texture responsiveness after the crisis and relief possibility

The texture responsiveness after the crisis and relief possibility	No.	Sub criteria	Not importance	Very low importance	Partly not importance	Low importance	Below avg. importance	Average importance	Above avg. importance	Partly High importance	High importance	Very high importance	Special importance
	1	Population density in the region (J)	0	1	2	3	4	5	6	7	**8**	9	10
	2	Vulnerable populations in the region (K)	0	1	2	3	4	5	6	7	8	**9**	10
	3	(Reverse no.) Sex ratio (L)	0	1	2	**3**	4	5	6	7	8	9	10
	4	Sidewalk length with less than 6 meters in width in the region (M)	0	**1**	2	3	4	5	6	7	8	9	10
	5	Organic texture surface of the region (N)	0	1	**2**	3	4	5	6	7	8	9	10
	6	(Reverse no.) Access to relief services in the region (O)	0	1	2	3	4	5	6	7	8	9	**10**
	7	(Reverse no.) Area of open spaces with an area over 500 square meters in the region (P)	0	1	**2**	3	4	5	6	7	8	9	10

Table 4.10: Questionnaire survey result - Importance level of sub criteria of reversibility after the crisis

Reversibility criteria after the crisis	No	Sub criteria	Not importance	Very low importance	Partly not importance	Low importance	Below avg. importance	Average importance	Above avg. importance	Partly High importance	High importance	Very high importance	Special importance
	1	Area of major activity centers in the region (Q)	0	1	2	3	4	5	6	**7**	8	9	10
	2	Employment rate in the region (R)	0	1	2	3	4	**5**	6	7	8	9	10
	3	Immigrants settled in the region (S)	0	1	2	**3**	4	5	6	7	8	9	10
	4	Illiterate population in the region (T)	0	1	2	3	**4**	5	6	7	8	9	10

A sample of questionnaire is mentioned in appendixes. It is worth to note that in the next sections of the study; the vulnerability of 19 urban districts of Qazvin is evaluated using Analytical Hierarchy Process (AHP).

4.8 Applying AHP Model for Earthquake Crisis Management

The three main steps of application of this method will be showed in the following:

4.8.1 Modeling

In this section in order to explain AHP used in the study, 3 different steps of crisis have been clear include pre, during and post crisis as intended options to choose an optimal step of the crisis management. Also the optimal step is

selected based on four criteria 1.Management and decision making, 2.Implementation and operation, 3.Monitoring and 4.Support.

Accordingly, management and decision-making criteria is divided into four sub-criteria; 1.1.Planning and develop a framework, 1.2.Establish a unified command, 1.3.Determination a trustee (leader) for each activity, 1.4.Determination of credits, funding and resources allocation.

Furthermore, implementation and operations are classified into three sub-criteria; 2.1.Use of human resources, 2.2.Use of equipment, 2.3.Increased coverage.

The monitoring criteria are divided into three sub-criteria; 3.1.Monitoring the costs, 3.2.Monitoring the Human Resources (HR) and equipment and 3.3.Quality monitoring. And finally support criteria are also divided into three sub-criteria; 4.1.Enhancing coordination, 4.2.Safety promotion and 4.3.Being equipped with suitable facilities and appropriate distribution among various organs.

It should be noted that the hierarchical process diagram has been shown as detailed in Figure 4.6.

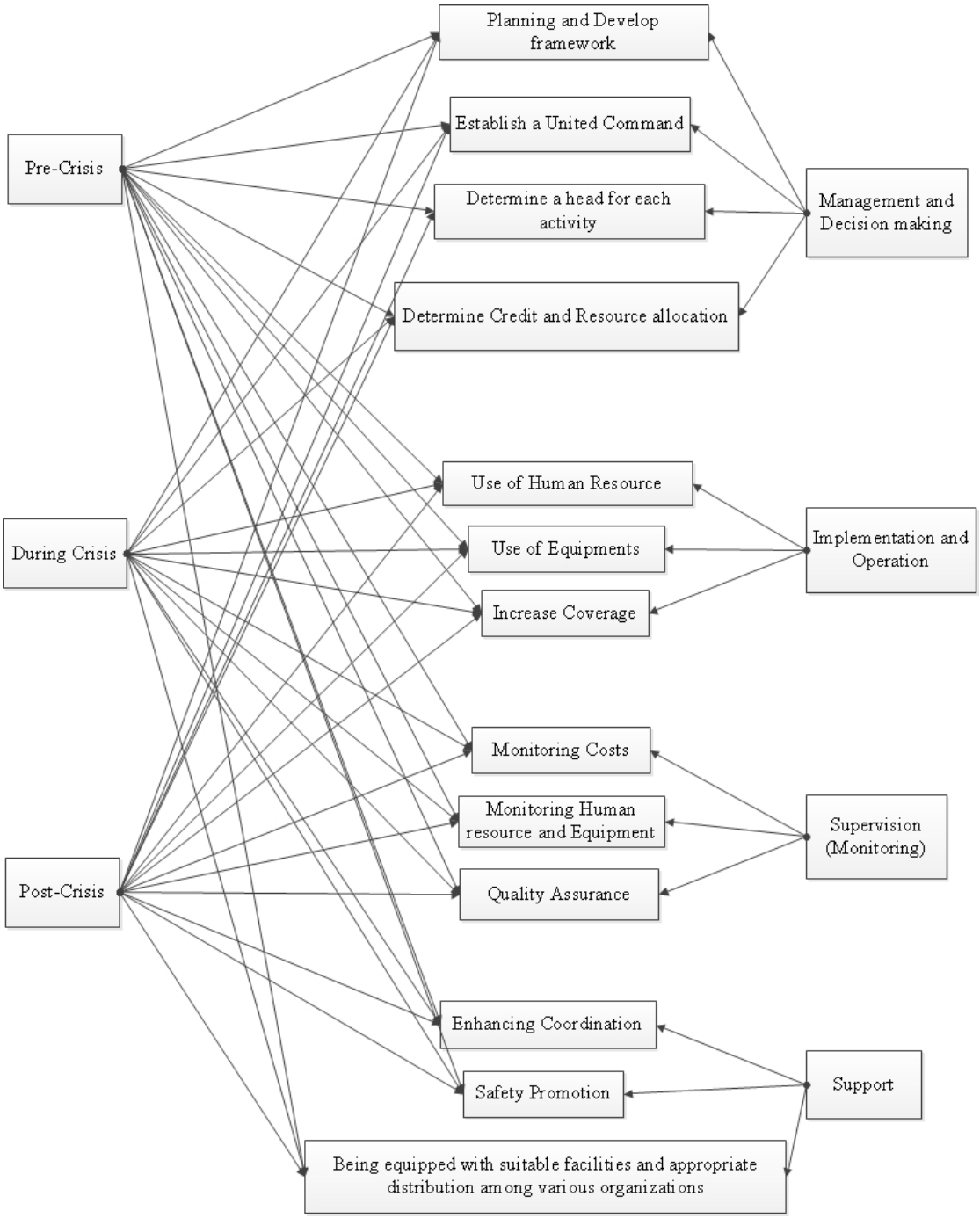

Figure 4.6: Analytic hierarchy process used to make a proper hierarchy in earthquake disaster management

4.8.2 Local Priority Calculations

Below is presented the pair wise comparison of criteria for an intended problem. The method of calculation is Approximate Method. And the geometric mean is used because it is more accurate to calculate the criterion index (local priority). In this method to calculate the coefficient of criteria at

first the geometric mean in the rows of matrix A was obtained and then it was normalized. As it can be seen in Table 4.11, sum of the coefficients of multiple criteria is equal to 1 and it is an indication of the local priority of the criteria.

Table 4.11: Binary matrix and local priority coefficient of criteria

Criterion / Criterion	Management and Decision (D)	Implementation and Operation (E)	Monitoring (F)	Support (G)	Importance coefficient of criteria
Management and Decision (D)	**1.00**	**3.00**	**5.00**	**7.00**	**0.59337**
Implementation and Operation (E)	**0.33**	**1.00**	**3.00**	**5.00**	**0.22732**
Monitoring (F)	**0.20**	**0.33**	**1.00**	**3.00**	**0.11128**
Support (G)	**0.14**	**0.20**	**0.33**	**1.00**	**0.06803**

Similarly, the local priority (coefficient) of all sub-criteria which has been calculated using a method described above, illustrated in Table 4.12.

Table 4.12: Determining relative importance coefficient of sub-criteria

Sub-Criteria	Local priority	Sub-Criteria	Local priority
Planning and develop framework (H)	**0.0836**	**Establish a united command (I)**	**0.4042**
Determine a head for each activity (J)	**0.3745**	**Determine credit and resource allocation (K)**	**0.1378**

Use of human resource (L)	**0.1162**	**Use of equipment (M)**	**0.2323**
Increase coverage (N)	**0.6514**	**Monitoring costs (O)**	**0.2952**
Monitoring human resource and equipment (P)	**0.1555**	**Quality assurance (Q)**	**0.5492**
Enhancing coordination (R)	**0.7460**	**Safety promotion (S)**	**0.1561**
Being equipped with suitable facilities and appropriate distribution among various sections (T)	**0.0979**	**----------**	**----------**

Finally, the coefficient has been calculated according to Table 4.13, based on individual subsets using binary matrices, geometric mean and normalization.

Table 4.13: Overall priority coefficient of alternatives based on each subset

	H	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**	**T**
Pre Crisis (A)	**0.7622**	**0.2323**	**0.5420**	**0.6514**	**0.2323**	**0.1162**	**0.0909**	**0.7523**	**0.2323**	**0.4286**	**0.2000**	**0.4286**	**0.2000**
During Crisis (B)	**0.0813**	**0.6514**	**0.2601**	**0.1162**	**0.6514**	**0.6514**	**0.4545**	**0.0833**	**0.6514**	**0.1429**	**0.6000**	**0.1429**	**0.6000**
Post Crisis (C)	**0.1565**	**0.1162**	**0.1979**	**0.2323**	**0.1162**	**0.2323**	**0.4545**	**0.1644**	**0.1162**	**0.4286**	**0.2000**	**0.4286**	**0.2000**

4.8.3 Integration of Local Priorities

The local priority of each element should be multiplied by high weight elements to get the overall priority in order to rank the decision options. By doing this step for each option, the overall priority will be calculated according to the following equation.

The final score (preference) of criterion “j”:

$$pr. = \sum_{k=1}^{n} \sum_{i=1}^{m} W_k W_i(g_{ij})$$

In which $\mathbf{W_k}$ is a preference coefficient of the criterion $\mathbf{W_i}$, “k” is the preference coefficient of sub-criterion “i” and $\mathbf{g_{ij}}$ is criterion score related to sub-criterion “i”.

How to determine the final score options is presented in Table 4.7 Based on the principle of hierarchical composition and using the importance coefficients provided. Options Final scores suggest that Option B is for the goals of the best choices and options A and C are priorities respectively.

Nearly all calculations as to AHP are performed based on the primary judgment of decision maker in the form of pair wise comparisons matrixes and it removes all incompatibilities and errors in the comparison and determination of the importance between options and indices of final results obtained from calculations.

Table 4.14: Overall priority (preference) of criterions based on the principle of hierarchical composition

	(0.59337) D				(0.22732) E			(0.11128) F			(0.06803) G			
	(0.0836)H	(0.4042)I	(0.3745)J	(0.1378)K	(0.1162)L	(0.2323)M	(0.6514)N	(0.2952)O	(0.1555)P	(0.5492)Q	(0.7460)R	(0.1561)S	(0.0979)T	Final score
A	0.7622	0.2323	0.5420	0.6514	0.2323	0.1162	0.0909	0.7523	0.2323	0.4286	0.2000	0.4286	0.2000	0.3639
B	0.0813	0.6514	0.2601	0.1162	0.6514	0.6514	0.4545	0.0833	0.6514	0.1429	0.6000	0.1429	0.6000	0.4052
C	0.1565	0.1162	0.1979	0.2323	0.1162	0.2323	0.4545	0.1644	0.1162	0.4286	0.2000	0.4286	0.2000	0.2309

The method which has been described was used to calculate the local and overall priority of all 20 sub-criteria to assess the vulnerability of the city. A 20 by 20 matrix was established. The hierarchical analysis formula was applied in Microsoft excel.

After the process, the calculated results are as a set of numbers. These numbers show the overall priority of each sub-criterion. These numbers were mentioned below as three tables under three described category.

Table 4.15: Overall priority of each of 19 district of Qazvin City for sub criteria of physical resistance of the city

Region	Sub-criteria	A	B	C	D	E	F	G	H	I	Total
1		0.028	0.022	0.038	0.033	0.06	0.004	0.041	0.0019	0.0121	0.240
2		0.0046	0.012	0.001	0.0136	0.033	0.033	0.058	0.09	0.05	0.246
3		0.0091	0.0078	0.0064	0.001	0.066	0.033	0.012	0.098	0.056	0.2893
4		0.035	0.016	0.086	0.007	0.064	0.033	0.001	0.007	0.00069	0.249
5		0.0014	0.036	0.0089	0.0028	0.0077	0.087	0.0009	0.007	0.099	0.2507
6		0.003	0.0098	0.0086	0.064	0.00078	0.0051	0.043	0.0047	0.089	0.227
7		0.036	0.079	0.045	0.0013	0.038	0.0057	0.0014	0.0146	0.0073	0.228
8		0.0037	0.098	0.0075	0.0065	0.035	0.0026	0.022	0.068	0.0008	0.244
9		0.0014	0.0086	0.056	0.0014	0.043	0.058	0.005	0.033	0.0087	0.215
10		0.086	0.084	0.033	0.0063	0.0014	0.0056	0.035	0.0064	0.029	0.317
11		0.0064	0.09	0.087	0.0043	0.017	0.0034	0.056	0.015	0.038	0.2867
12		0.008	0.033	0.077	0.012	0.0054	0.0075	0.064	0.021	0.021	0.248
13		0.07	0.0086	0.099	0.075	0.0063	0.0097	0.01	0.0012	0.004	0.283
14		0.0210	0.036	0.0056	0.0086	0.0087	0.0098	0.046	0.041	0.097	0.273
15		0.002	0.0045	0.0076	0.014	0.026	0.086	0.09	0.0089	0.0076	0.246
16		0.0089	0.021	0.012	0.033	0.065	0.0052	0.0053	0.0067	0.086	0.243
17		0.021	0.065	0.063	0.0064	0.0051	0.053	0.0013	0.0056	0.0086	0.229
18		0.027	0.027	0.0056	0.0089	0.099	0.093	0.0083	0.026	0.0013	0.296
19		0.0044	0.0048	0.036	0.0089	0.023	0.098	0.0031	0.046	0.01	0.234

Table 4.16: Overall priority of each 19 districts of Qazvin city for the texture responsiveness criteria after the crisis and relief possibility

Region	Sub-criteria	J	K	L	M	N	O	P	Total
1		0.0012	0.0023	0.0014	0.0123	0.0057	0.095	0.0021	0.12
2		0.05	0.00124	0.066	0.031	0.0058	0.0013	0.0041	0.159
3		0.002	0.0033	0.013	0.051	0.044	0.0036	0.0012	0.118
4		0.032	0.032	0.0013	0.0045	0.065	0.0034	0.0018	0.14
5		0.007	0.0059	0.089	0.013	0.0026	0.0033	0.0028	0.123
6		0.056	0.021	0.0031	0.0035	0.0031	0.0085	0.04	0.135
7		0.0012	0.055	0.0032	0.063	0.0088	0.0098	0.001	0.142
8		0.0026	0.0263	0.012	0.012	0.0044	0.0066	0.051	0.114
9		0.036	0.087	0.0021	0.0021	0.0065	0.0061	0.0028	0.142
10		0.041	0.0074	0.0086	0.0098	0.0062	0.0038	0.049	0.169
11		0.015	0.0061	0.0036	0.091	0.013	0.0066	0.0011	0.142
12		0.028	0.036	0.021	0.0028	0.0011	0.022	0.0034	0.114
13		0.061	0.0056	0.0022	0.0033	0.069	0.0031	0.0046	0.148
14		0.0066	0.0037	0.0011	0.0036	0.0045	0.011	0.098	0.128
15		0.031	0.021	0.053	0.0066	0.0012	0.0041	0.0031	0.12
16		0.044	0.0031	0.031	0.0069	0.0089	0.0099	0.0079	0.111
17		0.007	0.0065	0.0056	0.0044	0.0031	0.078	0.01	0.114
18		0.021	0.0212	0.0063	0.0036	0.0491	0.0013	0.00234	0.104
19		0.017	0.0036	0.0036	0.063	0.0031	0.0028	0.043	0.136

Table 4.17: Overall priority of each 19 districts of Qazvin city for the reversibility criteria after the crisis

Region	Sub-criteria	Q	R	S	T	Total
1		0.0036	0.0063	0.0021	0.068	0.08
2		0.021	0.031	0.031	0.016	0.099
3		0.0078	0.0069	0.054	0.009	0.06
4		0.0044	0.031	0.055	0.015	0.106
5		0.033	0.033	0.041	0.028	0.1357
6		0.009	0.0110	0.081	0.006	0.107
7		0.0028	0.002	0.0011	0.0921	0.098
8		0.031	0.011	0.024	0.011	0.077
9		0.098	0.021	0.0089	0.01	0.138
10		0.026	0.03	0.047	0.012	0.115
11		0.052	0.0036	0.005	0.015	0.076
12		0.01	0.038	0.0039	0.054	0.106
13		0.0013	0.056	0.001	0.0077	0.066
14		0.049	0.0021	0.01	0.0049	0.066
15		0.0014	0.099	0.021	0.053	0.175
16		0.03	0.033	0.045	0.023	0.131
17		0.08	0.0021	0.02	0.0079	0.11
18		0.025	0.035	0.052	0.077	0.189
19		0.002	0.01	0.073	0.026	0.111

Chapter 5

THE RESULTS OF VULNERABILITY ASSESSMENT AND DISCUSSIONS

5.1 Introduction

In the current chapter results based on elements which are mentions and described in previous chapters, are illustrated. Final results of questionnaire are shown as charts, afterward vulnerability assessment - partitioned by three effective aspects - one by one, aggregative and comparative figures are mentioned. Finally overall priorities of each element guide us to find a solution or recommendation for municipality officials.

5.2 Results of Analysis and Discussions

It should be mentioned that in an analysis performed in the study, different region of Qazvin have been assumed homogenous in terms of soil quality, soil strength against earthquake and ground water. The Amount of numeric criteria in Qazvin urban 19 areas, based on data and statistics in 2011, the existing lands use maps in 2012, workshop census in 2010 and comprehensive plan in Qazvin has been obtained. Sub criteria date based on questionnaire survey results in Tables 4.8, 4.9 and 4.10 are used to calculate.

The case study data which briefly mentioned in Table 4.4 have been entered to the designed file. The analyzed information was obtained as some numbers - called priority - in matrices for each group of data entered.

Information as level of priority (the name which is using in analytical hierarchy process) are numbers which can be compare to each other in each region of the city. In other words, a group of sub-criteria under each category of vulnerability have one number per each region. So the numbers can be compare to other region's number to find the level of risk. Bigger number means that the region is more vulnerable in related category. The same analyses have been done for all three categories (city physical strength, responsiveness of urban texture and relief possibility after the crisis and city reversibility criterion after the crisis) and comparative numbers have been calculated for 19 regions in each category.

Figure 5.1 shows the data from Table 4.15. City physical responsiveness ability has been evaluated in this chart. As it can be seen the range is less than 0.31 and region 11 with 0.3171 is the most vulnerable region in physical responsiveness. Regions 18 and 2 with 0.2961 and 0.2952 respectively are in next stage. Totally regions 2, 3, 10, 11, 13, 14 and 18 are the most vulnerable regions through the study area. But the other regions have no major difference, as all vulnerability numbers are distributed between "0.21" and "0.31" for all regions. The vulnerability numbers are like normal distribution through the city. It is a good point in city properties and it means that construction and urban condition are nearly the same through the city, so it makes all plans easy to implement after a crisis. In Table 4.15 number of vulnerability (priority) for each sub criterion (A to I) in each region was mentioned in order to compare with other regions.

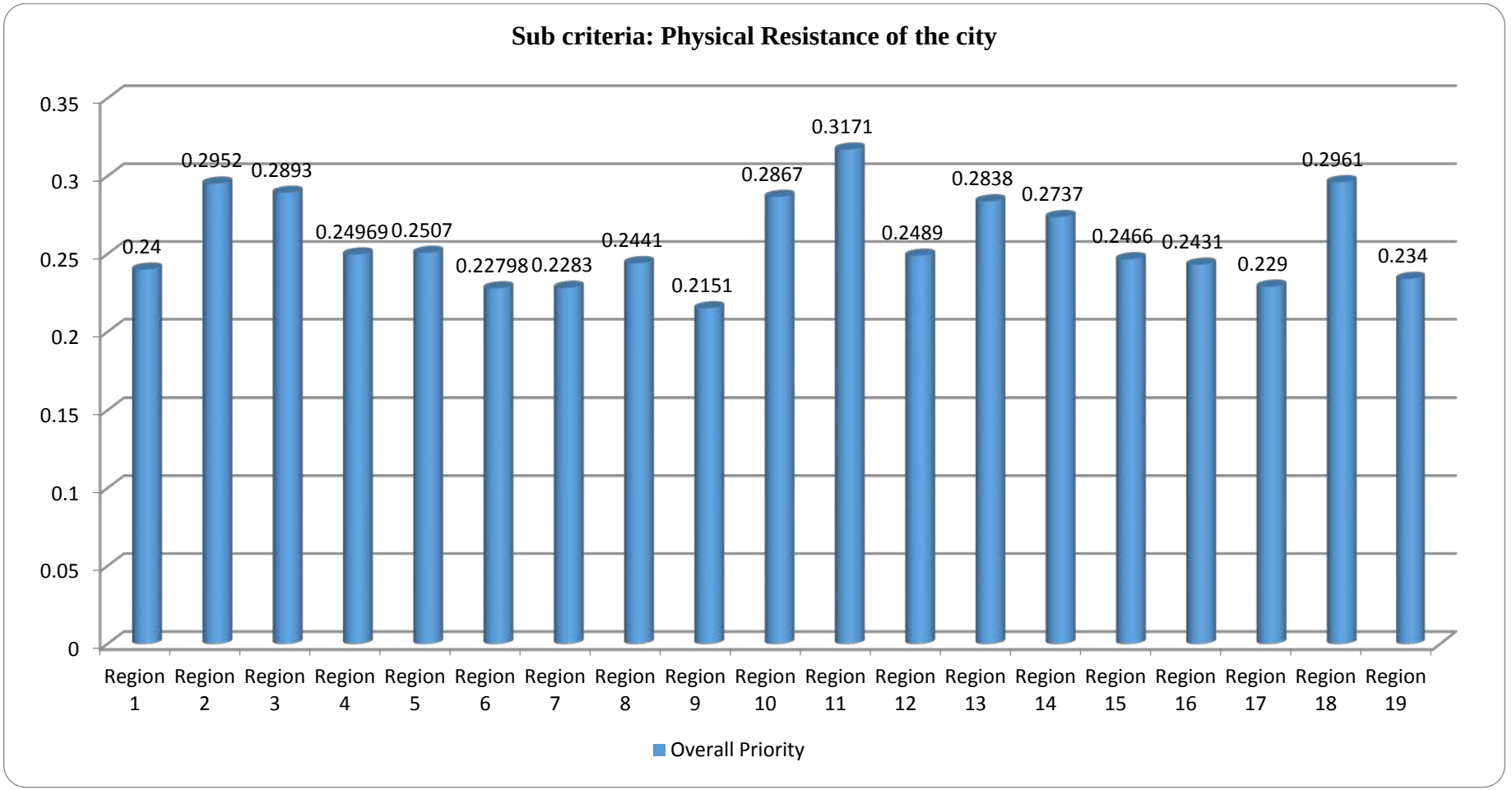

Figure 5.1: Overall priority of each of 19 districts of Qazvin city for sub criteria of physical resistance of the city

Figure 5.2 shows Table 4.16 data in a bar chart. The second vulnerability assessment category is texture responsiveness of the city. The numbers are less than 0.16, where region 2 with 0.1594 has more vulnerability in urban texture responsiveness rather than the other regions. In Table 4.16 it can be compare each 7 sub criteria by the regions. For example, when sub criterion of “access to relief services in the area” (O) is under study, it can be seen region 1 has the worst condition by 0.095. Regions 4, 7, 9 and 13 textures also have bad conditions in order to response after a crisis. This category like the previous has no major tolerance in the results where numbers are between “0.104” and “0.159”. It says that the city condition in texture responsiveness are near the same in 19 regions and the relief and aid actions should be distribute moderately throughout the city. Regions 18 and 16 have the best condition after a crisis.

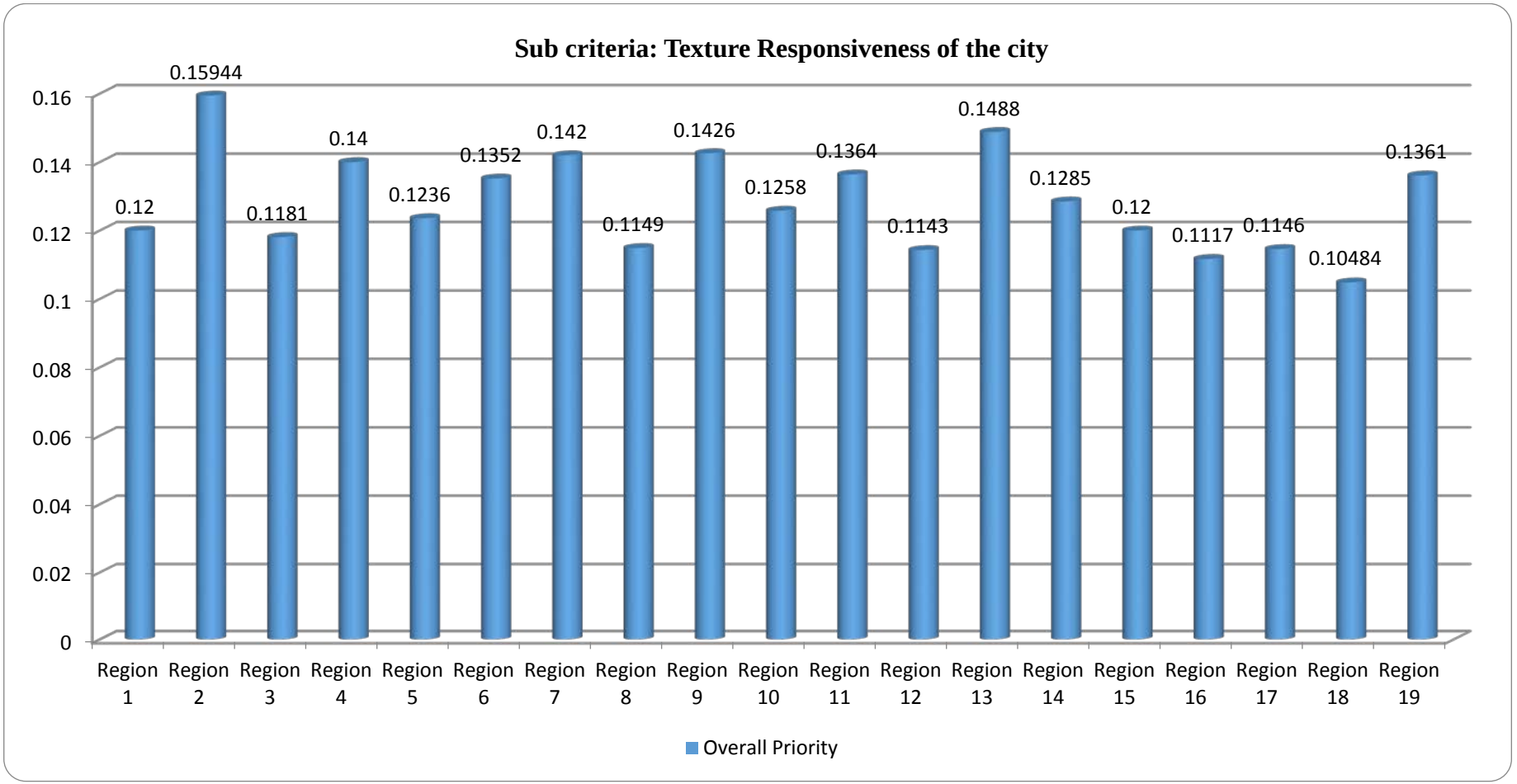

Figure 5.2: Overall priority of each 19 districts of Qazvin city for the texture responsiveness criteria after the crisis and relief possibility

The numbers that have been shown in Figure 5.3 are derived from Table 4.15 below the category of city reversibility. The sub criteria are “Area of major activity centers in the region”, “employment rate in the region”, “immigrants settled in the region” and “illiterate population in the region”. Each of mentioned sub criterion in a region is comparable with the other regions. As it can be seen from the chart, regions 18 and 15 with 0.189 and 0.1744 respectively have the most vulnerability in this issue. More over these two regions have a significant difference from the other regions where region 9 with 0.1379 stands in third place of vulnerability in reversibility. Regions 13 and 14 have the best position with the same 0.66. This result says that in reversibility plan which should be design in municipality, an exact attention to its construction process should be implementing. A major tolerance in vulnerability in reversibility section means there is a major problem after crisis in social condition, also in relief and reconstruction.

In Figure 5.4 vulnerability numbers for all three categories; city physical strength, responsiveness of urban texture and relief possibility after the crisis and city reversibility criterion after the crisis have been shown in one chart. Vulnerability numbers can be comparing by each 19 regions of the city. Each sub criterion’s number illustrated in the chart that can be compare in two ways, with other sub criterion in an specific region and with the same sub criterion in other regions. So it shows that which criterion has the most important role in vulnerability assessment throughout the city.

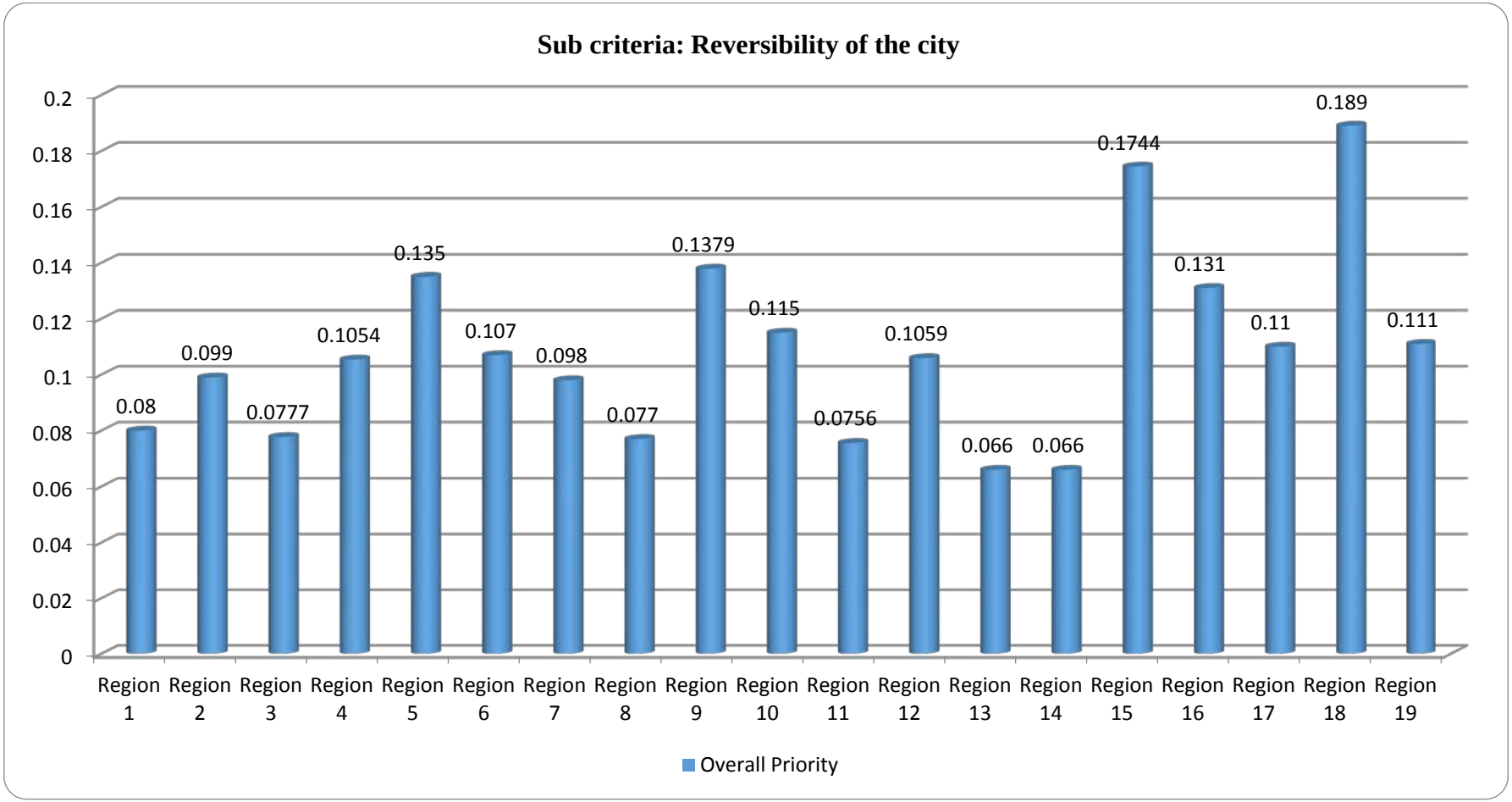

Figure 5.3: Overall priority of each 19 districts of Qazvin city for the reversibility criteria after the crisis

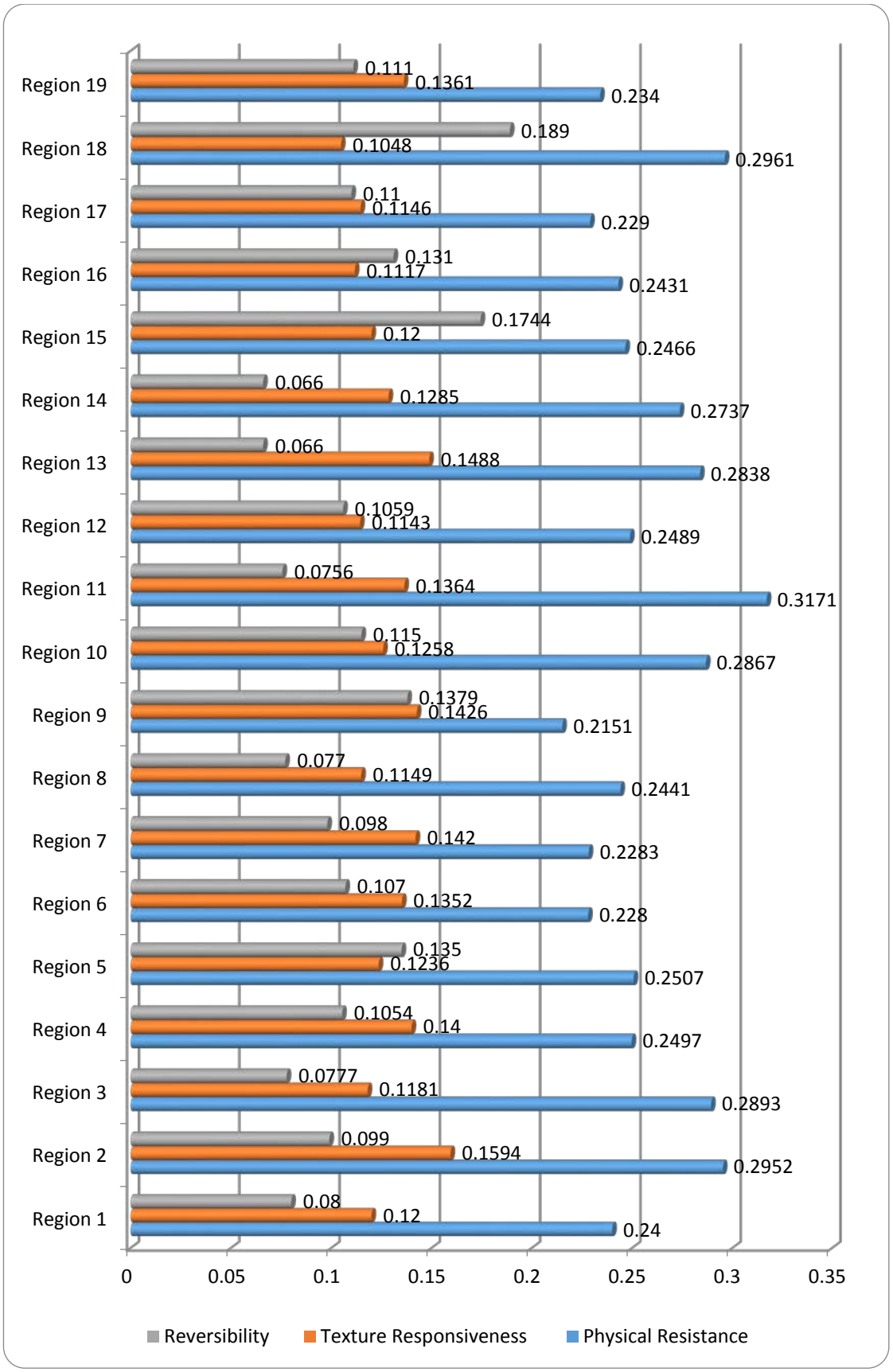

Figure 5.4: The overall priority of each 19 district of Qazvin city for all three main vulnerability category-comparison chart

Table 5.1: The overall priority of each 19 district of Qazvin city for all three main vulnerability categories

Region	**Sub-criteria**	the criteria of Qazvin city physical resistance	the texture responsiveness criteria after the crisis and relief possibility	reversibility criteria after the crisis	**Total**
1		**0.2400**	**0.1200**	**0.0800**	**0.45**
2		**0.2952**	**0.1594**	**0.0990**	**0.4817**
3		**0.2893**	**0.1181**	**0.0777**	**0.5092**
4		**0.2497**	**0.1400**	**0.1054**	**0.495**
5		**0.2507**	**0.1236**	**0.1350**	**0.5094**
6		**0.2280**	**0.1352**	**0.1070**	**0.469**
7		**0.2283**	**0.1420**	**0.0980**	**0.468**
8		**0.2441**	**0.1149**	**0.0770**	**0.463**
9		**0.2151**	**0.1426**	**0.1379**	**0.476**
10		**0.2867**	**0.1258**	**0.1150**	**0.554**
11		**0.3171**	**0.1364**	**0.0756**	**0.5127**
12		**0.2489**	**0.1143**	**0.1059**	**0.523**
13		**0.2838**	**0.1488**	**0.0660**	**0.497**
14		**0.2737**	**0.1285**	**0.0660**	**0.467**
15		**0.2466**	**0.1200**	**0.1744**	**0.541**
16		**0.2431**	**0.1117**	**0.1310**	**0.485**
17		**0.2290**	**0.1146**	**0.1100**	**0.453**
18		**0.2961**	**0.1048**	**0.1890**	**0.589**
19		**0.2340**	**0.1361**	**0.1110**	**0.481**

As it can be seen from results in Figure 5.4, region 11 for the category of city (Qazvin city) physical strength, region 2 for the responsiveness of urban texture after the crisis and relief possibility, region 18 for city reversibility have most vulnerability during and after a crisis. So should be focused on these regions during mitigation planning.

Finally, Table 5.1 it is characterized the final overall priority of each 19 areas of Qazvin for 3 main vulnerability categories. In this table, the effect of each trilogy on the final overall priority is obvious. Table 5.1 like the information illustrated in Figure 5.4, shows comparative numbers for each category of the city condition vulnerability through each region of the city. In the mentioned table, cumulative numbers of vulnerability was calculated to show the final priority.

According to the stated points about hierarchical method, the final vulnerability priorities have been shown individually in Table 5.2 for each 19 regions of Qazvin city. Totally, vulnerability assessment based on three main categories and criteria of vulnerability, and 20 sub criteria – which have been shown case study conditions in different aspects – says that regions 18 and 10 have high vulnerability risk with the numbers 0.589 and 0.554 respectively. Regions 15, 12, 11, 5, 3 and 13 stand in next ranks with numbers of 0.541, 0.523, 0.513, 0.5094, 0.5092 and 0.497 respectively. Although the differences are not minor but it can be said crisis risk in all regions in the city is close.

In the rectangle nemograph shown in Figure 5.5, the final vulnerability priorities of 19 urban areas in Qazvin city is presented based on paired comparisons in AHP and through which there is a possibility to compare the different regions in terms of vulnerability assessment. It can be used in the future measures required to manage the crisis due to an earthquake.

Table 5.2: The overall priority of vulnerability for each 19 district of Qazvin city according to binary comparison in hierarchical analysis

Region	Final Priority
1	0.45
2	0.4817
3	0.5092
4	0.495
5	0.5094
6	0.469
7	0.468
8	0.463
9	0.476
10	0.554
11	0.5127
12	0.523
13	0.497
14	0.467
15	0.541
16	0.485
17	0.453
18	0.589
19	0.481

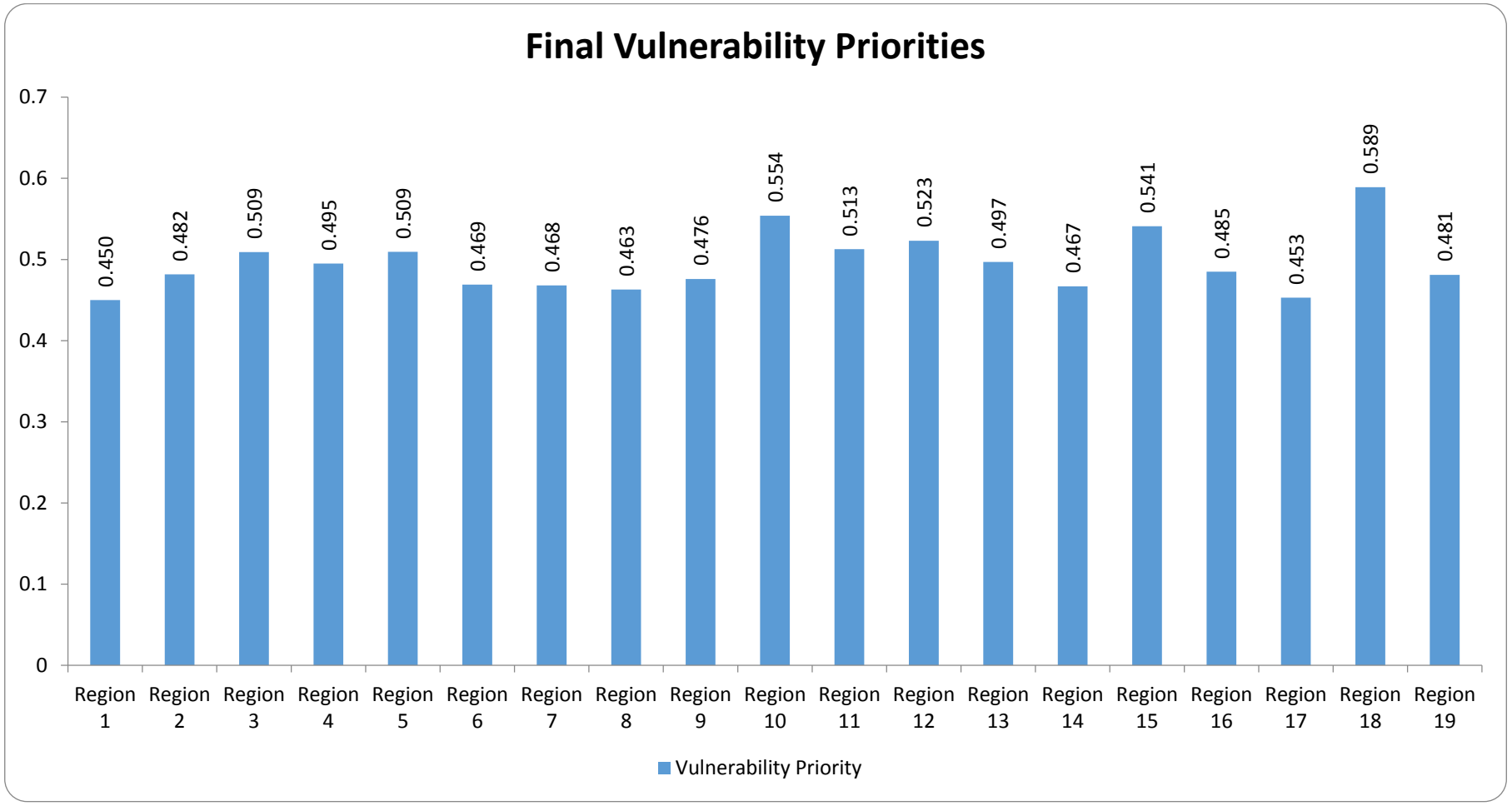

Figure 5.5: The final vulnerability priorities of each 19 regions of Qazvin city according to binary comparison in hierarchical analysis

Based on cumulative overall priority which mentioned in Table 5.2, regions have been categorized into 3 levels of vulnerability risk. As it was shown in Table 5.3 final vulnerability priorities categorized into low (less than 0.496), moderate (0.496 to 0.543) and high vulnerability (more than 0.543) to specify level of risk in each region.

Table 5.3: Ranking of vulnerability level for different regions of Qazvin city

Regions	Vulnerability Level
1, 2, 4, 6, 7, 8, 9, 14, 16, 17, 19	**Low vulnerability(0.4509-0.496)**
3, 5, 11, 12, 13, 15	**Moderate vulnerability (0.496-0.543)**
10, 18	**High vulnerability (0.543-0.589)**

The presented chart in Figure 5.6 shows the final weight of each criteria and sub criteria for the high risk regions to analyze the vulnerability assessment based on pair wise AHP. This vulnerability tree differently shows the vulnerability priority by each sub criterion. This can be key information which derives from the analysis. The figure shows the three main categories and 20 sub criteria schematically. Under each sub criteria the numbers of vulnerability for the high risk regions have been mentioned. These numbers brightly says that municipality should focus on which part to improve the city mitigation elements. According to this figure, High population density, area of old and repairable buildings, shortage access to relief and medical services, immigrant settled, a few organic texture area, sidewalk length with less than 6 meters width in the region are the most important elements affect

the vulnerability of these regions. The existing results have been presented briefly in a hierarchy tree in Figure 5.6.

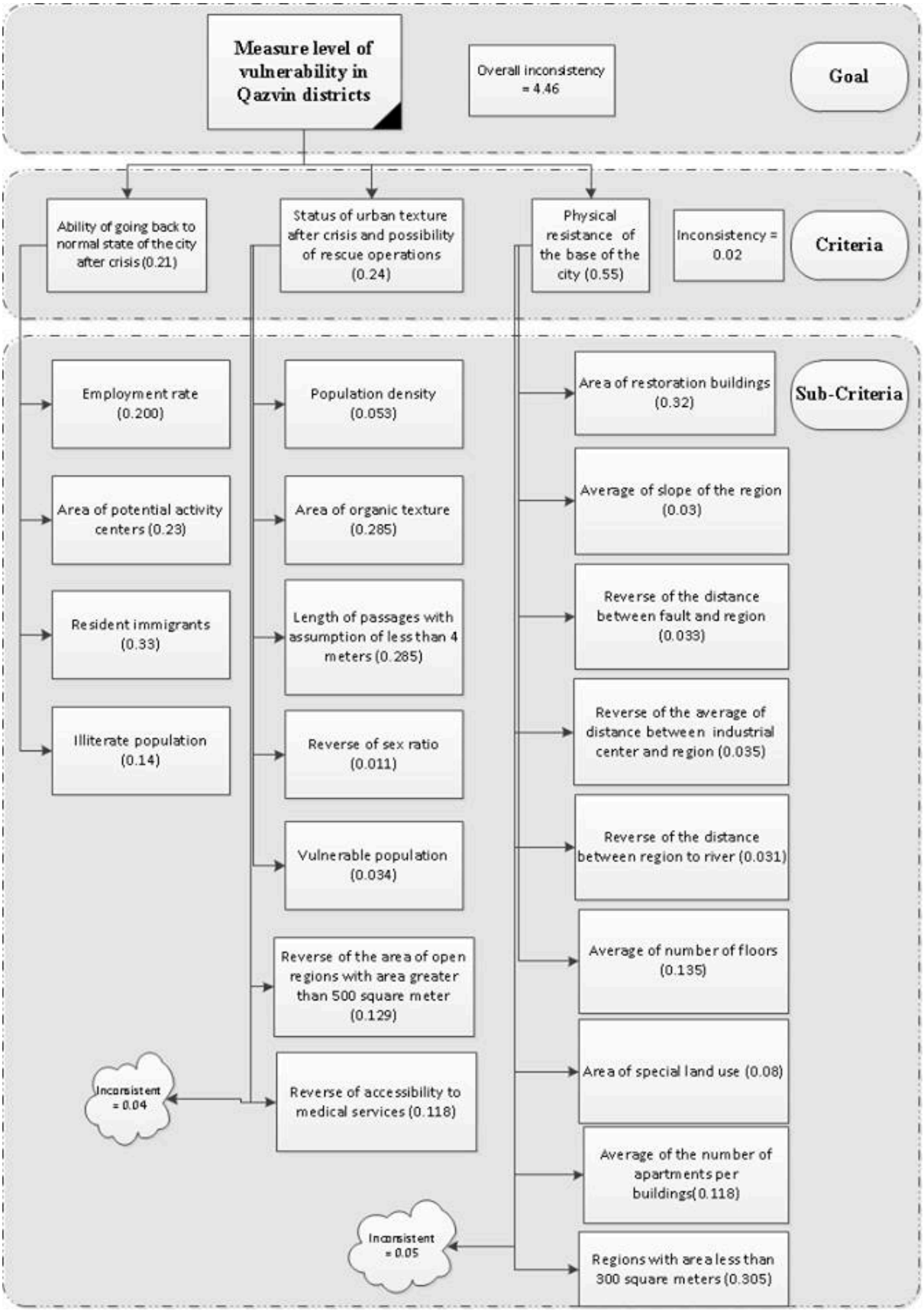

Figure 5.6: Hierarchy tree of vulnerability assessment for high risk regions of Qazvin

Based on this, from 19 districts in Qazvin, 2 cases are in the high vulnerability, six cases in moderate and 11 cases are in low. High population density, area of old and repairable buildings, shortage access to relief and medical services, immigrant settled, a few organic texture area, sidewalk length with less than 6 meters width in the region are the main reasons of the vulnerability of the urban textures. The regions with high vulnerability in the urban plans must be more paid attention in order to prevent the earthquake crisis as an important and sensitive issue and the regions should always be considered more than other regions. According to the different guidelines, we can manage the more vulnerable risk areas based on these strategies when an earthquake crisis happens.

This modeling in the Analytic Hierarchy Process (AHP) for evaluating crisis management in this study shows the result: in terms of urban management, the step during the crisis is very important. And all the planning and preparations for crisis management are better done at this stage. Because human life and property are threatened at this stage in a short time and Anomalies and irregularities covers all levels of society because it leads (in most cases) to a problem exacerbated by the crisis and disaster. Therefore, managers and urban planners should according to the data and results of previous disasters develop a crisis management plan and framework to prevent the occurrence or spread of human and financial losses in the future. The step before the crisis -in the second priority of Modeling - city managers can exercise before the crisis by proper assessment of crisis situations in the past and creation of special measures due to the lack of social and psychological pressures before the crisis.

Chapter 6

CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter is a brief review on what have been done in this study. The process of doing the study, aims, works done and the achievements will be reviewed briefly. Finally some recommendations about the study and for further research have been presented.

6.2 Conclusion

First of all the general principles of crisis management in cities was explained. It was concluded that the assessment of the vulnerability and immunization should be done in zonation and urban texture scale in order to reduce the effects of earthquake.

Hence, after a detailed description and comprehensive definition of crisis management procedures at the national and global levels, a systematically organized and systematic approach has been assessed to manage an urban crisis. Then, Qazvin was reviewed and assessed about the vulnerability of different 19 areas, as case study.

Then, vulnerability analysis of the urban textures in Qazvin has been introduced in the frame of 19 urban districts and based on 3 main criteria; 1.Qazvin physical resistance, 2.(urban) Texture responsiveness after crisis

and relief possibility and 3.City reversibility after crisis. 20 sub-criteria in the following sections have been studied and evaluated using Analytical Hierarchy Process (AHP). So an example of crisis management was analyzed using this method. As mentioned, to prepare a binary comparison between sub criteria, a questionnaire designed and distributed to a group of 50 related experts. By 70% return the survey has been done. Then the analytical hierarchy processor was modeled to use the data.

Based on the analytical results of AHP in the city of Qazvin, The conclusion was that from 19 areas, 2 regions have a high vulnerability (areas 10 and 18), 6 regions have moderate vulnerability (areas 3, 5, 11, 12, 13 and 15) and the remaining 11 regions have a low vulnerability. High population density, area of old and repairable buildings, shortage access to relief and medical services, immigrant settled, a few organic texture area, sidewalk length with less than 6 meters width in the region have been identified as the important high vulnerabilities of urban textures in areas 10 and 18 in Qazvin. The achievements of this study are as follows:

- Define a new structured crisis management cycle
- Find urban properties and characteristics then categorize them under three main criteria to analyze the vulnerability of the city against earthquake
- “During the crisis” step is very important in crisis management; and all the planning and preparations for crisis management are better done at this stage.

- Assess the vulnerability of 19 urban areas of case study to determine which regions are vulnerable in a crisis in which criteria
- Find the weak criteria in high vulnerability risk regions

6.3 Recommendations

The following subjects, which are continuing this study, can be considered for further researches.

- Evaluation of seismic effects on each 19 urban areas separately and appointing necessary prerequisites for crisis management
- Using the hierarchical analysis results obtained in this investigation to locate the optimal management of the crisis against the earthquake in Qazvin Using Geographic Information System. (GIS)
- Finding best locations based on this study to construct a crisis management, medical, and accommodation center (headquarter)
- Analyzing the vulnerability of different cities of Iran using AHP for zoning the crisis management priority.
- Planning and assembling pieces of land in the city of Qazvin's old textures using AHP to reduce risk in case of an earthquake in the city.
- Using together the Analytic Hierarchy Process (AHP) and Geographic Information System (GIS) for promotion of efficient earthquake crisis management in various cities.

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APPENDICES

Appendix A: Questionnaire Survey Form

Category	No.	Sub criteria	Not importance	Very low importance	Partly not importance	Low importance	Below avg. importance	Average importance	Above avg. importance	Partly High importance	High importance	Very high importance	Special importance
Physical resistance criteria of the Qazvin city	1	Average area slope (A)	0	1	2	3	4	5	6	7	8	9	10
	2	(Reverse no.) Distance to faults from the region (B)	0	1	2	3	4	5	6	7	8	9	10
	3	(Reverse no.) Average distance to industrial, chemical, nuclear areas (C)	0	1	2	3	4	5	6	7	8	9	10
	4	(Reverse no.) Region distance to river and watercourse (D)	0	1	2	3	4	5	6	7	8	9	10
	5	Area of old and Repairable buildings in the region (E)	0	1	2	3	4	5	6	7	8	9	10
	6	Building segments less than 200 square meters in the region (F)	0	1	2	3	4	5	6	7	8	9	10
	7	Average number of units in the buildings of the region (G)	0	1	2	3	4	5	6	7	8	9	10
	8	The average number of floors (H)	0	1	2	3	4	5	6	7	8	9	10
	9	Especial land uses area in the region (I)	0	1	2	3	4	5	6	7	8	9	10

The texture responsiveness after the crisis	**1**	**Population density in the region (J)**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
	2	**Vulnerable populations in the region (K)**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
	3	**(Reverse no.) Sex ratio (L)**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
	4	**Sidewalk length with less than 6 meters in width in the region (M)**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
	5	**Organic texture surface of the region (N)**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
	6	**(Reverse no.) Access to relief services in the region (O)**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
	7	**(Reverse no.) Area of open spaces with an area over 500 square meters in the region (P)**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Reversibility criteria after the crisis	**1**	**Area of major activity centers in the region (Q)**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
	2	**Employment rate in the region (R)**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
	3	**Immigrants settled in the region (S)**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
	4	**Illiterate population in the region (T)**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**