

# The study on the functional and physical issues of Tir Parks and design standards representation to develop tourism industry

Elnaz Shirkhanlo<sup>1</sup>, Mahdi Sashourpour<sup>2</sup>, Ramin Kiamehr<sup>3</sup>

**Abstract**— Tourism is one of the main factors of mobility-based development. Decrease in working hours and therefore increase in entertainment time and improvement of movement condition is a prominent process in tourism movement division which includes shortening in staying time, thus it is an undisputable factor in movement promotion and tourism short-term movement. Meanwhile, as function and physics of a space are two main characteristics of any space Tir parks play an effective role in trip capacity increase along the roads and promotion in tourism industry. This study is seeking to develop tourism industry with Tir parks designing standards and the issues of physical and functional aspects of Aftab Derakhshan Sahra complex in Qazvin. The methodology of mentioned study is based on the practical purposes with the origin of descriptive-case study. Data collection is in library and field study mode. The results show that the tendency of people to use Tir parks depends on various aspects such as functional, physical, perceptual, visual, social, cultural, economical, traffic, environmental aspects. Meanwhile, functional and physical aspects contain great portion which are related to some items including: present land uses in the complex, the location of the complex, space syntax, accessibility, local materials and etc.

**Keywords**— Tourism, Tir Park, Physics, function, Aftab Derakhshan Sahra, Qazvin

## I. INTRODUCTION

Historical researches confirm that Tir parks are like awnings as a place to feel relaxed, a place to stay, inns as a place to relax between ways and needed objects provision for passengers and even a place to exchange objects, trading and social and cultural communication. The main issue is that how and based on which standards should these Tir parks been designed to eliminate the needs of the passengers on one hand and be a vibrant, live place filled with social communication. Public space which shape up by the road and attract tourists and improve qualitative and quantitative levels of road trips, will lead to improve and develop road transportation system.

Therefore, present research is seeking to respond following questions:

1- What are the most significant problems in functional and physical aspects of Aftab Derakhshan Sahra complex in Qazvin?

2- What are the universal standards of functional-physical design of Tir parks?

Today some assessments and researches have been performed about Tir parks, while the principles of designing to attract more tourists, use roads and to heighten the level of the spatial quality in economy saving mode have been ignored. As the use of the land and the function happening there are the identifiers of a space and appropriate design of mentioned spaces would attract tourists, physics and its functions are considering significant. Aftab Derakhshan Sahra complex with semi-appropriate physical condition doesn't have the function that is needed indeed. Thus, the study about the design standards of these aspects seems essential. The purposes of the study are:

1- Identification, assessment and analysis of physical and functional issues of Aftab Derakhshan Sahra in Qazvin

2- Promotion in qualitative aspects of Aftab Derakhshan Sahra by the use of physical and functional potentials

3- Representation of physical and functional standards in order to design Tir parks

## II. METHODOLOGY

Present research is a kind of practical research that is performed by descriptive-analectic method. The section of collecting data is in library and documentary mode with field study base. The case study is Aftab Derakhshan Sahra in Qazvin where is located by the city. Eventually in order to analyze the data, numerical tools, Auto cad and Photoshop have been used.

## III. LITERATURE

The experience around the world would confirm that Tir parks of a country vary completely from the other country. Tir

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parks of turkey and Germany for instance, depend on various indicators such as natural characteristics, distance, and level of services (Davoudi, 2001). Therefore there is no instinct pattern for tir parks in countries, because the properties of each country force the authorities to have different policies about Tir parks. In Saudi Arabia for example, Tir parks are mainly constructed for pilgrims and passengers from other countries (Shie, 2003).

#### IV. CASE STUDIES

Nowadays, the cncentrtion on the services in the form of Tir parks in an accepted method all over the world. So, the governments not only concern about the economic issues of Tir parks, but also environmental, social, cultural, and political issues matter too. Turkish government for instance has developed an instruction to establish Tir parks on highway at the time of highway construction (Davoudi, 2001).

##### A: Ukraine

This Tir park which was designed by professor Frachield has divided services and welfare equipments at first step in a case that gas station which is one of the most significant items in Tir park is completely separated from the other parts. It is suggested that the project should be divided from the highway in a case that when user enters the project site, feels free from the noise of highway into the convenience of Tir park. Lurch Tir park is built at both east-west position incorporated with the nature. There is a pond in eastern Lurch which makes suitable space in addition to the pin-nic equipments, playground and green space. The building is higher than the parking lots. The main entrance is in parallel to the highway. Moreover, there are several detour entrances to the project. The building is in two floors which is obvious in the picture.



Fig.1-3: the equipments of tir park in Ukraine

##### B: The United States

Tir parks in the U.S are located within 6 Km and mostly contain equipments such as: 1- Water closet (W.C), 2- Playground, 3- Drinking water, 4- pergola, 5- information center, 6- weather report center, 7- Phone, 8- Waste baskets, 9- Typing machine for the deaf, 10- vending machine, 11- Parking lot. As it is shown in the figures below, these equipments are designed out of the highway.

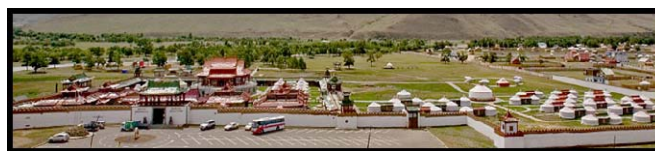


Fig. 4: Tir park in the US.

##### C: Australia

Ground and resting place belong to the government, cooperating with the investor to build a resting space in a case that the monopoly of mentioned place is for the investor for 30 years. After 30 years the ownership goes to the government or the contract is being extended since then. The distance between two resting places is 20-40 Km which is determined by the technical specialists. The area of the Tir parks usually are 8 hectares with some facilities including: 1- gas station, 2- shower, 3- mess hall, 4- children playground, 5- grocery, 6- parking lot, 7- car primary items shop. Some equipments and facilities are being introduced by the photos below.



Fig 5 and 6: Tir parks of Astralia

##### D: Iran

This complex is located on the 20<sup>th</sup> Km of Qazvin-Qom highway which includes gas station, restaurant, fast food, Sohan department store, coffee shop, auto repair, mosque, retail stand, parking and WC.

- This complex is defenseless for climate change.
- It doesn't make sense of belonging in people.
- Parking lots which are one of the most important elements of this complex, are mainly unidentified and without sunshades.
- There is lack of green spaces to change the spirit of mentioned complex.
- There is no suitable vision from the road to the complex.

As it is obvious from the case studies out of Iran, space making and place making is considered significant while in Iranian cases Land uses and passengers are considered important.

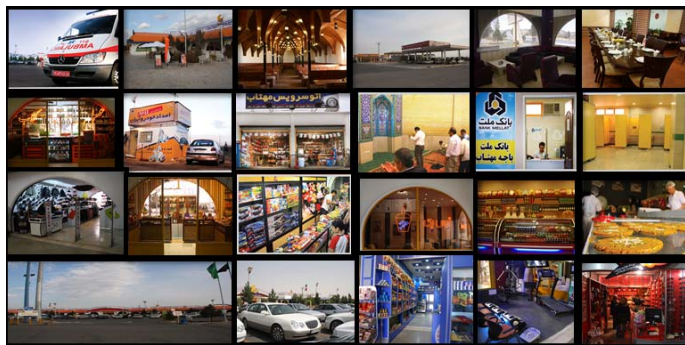
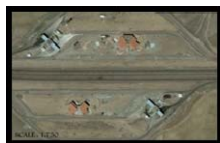
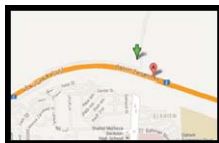


Fig. 7: Land uses of Mahtab

### E: studying area

As shown in map 1, Aftab Derakhshan Sahra Tir park is located on 16<sup>th</sup> Km of Qazvin-Zanjan highway by the road which is easily accessible for the passengers. This Tir park has two Northern-southern lanes in an area of 6500 m<sup>2</sup> which the equipments of both sides of the road are the same.



Map 1 (left) and figure 8 (right): the position of the studying area

## V. DISCUSSION

In this section, principles of functional and physical design for Tir parks are presented, in a way that for each presented principles, an objective examples of that principle is analyzed in Aftab Derakhshan Sahra Tir park. So, all the data has been analyzed based on analysis performed along the study, collected literature, analyzed case study and universal designing standards adopted from vic road.

### A. Physical aspect:

In this aspect of design items such as location of the Tir parks, their land uses and activities, the design of their interior buildings, used materials and the principles of accessibility in a Tir park is being studied.

#### 1. Location

- Tir parks should be located by the main roads (highways) (map1)
- The distance between highway and Tir park should be at least 7.5 m (figure 9)
- The distance between two tir parks should be at least 50 Km (map 2)
- Tir parks should not be built perilous spots of the highway

- Tir parks should be located at both sides of the highway (figure 8 and 10)

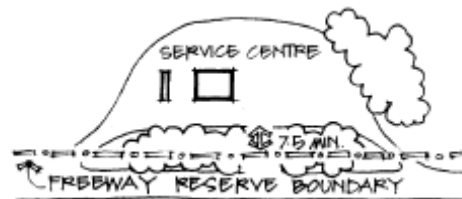


Fig. 9: the minimum distance of Tir park from highway



Map2 the distance to the closest Tir park (Ghazal) Zanjan-Qazvin highway

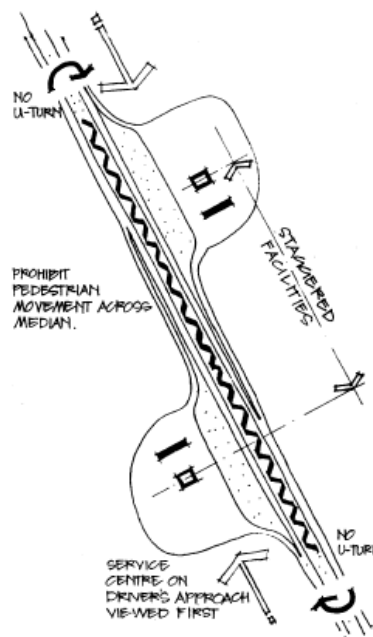


Fig. 10 the design of checked Tir park

#### 2. Land uses

- Integrity of the equipments is in higher priority than a complex of separated buildings in designing and place making (figure 11 and 12)
- Activities and land uses should be at the center of the complex in a concentrated form (figure 13)

- Parking lots either for the car or for the heavy vehicles should be located by the side of the site (figure 14 and 15)
- All of the water closets (WCs) should be located far from the restaurant and coffee shop (figure 16)
- The playground of children should completely be divided from the mounted way and auto accessibility (figure 11)
- A space for parents in order to observe their children at the playground should be prepared (figure 11)

- The entrance of the restaurant should be visible from the parking lot (figure 17)
- Loading stands should be separated from the main cycle of the cars and parking lots (figure 11)

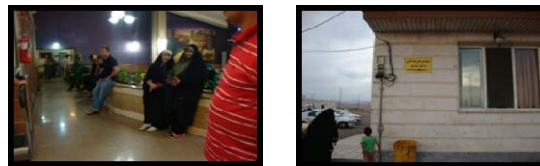


Fig. 16 the WC By the restaurant

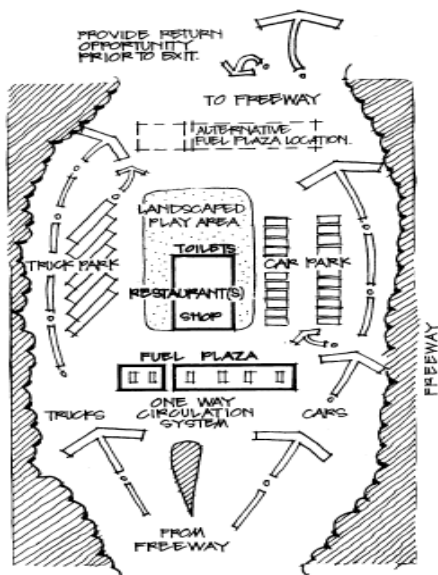


Fig. 11 an example of coherent equipments



Fig. 17 and 18 Parking lots and services at Sahra Tir park

### 3. Design of buildings

- Building design of the Tir parks depends mainly on the climate change (figure 19)
- All of the buildings in the Tir parks should be built with specific and coherent architectural methods based on style, height, material and color (figure 12)
- The same structure should be used for all the facades of the buildings (figure 19)
- Gas station should be shaded (figure 20)
- Lightening of the buildings should be appropriate and enough (figure 22)
- The retail stands should be lower than 240 m<sup>2</sup> (figure 21)
- Parking lots should be shaded and located in open space (figure 23)



Fig. 12 and 13 coherence of equipments and land uses centralization



Fig. 14 and 15 parking lots of vehicles



Fig. 19 correspondence of the buildings

- The place of restaurant and other public spaces should be away from the sound of highway (figure 18)





Fig. 20 shaded gas station of Aftab Sahra Tir park



Fig. 21 and 22 retails and lightening inside the complex

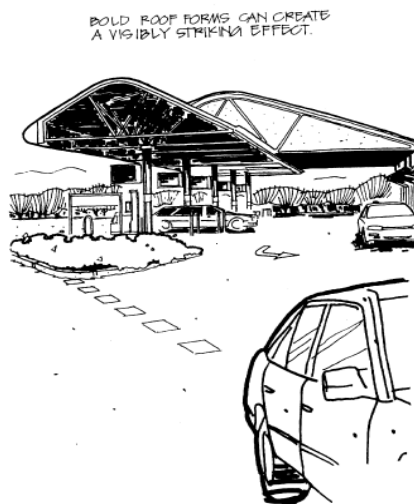


Fig. 23 the shades and the roofs

#### 4. Accessibility

- There should be one entrance for the Tir park to increase the safety (figure 27).
- The connection between two sides of the Tir Park should be with underway (figure 26)
- Left turn and U turn from one side to the other is not permitted (figure 26)
- Pedestrian access between two sides of the Tir park is banned (figure 26)
- The entrance of the Tir park should be safe and be out of the function of highway (figure 27)
- Cars and heavy vehicles should be separated (figure 24)
- Parking lots should be in a position that can eliminate the need of pedestrian to move far distance (figure 28)

- Access to the restaurant should be divided from accessing to the gas station and vice versa (figure 25)



Fig. 24 accessibilities to the Tir park

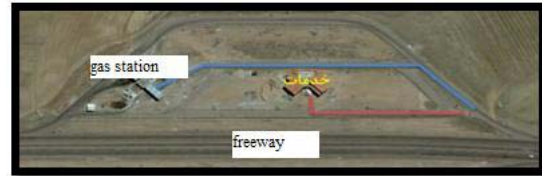


Fig. 25 land uses and gas station



Fig. 26 the connection between 2 sides of the highway



Fig. 27 the side park by the Tir park





Fig. 28 cluster buildings

## 5. Materials

- Materials used in the Tir parks should be climate-appropriate (figure 29)
- Use of reflexive glasses is banned in public spaces (figure 30)
- Materials used in the contour and façade should be visually incorporated (figure 12)



fig. 29 and 30 native materials (right) and typical glasses (left)

## B: Functional aspect

The principles of functional design of Tir parks based on essential equipments and land uses are being represented in this section. Therefore, the characteristics of all land uses based on their functions are introduced. These principles include:

- Land uses that encourage drivers to stop and relax at Tir parks are permitted.
- Restaurant (figure 31)
- Alcoholic drinks are banned in the restaurant
- Consign the food out of the restaurant is appropriate.
  - Fast food (figure 32)
  - Retail stands (figure 33)
- Retails and snack bars
- Cosmetics
  - Auto repairs (emergency repairs) (figure 34)
  - Coffee shop (figure 35)
  - Parking (figure 36,37 and 38)

Fig. 31 and 32 external and internal space of the Tir park

Fig. 33 and 34 the retails (right) and lack of parking (left)

- Parking should be shaded and open for various cars and trucks.
- The parking of disable people should be close to the entrance
- Parking of the trucks and heavy vehicles should be in a case that won't need reversing the car.
- Parking construction out of the borders of site is prohibited.
- The space of parking should be dry and light
- Parking should be flexible in a case that they could be transferred to other place at peak time of traffic.
  - Water closet (WC) (figure 39 and 40)
- containing safe, relaxing and convenience water closet
- All of the WCs should include equipments for disable people
- Equipments to change the diapers of babies are essential
  - Gas station (figure 41)
- Gas station of a Tir park should have all common fuels
  - Phone booth (figure 42)
  - Police station to increase safety
  - Pharmacy
  - Bakery (figure 43)
  - Green space (lawn, and tree plantation) (figure 44)
  - Mosque or pray room (figure 45)
  - Automatic tellers machine (ATM) (figure 46)
  - Clinic
  - Safe place for children as playground (figure 47)



Fig. 39 to 46 equipments of the Tir park

- The equipments for children should be colorful, safe, interesting and exciting.
  - Restaurant in open air

- Restaurant in open air should have sunshade, dining table and chair, waste basket

- All emergency and essential services of the Tir park should be 24/7 available (Police, clinic etc.)
- A place for shower is considered significant
- Possibility of stay (figure 47)
- A place for short time stay (figure 49)
- Recreational equipments specially for families
- Entrance (figure 50 and 51)



Fig. 47 an example of a playground



fig. 49 lack of bench outside the tir park



fig. 48 lack of relaxing space for passengers

- Entrance and exit should be designed in a case that the flow inside the complex stays safe and convenient.

- All entrances should prepare the disable people's accessibility as well.

The course of mounted and pedestrian should be separated



fig. 51 southern entrance of the Tir park.  
Source: the authors



fig. 50 northern entrance of the Tir park.  
Source: the authors

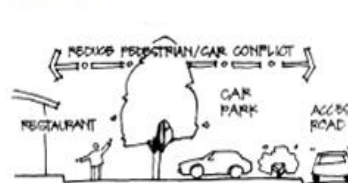


fig. 53 pedestrian and mounted way  
Source: the authors



fig. 52 Tourism Information center.  
Source: the authors



fig. 55 the stand of souvenirs of Qazvin  
Source: the authors



fig. 54 the clothes of Qajar Era in Tir park  
Source: the authors

## VI. CONCLUSION

With refers to the universal experience and by the use of vic roads standards and Iranian and foreign case study it will be obvious that design standards of physical and functional aspects of Tir parks depends mainly on some factors such as: climate, physics, society, culture, tradition, religion and etc. and the principles which should be noted all over the world vary from culture to culture and country to country. Among these principles some land uses such as: Restaurant, retail stands, auto emergencies, phone booth, emergency aid, rest rooms, long term vacancy, parking, gas station, police station, bank stands, green spaces, children playground, and designed open space and etc. seem important and essential which should be located in any Tir park to reach universal standards. Physical standards which have been analyzed depend mainly on some parameters such as: location, space syntax, accessibility, native materials, etc.. so as these complexes include lots of the land uses inside the city in smaller scale and locate out of the cities, the main reason of them is to service passengers on road trips. Thus, if their open spaces are designed in a way that entertainment activities, conversation, and etc. are being available, so all of the factors of a public space (public, limitless, and full of communication) are being considered and we would have a vibrant and live space to attract tourists.

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# Considering the present condition of urban green space (intraurban parks ) by GIS(case sample: district 18 of Tehran)

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**Abstract**— Urban uses are considered as the main column and frame of the city so that the cities are assessed according to the functions and services of how to establish them. Green spaces have different functions in the cities specially big and industrial cities among the urban uses. Green space improves the bioenvironmental conditions of the cities from one hand and provides the suitable conditions for citizens to spend their free time from another hand. The public uses cannot provide desirable services for the citizens because of some reasons like the high density of population, disordering of establishment and location, not paying attention to availability radius and population thresholds. This matter I more visible in big cities particularly for uses like the green space ( intra urban parks). Urban green space is so important that the existence of these uses is one of the indices of development of the societies today. The green space of the studied district (district 18 of municipality of Tehran) is considered in analyzing urban green space to study the distribution of these uses within the district. Then the data are analyzed by the geographical information system (GIS) so that some suggestions can be proposed by the attained results for determining the districts disadvantaged from using public facilities (parks) and directing the responsible to the necessity of paying attention to suitable locating and distribution of green space (intra urban parks) within the district.

**Keywords**— Intra urban parks, urban uses, urban green space, district 18 of Tehran, GIS

## I. INTRODUCTION

City is a live and dynamic system that parks and green spaces are parts of it. They are valuable in future development of the city due to their effective role in decreasing urban density, making directional paths, completing and improving the function of the educational, cultural, residential establishments and of the earth sources (Karimzadegan, 2003,12 ). In spite of its meaning in the mind, it is not a place with some trees and benches, but a symbol of the cultural and social thoughts of a

society and it is considered as an important factor in the urban space which is always socially, culturally and mentally attended by the public. It plays special role in urban planning (Salehifard, 2010, 51). Green space in the cities is so important that it is mentioned in the five important urban uses. The important of this use has found more important position since the fast and unprecedented development of the cities after the industrial revolution (Tiemuri, 2010, 137). The establishment of the urban parks is worth to be considered broadly due to their effect on the quality of the urban life and achieving the sustainable development from one hand and to their financial urban which is without returns for the municipalities (Manlun, 2003, 31).

## II. BACKGROUND OF THE RESEARCH

First, we mention some researches on this subject which we have used because the present research is considering the present condition of urban green space (intra urban parks). One of these researches is *studies of location finding for making green space* which specifies the qualified areas. This project is proposed by the Organization of Environment Protection. There is another research by Akbar Esmaili (2002), *Considereing And Analyzing The Use Of Green Space(intra urban parks) From The View Of Urban Planning*, The University of Tarbiat Modarres. This research considers the condition of intra cities parks by using GIS. Ashraf Rasulzadeh has proposed a research with the subject of *Geographical Consideration Of The Spaces For Spending The Urban Children's Leisure Time With Emphasizing On Parks*, case sample: Park of Shafagh, The Islamic Azad University, Unit of Tehran markaz. It assesses the space of Tehran City, different kinds of parks in neighborhood, regional and local scale and considers their compatibility and hierarchy according to the needs of the children for spending the leisure time and its suitability to the urban places.

The goals and hypothesis of the research

The main goal of this research is whether it has been paid attention to the vicinity uses in locating the green space (intra urban parks) of district 18 of Tehran?

It seems that no attention is paid in locating the urban green space (intra urban parks) of district 18 of Tehran.

### III. THEORY BASES OF THE RESEARCH

Analyzing the local- special suitability is a process which determines the suitable place in a specified block for a certain use (Hopkins, 1997, p 13). The process of determining the compatibility, capability and qualification of part of land for a certain and defined use is referred as analyzing the suitability of land. In another word, it is a process for determining the qualification of land source for a certain number of uses and determining the level of its suitability (Yang Manlun, 2003, p: 21) to determine the best way for future development. Suitability for different uses should be studied with the aim of growth in the best paths of the places. This analysis is an important method for planning. The suitability of land is determined according to some features like hydrology, geography, topography, geology, biology, social and so on (Al-Shalabi, 2006, p:2).

Population growth, development of the city, the birth of metropolises and disappearance of the traditional and natural texture of the cities has continuously made the thinkers of designing the urban environments look for reviving the vital needs of the cities like green space and natural landscapes and use the new equipment to do so (Khaksar, 1999). The scientists have understood that the green space can help the peace, rejuvenating and decreasing the violence of people. Urban nature can provide economic advantages for both urban managers and citizens besides these social and physiological advantages. For example, air conditioning that the trees do decreases the cost of decreasing the pollution and its rate. Moreover, the aesthetics, historic and recreational values of urban parks increase the attraction of the city, tourism value and the income (Cheisura, 2004:129).

Urban green space is a part of urban open space whose natural or often artificial areas are under the cover of the trees, shrubs, bushes, flowers, lawns and the other plants which are established and maintained under human supervision and management and according to the related rules and specialties in order to improve the welfare and life condition of the citizens and non-rural population centers. (Esmaili, 2002:12). If we divide the urban green space into three categories of public, semi public and private according to the ownership, urban parks are in the category of the public green spaces. Basically, due to the nature of these spaces, all of the people can use it (Majnunian, Henrick, 1995:34). In another word, parks are green spaces designed with different uses for public to use them for research, education, recreation and health

maintenance (planning and management organization of the country, 2001, 26). In fact, parks are the parts and textures of the city which is physically and visually available for the public and some activities are performed in them. In fact, they are places for spending leisure time, interaction, conversation, education and so on (Kimia, 2002, p 149).

Returning an open space to a city where both aesthetic aspects and enhancement of the urban space and improvement of the bioenvironmental aspects, increasing the health and urban health are paid attention to is the main aim of the urban park. the urban parks plays a social, economic and ecologic role which has advantages like curing the mental illnesses, a desirable place for bringing up the children, social uniformity, peace maintenance. They are an index of enhancing life quality and development (Balam 2005, p149).

Today, although green thought and green city are considered as the high aims and thoughts in the developed countries, considering the matter of urban green space is mainly empirical and casual in Iran (Hataminejad 2010, p67). one of the important green spaces in the cities is the urban park. As it was said before, urban parks are parks with the recreational, cultural, bioenvironmental and environment healthy making aspects. They service different districts of the city. Such a space is divided to four groups according to its extension (Saidnia 2000:53):

1. The neighborhood park which several housing units use in the neighborhood scale and it's less than half a square hectare.
2. The local park which is located in a neighborhood and it's about twice as big as the park in the neighborhood scale (about one hectare).
3. The regional park which is located in a housing region and it is from two to four times bigger than the local park (4 hectares).
4. The district park which is used by the residents of a district. It is at least twice the regional park. It usually takes more than 15 minutes from the farthest point of the district to the park by the motor vehicles (8 hectares).

Urban parks are the products of revolutions in the social life and garden building methods which start from the Ghajar period with the other aspects of architecture and urbanism and its main results have entered the arena of urban space with half a century delay (Soltani, 2007:48).

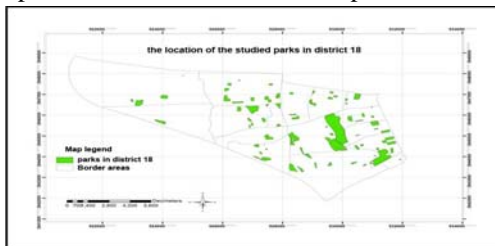
#### IV. METHODOLOGY

Today, it is clear for all of the urban specialists and managers that it is impossible to manage the different affairs of the cities by the traditional tools. The importance of using geographical information system (GIS) is certain in urban planning due to the fast development of the cities and mazing growth of the information which should be processed for the urban planning (Farajzadeh Sorur, 2002:180).

The aim of the present research is an applicable one. It is a case-cross sectional research. The statistic data are collected by the documentary and library resources. Then, they are classified and analyzed by entering them into computer soft wares like collecting information software with CAD&SHAPE format and processing software of ARC GIS.

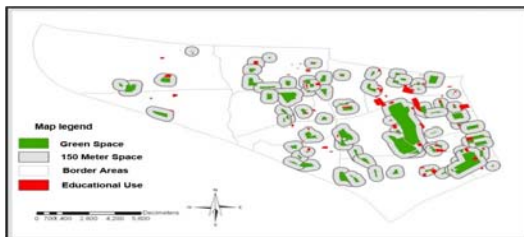
#### V. THE FINDING OF THE RESEARCH

Map 1: the location of the studied parks in district 18

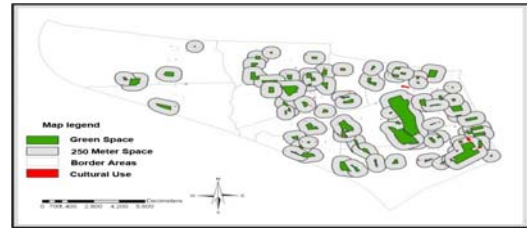


Compatible uses are quiet compatible with the uses of the green space (intra urban parks) and they have desirable effects on the users according to safety, spiritual and mental comfort. Cultural, household, educational and sport uses are considered as the compatible uses of parks in this research.

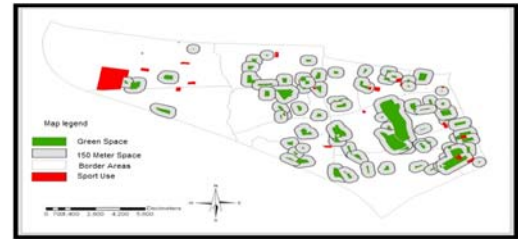
Map2: the location of green space to the educational use



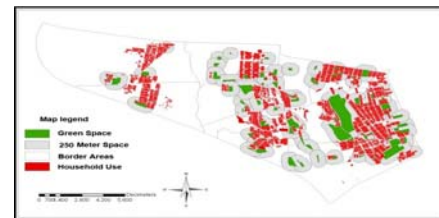
Map3: the location of green space to the Cultural use



Map4: the location of green space to the sport use

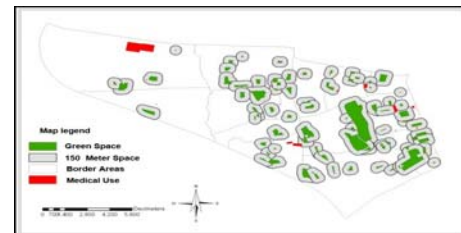


Map 5: the location of green space to the household use

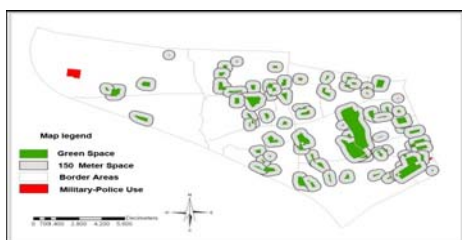


Semi compatible uses which are considered in this group are the uses whose vicinity is not suitable for green space use, but they are useful according to the fast availability to these centers in bad events. The semi compatible uses which are considered in this research are medical, military- police uses.

Map 6: the location of green space to the medical use

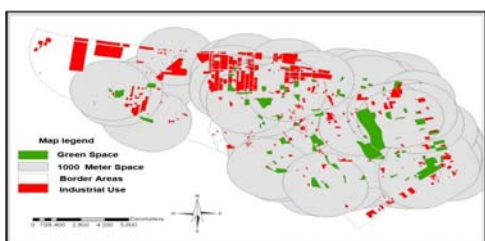


Map 7: the location of green space to the military-police use

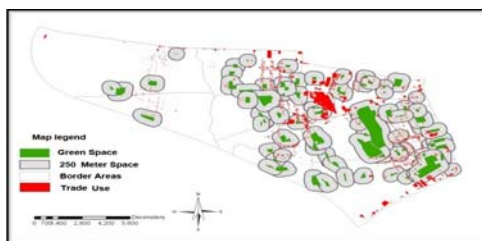


Incompatible uses are the uses which are quiet incompatible with the green space use and they have undesirable mental and spiritual effects on the users. Industrial and trade uses are among the incompatible uses which are considered in this research.

Map 8: the location of the green space to the industrial use



Map 9: the location of the green space to the trade use



## VI. CONCLUSION

Finding no suitable location for the urban green spaces and paying no attention to their vicinity uses cause disorders such as limitation in proposing suitable architecture design, limitation in selecting and arranging the suitable plants, confusion in the urban portray, difficulties in irrigation and soil reformation, no suitable social interaction, difficulties in management and maintenance, decreasing mental and social safety and so on. Compatibility and incompatibility of the vicinity uses are not considered in locating urban green space (intra urban parks) uses of the studied district. The hypothesis is confirmed that Compatibility and incompatibility of the

vicinity uses are not considered in locating urban green space (intra urban parks) uses of the studied district according to the information of the upper maps which show the location of the uses with the parks of the studied district and the considered territories. These results are found by using field observation and GIS:

As the maps show, in establishing the parks of the studied district, parks are in a very good situation according to their cultural use and their situation is relatively suitable in vicinity with sport uses. The conditions of parks are quiet suitable in their vicinity with educational and household uses which are compatible.

The conditions of the parks according to their vicinity with semi compatible uses: they are in a good condition according to the medical uses. The conditions of parks are almost suitable in vicinity with military and police uses. They are not in a suitable condition in their vicinity with troublous industries and workshops which are incompatible industrial uses. The conditions are unsuitable in vicinity with trade centers.

Some suggestions are proposed in this area:

1. A suitable place for establishing new green spaces (intra urban parks) should be selected by geographical information system to avoid time, energy and cost wasting in different institutions. A powerful database in most of the related organizations and offices is required to do so.
2. Transporting the industries and troublous industrial polluted workshops and the centers whose vicinity with parks have undesirable mental effects on the users and are unsafe to the district suitable for these uses in order to provide the required levels of the needed uses particularly the green space use in the district and to provide new facilities for the owners of the industries and workshops by the municipalities and the other organizations.
3. Prioritization of the prone places of the district for building intra urban parks.
4. Employing the forces specialist in locating, designing, building and maintaining the parks.
5. Attracting the participation and coordination of the residents for maintaining and developing the green space of the district by Tehran Municipality using the effective advertisements by the mass media like TV and radio.



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# Features of Qajar Era Houses in the Temperate Climate of the Caspian (Case Study: Kolbadi's House and Sardar Jalil in Sari)

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**Abstract**—Mansion of Manuchehr Khan Kolbadi is located in Abanbar-e-no neighborhood in Sari, and was built around 140 years ago in the late Qajar era by the order of Sardar Jalil, a Sardar of army at the time. This monument was registered as one of the Iranian national monuments on October 31st 1998 with the registration number 2148. Currently, it has been turned into the Museum of Sari city. Architecture of this mansion and the house of Sardar Jalil are influenced by Qajar era architecture, having interior and exterior parts taking the climatic and architectural aspects into considerations. The main building of the two mansions in the interior part was built on two and three floors, and a basement and a dais and two-way rooms on each floor. Dais of the second floor is one of the most beautiful rooms of the mansion, and every part of it recalls the decorative arts practices of Qajar era. Properties of the architectural components of the building such as rooms, chambers, dais, bath, stable, yard, the art used on their windows, sashes and their decorations with colored glass are unique in their own kinds. Over time, kitchen and parts of the servers' residential units got ruined and now it has been replaced by new buildings. Like most buildings of Qajar era, this building was built with mud, lime, reed mace, stone, glass, ceramics and wood. The building has ceramic roof, false arc, lion head shapes, sash windows and brick façade. This paper applies library research method, and most of its subjects are obtained from people familiar with the building, and are descriptively presented in the paper. People who have tried to understand and introduce Tabarestan were mostly employees of the province's cultural heritage and crafts organization.

**Keywords**—Hojabr Sultan, House of Sardar Jalil, Kolbadi's House, Qajar Architecture, Sari

## I. INTRODUCTION

One of the characteristic of a city is its dynamicity. It means that no finished and complete form can be defined for it, because cities are constantly changing in the development process for their compliance with environmental, economic, and other conditions.

However, a period of the formation of the cities which is relatively stable can be defined. Historic town of Sari has been known as the state capital since the oldest days of its inception. Geopolitical position of Sari i.e., its centrality to the subareas of the state, on one hand, and the favorable natural conditions, such as proximity of Tajan River, the fertile plains of the Alborz Mountains and the Caspian Sea, on the other hand, has created an opportunity for selection of this location for founding a city.

The structure of the initial model of the city is based on the factors mentioned above, i.e., the need to access to subareas of the government in the East and West and coasts of the Caspian Sea and Alborz, which form two intersecting communication axes and the main focus of the city activities forms at the junction. With the foundation of the city, feudal castle (8th century A.H.) of four city gates of Babol Gate, Gorgan Gate, Sea Gate, and Kahestan Gate was built.

## II. LOCATION OF CITY SARI

### A. Construction of Sari in Millennium BC

Based on multiple versions, building Sari is attributed to many famous people. It is mentioned in the travelers' diaries that people attributed it to Qumars Pishdadi, the first king on earth as Ferdowsi quoted. Some people including Hamdollah Mostofi, attribute its building to Tahmurs Shah Divbandi Pishdadi. Many, from the evidence, believe that it was the platform of King Fereydoon on the world but almost all believe that Toospor Nowzar, one of the descendants of King Fereydoon and generalissimo Keikhosro built it and called it Toosan. Beyond our national anecdotes, ancient Greeks stated it Zadrakarta, capital of Hirkanya civilization. Spiegel, a German orientalist and neo-Naziist noted that the current name of Sari is derived from the name of Saoroo nation who lived in Asram ancient city which is now name of a village 10 km away from Sari before the invasion of Aryan tribes to this area. Edward Pollock believes that the name Sari is transformation of the term Sadrakarta. Dr. Eslami wrote in his

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book that Zadrakarta is likely taken from Zardgerd name as well (Mahdavi, 2007).

### *B. Sari Architectural Features*

One of the characteristics of residential buildings in the area is that they have introvert inclination, which is due to open and wide relationships between family members as well as weather and climate position of the city. Buildings have direct access to public spaces and this relationship is maintained through open spaces and through many windows. There are open spaces surrounding residential units and the connection between open and closed spaces is generally made by covered verandas. Ceilings of all buildings are steep with wooden beams and a coating of clay.

Materials used in the buildings are brick and mortar of lime and rice straw ash. In addition to functional relationships of buildings, they are built in the pass of air current and rapid flow of air which causes air flow in the building. Doors, windows, and sash windows are made of wood and have wooden decorations. Also old houses have light doors which have decorative aspects. Areas that are newly formed have particular texture; all directions are perpendicular to each other and building blocks are in the streets and connected to each other. Open and wide spaces are disappeared and replaced with private open spaces limited to very small courtyard [5].

### *C. Climate*

In Kolbadi mansion, like all traditional buildings, some solutions are envisaged implemented for compatibility with climate that as follows:

1. Due to heavy rainfall in the region, the house has a gable roof.
2. Stretching of the house plan is east to west.
3. A lot of ducts were built on the north and south side of the house to prevent weather sweltering and creating air current.
4. A galley was built under the ground floor for air ventilation.
5. The shape building is extrovert.
6. The building has porches or corridor [8].

## III. HISTORY

### *A. History of Qajar houses*

In the Qajar era, the old living system underwent a transformation influenced by factors mostly having universal origin and new aspects of urban life with a special hierarchy emerged.

In this era, construction with drawing plans was introduced for the first time. Moreover, design and construction were given to individuals unlike the teacher-student system and

teaching architecture at the presence of European teachers was started in Darolfonoon.

Qajar era architecture is called the period of building architecture or residential houses architecture, because most constructions were inclined to building shelter and housing for the immigrants and newcomers to the city due to the increase in urban population in this period. Excessive construction with inappropriate economic conditions prevented the dramatic change in the dynamics and spatial structure of the houses.

House of Commons were built based on the neighborhood contexture and in compliance with the terms of that time model for Iranian houses. These homes had central courtyard, three and four door rooms with sash windows and the entrance spaces included vestibule and corridor.

Just houses of the nobility and privileged classes were built in good neighborhoods like the traditional palaces and mansions.

### *B. DECORATIONS*

English and French decorations with broad surfaces, lawns, ornamental trees and shrubs, large and small rectangle pools, broad planting gardens and building landscaping that made it somewhat out of being central. Decoration of the interior spaces with old mirrors and elegant and delicate plaster work. Other decorations in the building include: European-style marble columns and capitals, f rescos on various topics such as major historical events, portray, paintings, and landscapes which covered all interior surfaces of the walls, interior and exterior collections of marble and bronze, Sash and colored glass, outdoor landscaping with tables, chairs and sofas.

### *D. Physical properties of spaces*

1. Plans are drawn along the facade, tower are built on one side or both sides of the building.
2. Broad verandas in the front part of the building.
3. Large lobbies and halls with central stairs.
4. Wall heaters, and gable roof and light roofs.
5. Large landscapes by windows and large and small skylights in the facade of buildings.

Overall, the architectural style in this period is a fusion of traditional Iranian houses along with some cultural perspectives. Following the evolution of architecture style in building houses, gradually the main concept of mental and physical architecture "introversion" was replaced by "extraversion" in the construction of houses that numerous examples of it can be found in Tehran at that time [6].

## IV. POSITION OF KOLBADI MANSION

### *A. Position*

Sari city can be divided into several different areas based on reviews each of which has its own social characteristics. Sa'at square which is located in the center of Sari is the starting point or end point of the route of a lot of buses and taxis. This

square is located in the midst of Imam Square to Babol Gate, and from there to Gorgan Gate (Shohada Square) to Tajan Bridge. Neighborhoods around the Sa'at Square are of the ancient part of the city with old texture. Kolbadi Mansion is also located in the old texture of Sari city and in Abanbar-e-no neighborhood. This texture and neighborhood is somehow the core of Sari where in many monuments are located. In fact, the role of this neighborhood is summarized as a business and administrative district in the city. In addition, old park of Sabzeh Meydan and the city Barracks are located in the core of the city that attracts particular attention in the city both in terms of commercial and administrative because it is one of the core elements of the city. Its municipal location on the map of Sari is displayed.

### *B. Regional and Local Position*

Manuchehr Khan Kolbadi mansion is located in Abanbar-e-no neighborhood which is one of the oldest neighborhoods in Sari. Most historic buildings in the city are located within the neighborhood. Major commercial – administrative activities are centered on the streets of this area and Nargesieh Market. Area of this neighborhood is 5/4 % of the total area of the city and its population holds 7% of the total population of the city. This region is one of the crowded and busy regions of Sari and residents of the area are mostly shopkeepers, merchants and staff who are the middle class of the society. Ancient buildings of two stories and more are located in this area.

Old monuments in Sari include Abanbar-e-no, Kolbadi house, Mustafa Khan theological School of, Okhovatian house, Fazeli house, Abanbar-e-miraz Mahdi, Imamzadeh Yahya, Imamzadeh Zein Al Abedin, Sardar Jalil house, Grand Mosque, and Finance buildings.

Abanbar-e-no is one of the old neighborhoods which has narrow alleys and materials of its old building mostly consist of bricks, cement and wood. Kolbadi mansion is located in this neighborhood which was at that time one of aristocratic homes and it was more luxurious and important than other nobles' large houses in terms of construction and interior spaces because of the use of its owners who were military and political leaders.

The famous building of Abanbar-e-no, Fazeli House, Mustafa Khan theological school, and Sa'at square are the monuments in the neighborhood that were related to Kolbadi house. Furthermore, ancient Vaziri Bath is also located in the vicinity of this building. Position of this house in the neighborhood is shown in the picture 1.

### *C. History of Kolbadi House*

Manuchehr Khan Kolbadi mansion was built in Abanbar-e-no neighborhood around 130 years ago by the order of Sardar Jalil who was a military Sardar and was called Amirieh in the name of his eldest son, Amir Nosrat. Amir Nosrat died in his youth and the Sardar bestowed it to his son Manuchehr Khan.

Manuchehr Khan Kolbadi who was later one of landowners and representative of Sari people at the Parliament and after his death in 1983 the building was given to Cultural Heritage Organization in 1991.

Architectural style of the building was inspired from Qajar period mosques and has two parts of interior and exterior. The main part of the mansion in the interior part was built on two floors and a basement and each floor has a dais and two-way rooms.

Dais of the second floor is one of the most beautiful rooms the mansion and anywhere in it recalls decorative arts practices of that period. Construction materials of the building include wood and brick with a gable roof and ceramic coatings.

Unlike written sources, oral sources attribute the mansion to Amir Asadullah Khan Hojabr Sultan Bavand, the third child of Amir Moayad Bavand from Savadkuh who was killed in an armed conflict with the central government (Vothugh Al Dole- 1921) on June, ninth, 1923 by the order of Army Sardar Reza Khan. Naturally after his death, all of his possessions including the building were confiscated and finally transferred to the newly appointed military governor of Mazandaran, Sardar Jalil Kolbadi. In authors' view, this could be a big challenge in the field of historical research especially history and ownership of this building for researchers and create a new field of study and research [9].

Asadullah Khan Hojabr Sultan Bavand, a valiant Sardar was born in the mountains of Savadkuh in 1887. His family descended him from Bav, Shapur's son, major general of Tabarstan, to the brother of Khosro Anoshiravan. His ancestors had 2000 years government in Tabarstan and his father was the governor Savadkuh and a famous statesmen.

Sultan Hojabr was the third child of Amir Moayad Savadkuhi who was braver and more knowledgeable in Military affairs, mountain wars and guerrilla operations than his two brothers - Seif Allah Khan and Abbas Khan Sahm Al Mamalek. Since childhood at the time of Mohammad Ali Shah when his father was a Sardar of 10000 men in the army of Mazandaran, he learnt military trainings and held the title of Ilkhani. Prior to 1910, he acquired the title of Sultan Hojabr for his bravery and courage against the invading Russian forces [5].

Since Esmaeel Khan Amir Moayad who looked Reza Khan down, encouraged Hojabr and his other sons to prepare an army and weapons.

But when Zahir al-Mulk, ruler of Mazandaran, announced general disarmament with the command of Vosugh al-Dole, the prime minister at the time. Hojabr and other boys of Amir Moayad refused to deliver their weapons and continued their armed struggle against the contract in 1919 until the fall of Vosugh al-Dole and cancel of the infamous contract. When Sa'dollah Khan, representative of Mirza Kuchak Khan took position in Babol with his fighters, Hojabr arranged a partisan organization with a Russian officer in the Park of Babol city.



Birthplace of Reza Khan was Savadkuh that he would not want someone like Amir Moayad to exist in the region with such record and also machinations of people around him especially Amir Akram due to personal displeasures left by the centralist policies of the British government in the past all led to a bloody battles between soldiers of Amir Moayad and the government forces appear [5].

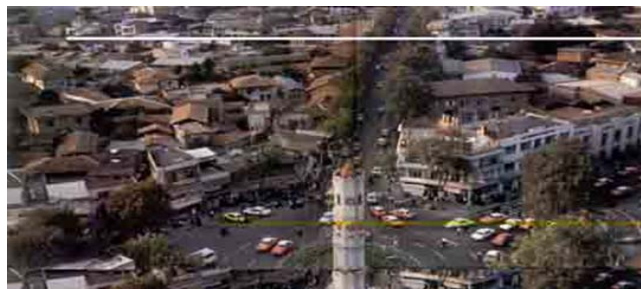
Now with a simple calculation we find that the history of political presence of Sardar Jalil in Mazandaran is much later than construction date of the building. Because when Sardar Jalil was appointed as the military governor of Mazandaran, construction of the building was passed about half a century. However, it appears more correct from oral sources that said Amir Moayad Bavand from Savadkuh dynasty was the owner of the building.

However, comparing the building of Sardar Jalil that was built by his order, we find that despite the simplicity of form, function and decoration, it is tried to show the strength and position of the head and owner of the building. As we know, the house of Sardar Jalil was made three- ranch house and at the time, it was the tallest building in Sari and even Mazandaran. In addition to these assumptions, technique awareness and the way materials were used in the building indicates high speed of its architect, so that haste of the employer in the construction is quite evident.

In any case, when the house of Sardar Jalil was being built Kolbadi Mansion was had been built half a century earlier. This is evidenced by the comparison of two in terms of form, function, decorations and technological structure which itself represents a clear difference between the two buildings.

The main point to be mentioned about the architecture of the building is that this house is a clear example of vernacular extroverted architecture of humid climate zone of the Caspian Sea in the late Qajar in which the feudalistic impact of the ruling class of the time is evident in it.

The main outdoor space of the building included the southern front yard, the middle courtyard and northern backyard and indoor areas included the house and peripheral spaces such as the bathroom entrance - stable - dock - and rooms for severs and kitchen that are located surrounding courtyard and separate residential areas.



Picture (1): General view of the central square (Sa'at) in the historical texture of Sari

#### *D. Climate*

##### *1. Climate Condition of Southern Coast of the Caspian Sea*

This area is of the greenest and the rainiest climate zones of Iran, and it is rainy in all seasons. Despite low width, this coast is comprised of almost two distinct areas. Firstly, it's a narrow strip of plain region developed along the sea with large plantations and large cities. Width of the plain is more in the areas adjacent to the rivers of Sefidrud, Tajan, Haraz and in the East area of Caspian Sea. Secondly, it's a mountainous area in the north of the Alborz chain Mountains which are covered with forest trees. In most parts of the areas, especially in central and northwest regions, the distance does not exceed a few kilometers from the mountains to the sea. Form of traditional buildings and the materials used in these two areas are somewhat different.

##### *2. Climatic Characteristics*

- a. high precipitation in all seasons, especially in autumn and winter
- b. relatively high humidity all year round
- c. low temperature variance between night and day
- d. broad vegetable coverage

Due to the existence of Caspian Sea and immense air humidity, temperature fluctuation during night and day is very low and does not exceed a few degrees Celsius. Especially when the sky is cloudy, temperature fluctuation reduces since cloud acts as a heat nonconductor during the day and reflects some of the sun's light and heat to the outer space and also during the night it reduces heat radiation from hot ground to the cold sky.

Rain and favorable conditions caused rapid growth of plants in all parts of the region which has had its impact on traditional building materials.

Plants and forest density in west parts of the coast is more than eastern parts. For human comfort, features that humid and rainy climate would demand is that in warm seasons, wind flow in all urban areas and two-way air current in the building should be used to the maximum. During these seasons, with flow of air and shadows provides the best conditions for human comfort. In cold seasons, cold wind and winds with rain should be blocked. Another point to mention is that in all

seasons, the building should then be protected against humidity and torrential rain.

### 3. *Urban Texture on the Southern Coast of the Caspian Sea*

In areas near the beach or with high rainfall, air humidity is such a major problem. Moist air is heavier than dry air therefore it is placed under dry air. If the urban area is enclosed and air current and the wind do not flow in it, all the spaces of the city would be full of moist air and breathing would be very difficult. This is why you should take advantage of the air flow over the urban space to prevent moisture from settling down.

Therefore, buildings are constructed separately in this climate with open and large spaces, and fences often shorter than a man's height around these spaces, due to the use of air flow through the building to take the humid and stagnant air away from the living spaces. Benefiting from the beautiful nature and verdant region is another reason for integrating residential environment with nature. It should be noted that as we move from edge of city to downtown, the distance between buildings is less because of the population density and the value of land. However, for the central area of the city, it is also tried to use maximum airflow between the sea and the land or to use the prevailing wind current in the area to ventilate the air of spaces. This way of urban structure that has arisen due to the humid climate is quite on the contrary with the confined and closed rural and urban texture of the cold climate and hot and dry climate [5].

### 4. *Total Urban and Rural Texture Characteristics*

- a. widespread and open urban and rural texture
- b. relatively large urban areas
- c. surroundings with short walls
- d. relatively wide allies
- e. separate buildings in interconnected urban centers

### 5. *Building Forms and Materials on the Southern Coast of the Caspian Sea*

Due to excessive rain and excessive moisture, building forms are mainly established to deal with these two factors [5].

#### E. *Type of Materials*

Building materials of these areas are often local. Due to the fertile plains and vast fields and forests in the foothills and mountainous areas, building materials on the coast are often vegetable materials. Using this type of material is very affordable because it is so prevalent in this area and it is easily accessible. Also exploitation of these materials over the centuries has developed suitable methods for implementation of vegetable materials in buildings.

The most common type of plaster is plaster of clay and straw (thatch) which is a mixture of argil, water and straw. Here, as in other parts of Iran, the coating is exercised well and length of straw typically does not exceed 10 cm in it. Thatch is used for filling the space between the wood walls by plastering them.

There is another plaster in the area called "Fal mud" which is a mixture of argil, water and pulverized rice skin.

### F. *House and its Elements*

#### 1. *House*

"Home is the only place that the immediate and direct experience of the space takes place in isolation and in group. Having privacy with ourselves, wife, children and others, all and all is possible non- aggression in the house" (Tadao Ando).

House as a real phenomenon, is the first human ever grappling issue that made him always try to change it and think a reasonable response to it. So house is a necessity.

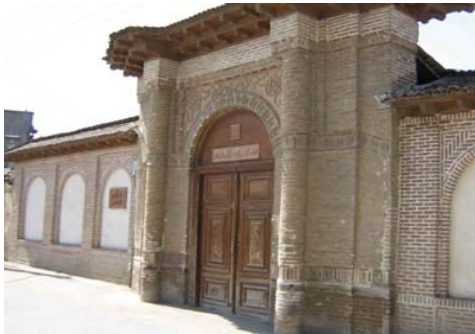
#### 2. *Elements and components of Kolbadi House*

Kolbadi house is located in Abanbar-e-no neighborhood which is one of the oldest neighborhoods in Sari in Qajar era and like most houses in Qajar era in this climate consists of a basement, first floor and second floor. Although this house is architecturally similar to other houses of their age, due to the owner's social status (noble class) and political role in the country, this house has substantial advantages over other houses and its intricacies and application distinguishes it and adds to its glory.

#### 3. *Entrance*

The house's main entrance door opens to the alley of Abanbar-e-no. It is made of wood with wood inlays and high altitude which has a facade made of bricks. In most traditional homes had double doors, each leaf had a knocker. Women rang the door on the left which had treble tone and men rang the door on the right which was hammer like and had a bass tone.

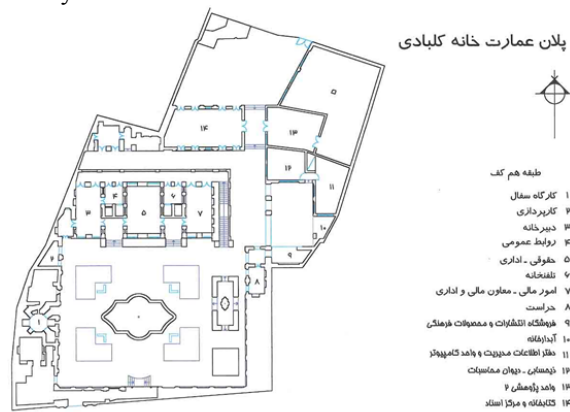
After the entrance door of the house, there is a relatively narrow entrance corridor to the entrance of courtyard. There are also two sets of stairs on the left and right sides that lead to the yard located in the lower level.



Picture 2: Entrance of Kolbadi House in Sari

#### 4. Interior and Exterior

Architectural style of Kolbadi building corresponds with the local residential as well as Qajar era mosques architecture which have two parts of interior and exterior. The main building is constructed in the interior part with a rectangular plan on two floors and a basement cellar. Each floor has a dais and symmetrical rooms on both sides.



Map (1): Kolbadi House Plan

The exterior part which is located on the left side of the main entrance contains a small yard and room to handle miscellaneous affairs and a path to the large courtyard of the interior.

#### 5. Yard

The main courtyard of the house is square with a polygon pond in the middle and a garden for decoration around it. The house has a small yard on the left side of the main entrance which has a room for handling miscellaneous affairs and a path to interior large courtyard.

#### 6. Foundation

To construct the building and its foundation materials such as rubble, lime, brick etc. were used. The use of lime in building, while repelling moisture, is anti-moss and tree roots.

#### 7. Materials

Like most buildings of Qajar era, this building was built with mud, lime, reed mace, stone, glass, ceramics, wood, etc. The building has ceramic roof, false arc, lion head shapes, sash windows and brick facade.

#### 8. Roof and Layout

In general, native Qajar building roofs like Kolbadi house were made of ceramics. The size of ceramics is  $12 \times 30$  and it is steeped to have to deal with wind and rain. Ceramics were put on each other without the use of mortar and just front part of it was sealed with lime and clay. Beams and wooden decorations were used on ceiling. The layout of the building is quadrilateral.



Pictures (3): the roof of the Kolbadi House

#### 9. Dais

It is the largest and most beautiful room on each floor with beautiful decorations such as niche and sash windows and beautiful wood ceiling which are all decorations of Qajar era. This room was used for serving dignitaries and special guests.

#### 10. Rooms

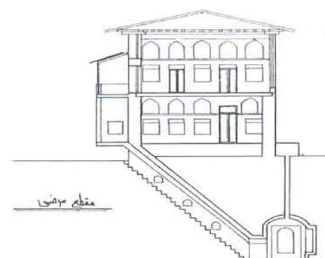
Rooms on each floor are located symmetrically on either side of the dais and mostly have rectangular plan with window sash and that they all have a path to porch.



Picture (4): an interior view of the Kolbadi House

#### 11. Cellar

It's a place embedded deep underground. Due to a lower temperature than other floors of the house it was used as the refrigerator i.e., a place for holding and storing spoilable food.



Map (2): cross-section of Kolbadi House in Sari

#### 12. Decoration

Sash windows, wood ceiling, niches, entrance doors, cornice and skylight lattice above it and lion head shapes and more were the decorative arts of the period used in the house.

Second floor of the house is decorated entirely with Sash windows which is the main manifestation of this house.



Picture (5): the stone Decorations in the Kolbadi House

### 13. Sash

A type of window that was opened in line with the vertical axis and was used as a decoration element.

### 14. Niche

Space to put items which was built inside the wall. There are two rows of niches in Kolbadi house that the top row was used for decorative items and the bottom row was used for easier access to their applicable things.

### 15. Stable

It was a place to keep horses. This space was isolated and left in the period that the use of animals in cities, due to the entry of cars was abolished.

### 16. Bathrooms

Kolbadi house not only had a bathroom in it, it had another bathroom in North Side that in the past had two entrances through the streets of Abanbare-e-no and the current Street of 18 Dey, but now both routes are closed and access is possible only through the northern courtyard. The bathroom was famous as Vaziri Bathroom due to the proximity to Vaziri home.

## V. COMPARISON OF SARDAR JALIL HOUSE WITH KOLBADI HOUSE

### A. History of Sardar Jalil House

Sardar Jalil House is located in a street of the same name in the old texture of Sari.



Picture (6): Exterior panoramic view of the Sardar Jalil building.

### B. Elements and Components of Sardar Jalil House

This house was built in three floors three-storey with a rectangular plan.

First floor: The building has 3 central rooms that have an open and close corridor in different sides. The rooms are connected

to each other by wooden doors and light of the rooms is supplied through doors in the hull. There are many holes above the doors which were likely made for decorative reasons.

Second floor: It is quite similar to the first floor and has 9 in doors which were light supplier into the corridor and the rooms. The upper part of the door has colored glass into wood.

Third floor: Like the first and the floor, it has 3 rooms in the middle without corridor. Instead of corridors there are terraces located on different sides that were probably used in warm seasons.

The roof of the building has wood bars and it is covered by ceramics.

The pillars of terrace part which support the roof, has lion's head shaped capitals.

### C. Features of Sardar Jalil House

1. Combination of traditional architecture with the Qajar era.
2. Architectural decorations including special wooden and architectural decoration are the only surviving example of the Qajar era.

## VI. CONCLUSION

These two mansions are typical examples and products of environmental, human and surrounding compliance in this region. Architecture of the buildings was influenced by the architecture of Qajar era having interior and exterior parts and respecting climatic and architectural considerations. The main building of the two mansions in the interior part was built on two and three floors and a basement and a dais and two-way rooms on each floor. Dais of the second floor is one of the most beautiful rooms of the mansion and anywhere in it recalls the decorative arts practices of Qajar era. With this difference referring to the issue of ownership and the year of the construction of two buildings, Sardar Jalil house was made much simpler and in less time based on adapting the form, function, decoration and technology of construction. Sardar Jalil house was built more than half a century after Kolbadi house! With regards to the authoritarian spiritual of Sardar Jalil it is hypothesized that his house was built in early 14th century based on Persian Qajar architecture in three floors with the aim to boast his political position and the position of the director and producer. It was built so fast and it is evidenced by the vast differences between the two buildings of Kolbadi mansion and Sardar Jalil house. So there is the assumption that attributing the ownership of Kolbadi mansion to the family of Sardar Jalil is a history mistake or exaggeration. On the other hand, based on oral sources and comparison of the parameters and characteristics of the two buildings, attributing the ownership of Kolbadi mansion to the family of Amir Moayad Bavand Savadkuhi, especially his son, Hojabr Sultan is more accurate.



#### ACKNOWLEDGMENT

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# Pathology of urban seismic areas using Inversion Hierarchical Weight Process (IHWP) and GIS; case study: Gorgan

Qadir Siaami<sup>1</sup>, Kazem Taghinejad<sup>2</sup>, Seyyed Moein Moosavi Nadoshan<sup>3</sup>

**Abstract**— Physical components of urban areas such as buildings, open spaces and their physical characteristics like the size of mass, manner and place of settlement, size and appearance and their positions have a determining role in intensity and extent of cities' seismic vulnerability during an earthquake. Many Iranian cities are located on the areas with medium and high risk of earthquake. Therefore, considering the quality of the elements and physical components of urban areas can dramatically decrease man-made disasters in Iranian cities. The city of Gorgan, with a population over 330,000 and an area of 3600 hectares in 2011, is one of the cities which are located in earthquake-prone areas with high risk of earthquake. Residence of some 12 percent of the population in time-worn buildings (consisting roughly 10 percent of the whole area of the city) as well as the lack of a pathological zoning (seismic zoning) of the city has made the seismic zoning of the city a crucial issue. In the present article, vulnerability to earthquake was considered through calculation, analysis and combination of factors such as access to medical centers, the ratio of the streets width to the buildings height, (enclosure), PGA (Peak Ground Acceleration) of the area, building density, population density, land use, the structures quality and the extent of vulnerability in Gorgan using Inversion Hierarchical Weight Process (IHWP) and GIS. The study showed that the buildings in the southern parts of Gorgan – compared to the other areas – are less vulnerable. Moving from the south to the north, seismic vulnerability increases. It is due to the fact that the north of the city enjoys wide enough streets and resistant, young buildings.

**Keywords**— civilization, vulnerability, earthquake, Gorgan, Inversion Hierarchical Weight Process, GIS.

## I. INTRODUCTION

According to the United Nations' report from 1980 to 2008, 73,276 people have been killed due to the earthquakes occurred in Iran. Economic loss has been estimated to be over

\$10,300,000,000[18]. Improper establishment of the physical components and urban uses, insufficient street networks, densely populated urban areas, improper placement of infrastructures and shortage or poor distribution of urban free spaces play a key role in increasing damage to the city when an earthquake hits. In this line, seismic zoning regarding the extent and kind of urban areas, reaction to an earthquake using new methods and using techniques such as GIS and AHP can greatly increase toleration of the Iranian earthquake-prone cities. The city of Gorgan (the capital city of Golestan province) with a population over 329,546 and an area about 3600 hectares in 1390, is one of the large settlements of the northeastern part of Iran which is located in an area with high relative risk of earthquake. Since 12 percent of the population resides in a time-worn texture (10 percent of the whole area of the city), the lack of a seismic zoning is disturbing. Hence, the goal of this study is seismic zoning of Gorgan using IHWP and GIS in which standards and effective indices in zoning such as access to medical centers, the ratio of buildings height to streets width (enclosure degree), PGA of the area as well as the layers of the city's vulnerability were extracted by studying geological structures and seismicity in Gorgan.

## II. THEORETICAL FRAMEWORK AND METHOD

Today, earthquake threatens at least 35 countries all over the world and has become a major cause of casualties, injuries, homelessness and damage [16]. Being on Alpine-Himalayan earthquake belt, Iran has been subject to 130 earthquakes with magnitude over 5.7 (or greater) on the Richter scale during the past centuries [4].

Vulnerability is a term which is used to show the extent and size of probable damage caused by natural disasters to communities, buildings and geographical features. Assessing vulnerability of the existing buildings is, in fact, a damage prediction to them when an earthquake strikes [20]. Analyzing vulnerability is a the process of estimating specific elements which are subject to potential risk of disastrous events [3]. In other words, analyzing vulnerability is considered to be analysis, assessment and prediction of probable casualties, property damage and moral damage on the part of the city and the city dwellers. Vulnerable elements like natural, physical,

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social, economical and fundamental factors, as well as rules and regulations are various and are constantly affecting each other as a single system, not separately. On the other hand, vulnerable groups to crises relate to demographic factors such as age, religion, minority, poverty and literacy [11]. Preventing and reducing earthquake risk in cities and villages, and increasing the safety factor in new constructions through positioning and optimizing the usage in urban and rural population centers and improving sensitive facilities with regard to relevant to seismic zoning and seismic vulnerability in the present situation, focus on saving people's lives by developing and revising the urban and rural development plan are of great importance [17]. By developing the structure and economy of urban communities, the necessity of decreasing the danger not only has become a safety factor in controlling the risk of hazards, but also has gained increasing importance after management proceedings in line with planning and consistency following preventive programs form vulnerability [10]. The purpose behind urban planning is preventing disasters, recognizing hazardous elements and reinforcing the environment safety in order to improve and adjust cities [1]. One of the most effective factors in decreasing the repercussions of earthquakes is specifying vulnerable spots of a city. Also, a community should be well prepared to face earthquakes. Urbanizing knowledge can dramatically mitigate the effects of such disasters by determining rules and concepts and by relying on geographical data. Civil managers can observe the needed managerial principles to decline the Iranian cities' vulnerability to these events using the gathered data [7]. Geographical data is of great importance to perform and accomplish the vulnerability of a given area, and can be used as a planning guideline for preventing civil disasters. In practice, the lack of such data is the most serious problem of performing such studies, especially in developing countries. In order to evaluate the degree and severity of natural hazards, preparing maps for vulnerable spots and geographical data related to geologic structure, land use, population, quality and density of the buildings, connecting roads, civil equipment and other aspects of civil activities seems unavoidable. The data can be processed using Geographical Information System (GIS) and be used through presenting proper output. Effective elements and components of civilization on the extent of vulnerability in cities such as characteristics of the place of residence, locating the uses, form of a city and its functional aspects, the size of it, the manner of growth and its management, designing buildings and networks, bad situation of the infrastructures in a city and shortage and improper distribution of urban open spaces, as well as some other factors play an important role in severity and extent of the damage by an earthquake [8]. In contrast, the existence of a number of factors such as the number, distribution, and size of parks and open spaces, the existence of appropriate rescue centers, hospitals, fire stations, appropriate connecting networks, cooperation among people and crucial instructions before an earthquake [21]. On the other hand, land use,

population density, buildings density, quality of structures, width of the roads, height of buildings, paths' logical order and the distance to medical centers are important factors in decreasing or increasing the damage resulted from earthquake. Geographical Information System (GIS) is a computer-based system that saves and processes reference spatial data in different time sequences (e.g. in applying, analyzing, modeling and representing) [19]. One of the prominent duties of GIS is decision-making based on the achieved data from different layers. GIS can have an active role in scientific management, analyses and modeling of environmental aspects [14]. Estimating the potential vulnerability is limited by ambiguities and uncertainties and IHWP model, which is a combination of fuzzy logic and Analytic Hierarchy Process (AHP), allows for membership as a unified spectrum to the standards of vulnerability [6].

### III. MATERIALS AND METHODS

#### 1. Research Methodology:

The present study is developmental-applied in terms of objectives and analytical-descriptive from the perspective of the study design. Data collecting tools in the study included field surveys, observation, questionnaires and interviews with the experts from Gorgan Municipality and also documentary method; by referring to written sources such as books, articles and reports, especially comprehensive and detailed plans of Gorgan as well as land use maps. GIS has been used as desktop software in this work. Moreover, Inversion Hierarchical Weight Process (IHWP) technic has been employed.

#### 2. Explanation of the framework, principles and process of Inversion Hierarchical Weight Process (IHWP) model:

The analyses in the present study were in the form of a process and included the following steps:

##### 2.1. Identifying the importance and rank of the data:

In the first step, the indices (criteria) for identifying vulnerable zones to against earthquake (based on the importance of each index in vulnerability of a given place against to earthquake) according to entropy (based on experience) were ranked. Afterwards, the reversed rank of each layer was considered as its weight in IHWP model. In Delphi model – according to the opinions of specialists – seven different criteria in different levels with different degrees of importance were ranked. Therefore, the most important index of vulnerability – from a seismic viewpoint – is 7 and 0 is allocated to the least important index [6].

##### 2.2. Determining the weighting assumptions

At this stage, hypotheses are considered for the seven criteria of the study. For instance, in enclosure index, the main assumption is that buildings with low height and higher width (lower enclosure degree) have more room to maneuver because the volume of debris is lower in the streets, but the

degree of vulnerability in buildings with higher enclosure degree is higher. Therefore, the map of enclosure is divided to seven classes. Regarding the score gained by this very index among all, buildings with the lowest enclosure degree will have the least vulnerability and buildings with the highest enclosure degree will receive the highest scores. Access to medical centers has a vital role in reducing the negative impacts of natural and man-made disasters. One of the main functions of this, is reducing the number of victims during an earthquake thanks to access to medical centers. Therefore, access to the medical centers during urban crises will increase or decrease the degree of vulnerability[6].

### 2.3. Calculating scores of the related layers

$X = D/N$

X= Raw score of each index

D= the score obtained from Delphi model

N= the number of levels for each index

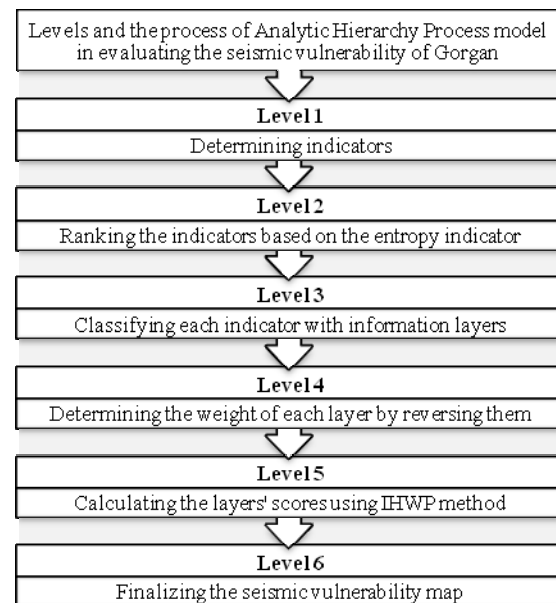
$J = D - (N - i)X$

J= the score obtained from different levels of each index

i= the allocated digit to different levels of each index

### 2.4. Merging the layers and finalizing the vulnerability map

By classifying of the seven indices (criteria) and calculating the related scores to each level through IHWP model, columns of scores – related to each of the created information layers – are added up together in order to identify the vulnerability of each building unit compared with the other units; using each piece of scores. At the end, the finalized map will be prepared by classifying the data in five different levels (i.e. very low, low, average, high, and very high) representing the seismic zones [15].



Levels of the process of determining the seismic vulnerability of Gorgan using IHWP and GIS

### 3. Introducing indices of seismic vulnerability evaluation

In order to evaluate the seismic vulnerability of the study area, seven indices were selected, including:

- *Access to medical centers:* Access to medical centers can accelerate rescue operations and service providing. Thus, the farther the medical centers, the higher the vulnerability. The issue regarding the lack of proper access to vital centers like hospitals is one of the problems that is caused by neglecting the necessity of access to such centers at the time of, or even after locating them.
- *The ratio between the width of streets and height of buildings (enclosure):* By increasing enclosure (buildings' height greater than streets' width), chances of blockage in the paths will increase, which in turn will cause problems for rescue and sheltering operations after debris shed and streets are closed. In many residential areas, also, the central parts of the neighborhoods are only accessible through narrow, meandering alleys which will be inaccessible after taking damage.
- *Area's PGA:* One of the important criteria in designing, yet the main cause of the damage, is peak ground acceleration which is expressed in g (the acceleration due to Earth's gravity) [5]. PGA unit used in this study is decimal;  $m/s^2$ . As the vital centers are located in areas with high risk, their vulnerability will increase. It's clear that even a major building which is designed and built in accordance with the terms of regulations having the base acceleration



(i.e. 0.35 g) will definitely be vulnerable being in an area with maximum acceleration of 0.60 g.

- *Building density:* An important index. The higher the building density, the higher the probability of structural damage and vulnerability. The loss of green space and gardens and their conversion into high density units will result in loss of living quality, biological resources and environmental destruction. Moreover, it will cause improper distribution of open space. This will impose hardship on temporary housing operations and will create serious shortage that makes the transformation of the earthquake victims unavoidable.
- *Population density:* The index which specifies the population size during an earthquake. The greater the population density, the lower the speed of sheltering and service providing and rescue, and vice versa. In major earthquakes, old buildings with low population density are less hazardous than new buildings with high population density. Moreover, due to technical reasons, even new metal-concrete structures are not expected to be safe against powerful quakes [13].
- *The quality of structures:* A building as the final product of a process depends on complicated sets of regulations, services, products and equipment. Here, the quality of construction and its performance depends on the importance of the building, the number of floors, the system of construction, quality control, quality insurance, state of the insurance industry in this section, the level of public awareness, literacy level, and in general, the rate of development in a given country[9].
- *Land use:* Depending on the type of use, vulnerability will be more or less. Therefore, the uses of the study area have been divided to three groups, namely high risk, medium risk and low risk uses. As long as adjacency principles are observed and incompatible uses are not put alongside, quick evacuation is possible.

#### *4. Introducing the city of Gorgan from the viewpoint of effective spatial-local data on vulnerability to earthquake*

In general, there is a wide and diverse range of spatial-local information to explain natural and human characteristics of given areas. This section an endeavor to research and evaluate the majority of such data that can be effective in increasing or decreasing the effects of earthquakes and in considering vulnerability scenarios for the area during sevr earthquakes.

#### *4.1. Physical-demographic analysis of Gorgan in regard to earthquake*

Gorgan, the capital city of Golestan province, with an area of 3,600 hectares has a population over 329,546 in 2011 (Statistics newsletter of Golestan). Based on satellite images, geological maps, dissertations, scholarly articles (Persian and Latin) and seismicity reports presented for different parts of the city, approximately 30 faults – mainly located from 2 to 100 km to the south of the city – have been found. The largest earthquakes caused by the Khazar fault activity include the quakes in 874, measuring 6 magnitudes on the Richter Scale and in 1944, measuring 5.2 magnitude on the Richter Scale that the latter caused devastation of some 30 percent of the homes and villages around Gorgan [4]. According to the investigations, rapid growth of the city began in 1365, but it was an intensive growth until 1996. The years after 1996 and 2006 can be called the era of rapid and increasing horizontal growth of Gorgan – regardless of its quantity. Unfortunately, this trend is still continuing. A wide and unnecessary range of uses like the presence of military zones, and wastelands in the city, emigration from villages to the city, the policies of donating land and house after the Islamic Revolution, an increase in the rate of owning cars, merger of surrounding villages with the city, ambiguity in civil laws and regulations and frequent changes of the city managers

Table 1. The changes in population density of Gorgan during 50 years

are the most important reasons of the sparse and scattered growth of the city [12].



Picture 2. The location of Gorgan, the capital city of Golestan Province



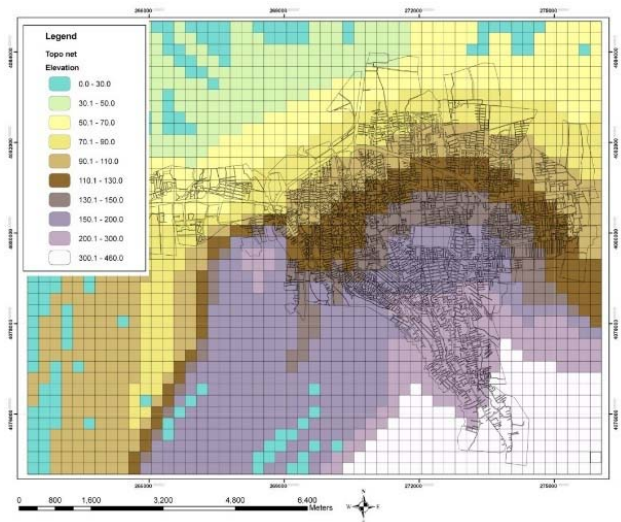
Picture 3. Blocks of Gorgan

##### 5. Morphological structure of Gorgan with emphasis on tectonic and geological structure of the city

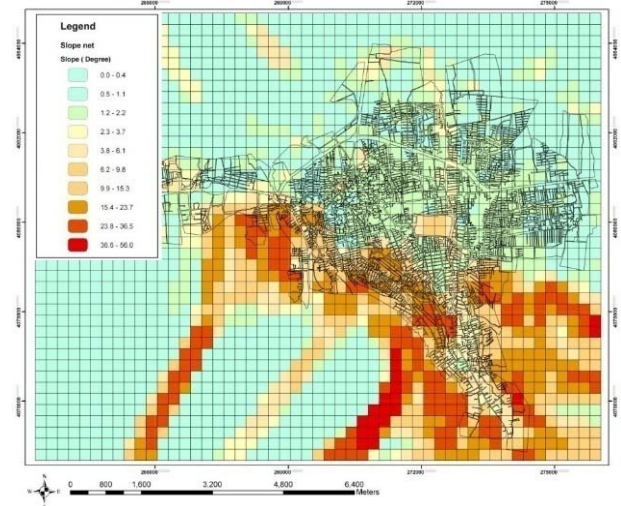
Two information matrices of height and slope from the family of morphological information are significant for preparing and developing the city's vulnerability to

(over density in each hectare)	area ( hectares)	population	year
99/2	286	28380	1956
93/5	547	51181	1966
88/2	997	88033	1976
80/9	1722	139430	1986
67/1	2809	188710	1996
77/08	3560	274438	2006

earthquakes. In areas in which the fluctuation of height is great, the height factor will matter. However, in an urban range like Gorgan, although a gentle change in height from north to south is evident, the effects of height change in earthquake crisis management will not be very significant. In contrast to the information layer of altitude, the effect of slope in some areas of Gorgan will be quite important. Therefore, it should be included in the calculations. In picture 4, height zoning of Gorgan – based on the digital 1/2000 maps of the so-called “detailed plan” and 1/10000 maps of the water organization of Gorgan – is presented. The slope values are in degree and in the southern areas of the city towards Naharkhoran district, a steep slope – which can cause inductive thrusts in some areas during major quakes – is observable.



Picture 4. Altitude zoning of Gorgan and suburbs



Picture 5. Slope values of Gorgan and suburbs

The boundaries of Gorgan – with regard to different provincial geological segmentations are located near geological subregions of the Alborz subregion, the Caspian basin subsidence, Gorgan-Rasht subregion and Southern Caspian subregion. The majority of the study area is located in eastern Alborz boundary. Structures in this area are mainly thrust faults and folds.

#### IV. CALCULATING THE SELECTED LAYERS SCORES USING IHWP MODEL

In the following tables, the selected indices are presented alongside the category of each index and the related scores. The numbers in the brackets of the indices are the obtained scores from Delphi model (D) and the numbers in the brackets of each index's category represent the allocated number to

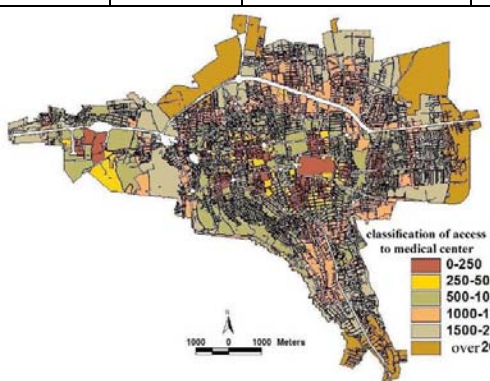
different categories of each index (i). Finally, the scores related to each category of indices is calculated.

#### Access to medical centers(1)

The distribution of medical centers in Gorgan is improper and these centers are located in central parts of the city, inclining to south. In western part, Jorjani and Taheri (under construction) hospitals will partially solve the problem of service providing to the western part, but the eastern and northern parts of the city are void of any hospitals and transferring the victims will face difficulty. The layer of access to medical centers is divided to 6 levels and by reversing the weight of each layer, the blocks having the least distance to medical centers will be assigned the lowest and blocks having the most distance to these centers will be assigned the highest scores.

Table 2. Classifying and calculating the scores related to the levels of indices of access to medical centers

J=D-(N-i)X	X=D/N	Classification	index
0. 166	0. 166	(1)0-250	access to medical centers (1)
0. 332		(2)250-500	
0. 498		(3)500-1000	
0. 664		(4)1000-1500	
0. 830		(5)1500-2000	
1. 000		(6)Over2000	



Picture 6. Map of access to medical centers in Gorgan

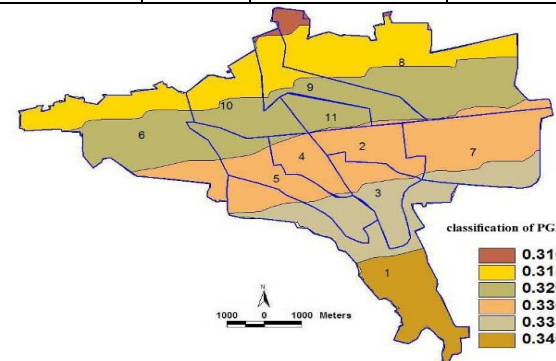
#### PGA index(2)

With Caspian fault being located in Ghaleh Hassan district – in northern part of the city – and analyzing the PGA map of the city, it becomes clear that the maximum amount of acceleration will gradually decrease from the southeast to the northwest of the city, but the amount of decrease – regarding the dimensions of the area – is not very significant. Therefore, in the corresponding table, the northern parts of

Gorgan, the lowest and the southern parts are given the highest scores.

Table 3. Classifying and calculating the levels of Peak Ground Acceleration (PGA) index

J=D-(N-i)X	X=D/N	Classification	index
0. 333	0. 333	(1)0.310	PGA (2)
0. 668		(2)0.315	
1. 000		(3)0.320	
1. 333		(4)0.330	
1. 667		(5)0.335	
2. 000		(6)0.340	



Picture 7. Zoning map of PGA

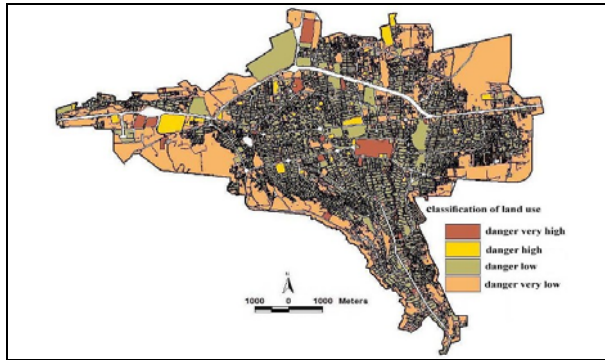
#### Land use index (3)

On the basis of the importance of damage due to earthquakes, the current uses were divided into four levels, namely low risky, medium risky, high risky and very high risky uses – with the highest scores. Schools or military zones are among high risky uses, residential, official and commercial uses are medium risky and salons, warehouses and vacant lands are low risky areas – with the lowest scores.

Table 4. Classifying and calculating the levels of land use

J=D-(N-i)X	X=D/N	Classification	index
0.75	0.75	(1) low risky	land (3)use
1.5		(2) medium risky	
2.25		(3)high risky	
3.0		(4)very high risky	





Picture 8. Risk-taking map of land use

*Enclosure index(4)*

Enclosure index is defined as the ratio between width of the streets and height of the adjacent blocks. In the majority of the city's paths – especially the old texture – the streets haven't been widened. Moreover, low degree of enclosure is evident in such areas. Such streets will be blocked in case of an earthquake, making problems for rescue and relief operations. This index is divided into eight levels for the streets of Gorgan. Low degrees of enclosure pertain to the central parts which are mainly time-worn. In contrast, blocks which are located in the southern parts (Naharkhoran District) have high degrees of enclosure.

Table 5. Classifying and calculating the scores of Enclosure index

$J=D-(N-i)X$	$X=D/N$	Classification	index
0.5	0.5	(1) Low of 0.5	(4) Enclosure
1.0		(2) 0.9 – 0.8	
1.5		(3) 0.9 – 1.1	
2.0		(4) 1.1 – 1.4	
2.5		(5) 1.4 – 1.7	
3.0		(6) 1.7 – 2.0	
3.5		(7) 2.0 – 2.5	

Picture 9. Map of Enclosure index in Gorgan

*population density index(5)*

The highest population density (400 people per hectare) is primarily located in the southern regions of the city, including Naharkhoran district, Golshahr, Dokhaniai and Soroush, with the highest scores in the corresponding table.

The lowest population density is seen in northern and western outskirts of the city, with 1-100 in each hectare, and the lowest score.

Table 6. Classifying and calculating the scores of population density index

$J=D-(N-i)X$	$X=D/N$	Classification	index
0.835	0.835	(1) 0	(5) population density
1.668		(2) 1–100	
2.501		(3) 101–200	
3.334		(4) 201–300	
4.167		(5) 301–400	
5.000		(6) Over 400	

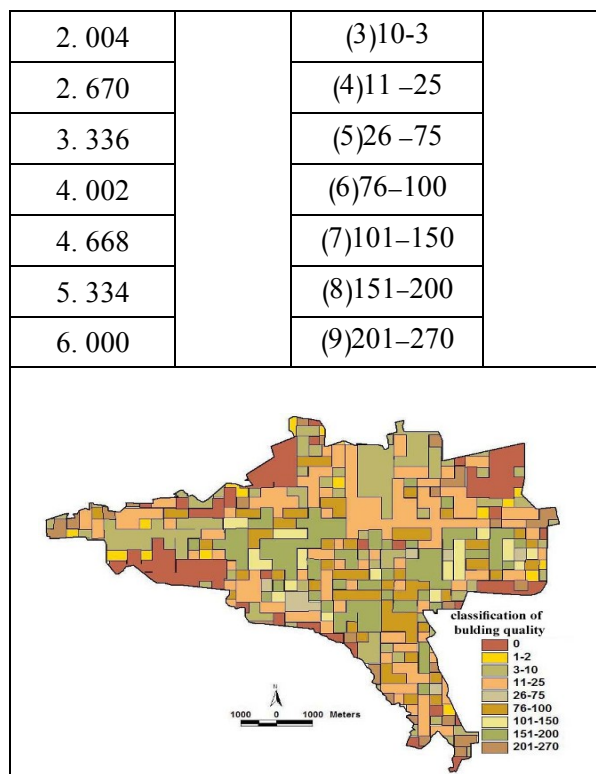
Picture 10. Map of population density in Gorgan

*Building density index(6)*

Building blocks located in southern parts of Gorgan have the highest population density. These blocks include the buildings located in Naharkhoran Boulevard, Dokhaniai, Soroush, Minagol, Shalikoobi and Golshahr neighbourhoods. Nearly, 60% of the buildings in the mentioned areas are four-story or higher and have the highest scores. In contrast, the lowest building density is seen in northern parts of the city in which some 93% of the buildings are two-story or shorter and are given the lowest scores.

Table 7. Classifying and calculating the levels of building density index

$J=D-(N-i)X$	$X=D/N$	Classification	index
0.672	0.666	(1) 0	(6) building density
1.338		(2) 1-2	



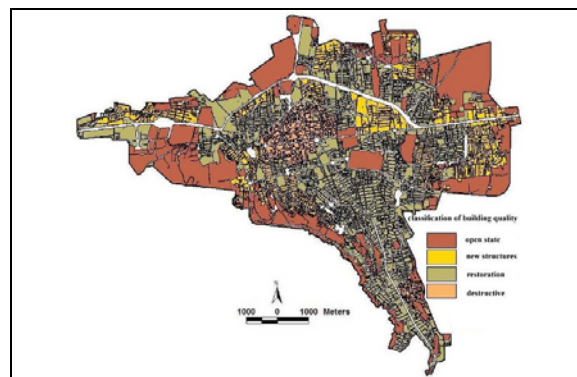
Picture 11. Map of building density in Gorgan

*Buildings quality index(7)*

Regarding the map of building quality, it was found that the majority of blocks located in Iranmehr, Shahid Bahonar, Emam Reza, the old texture of Gorgan, Shohada, Ghaleh Hassan and Eslam Abad do not have any proper structures. About 60% of these buildings are old and lack earthquake resistant structures. Therefore, condemned buildings which are mainly located in such areas gain the highest and new buildings which are primarily located in southern boundaries receive the lowest scores.

Table 8. Classifying and calculating the scores of the levels of building quality index

$J=D-(N-i)X$	$X=D/N$	Classification	index
1.750	1.750	Open spaces (1)	building (7)quality
3.500		Newly-built (2)	
5.250		Dilapidated (3)	
7.000		Condemned (4)	



Picture 12. Map of building quality in Gorgan

## V. ANALYZING THE RESULTS OF CONSIDERING THE LAYERS

Considering the seven layers of vulnerability in Gorgan suggests that maximum Peak Ground Acceleration increases while moving from the north to the east of the city. This, is due to proximity to the Caspian fault and therefore, vulnerability to earthquake – which is particularly in zones 1 and 3 – increases. Moreover, the highest building density is observed in zones 1 and 3. The highest street enclosure and poor quality of buildings are seen in zones 5, 10 and 11, which have a key role in the extent of damage and the manner of providing rescue and relief for the casualties. Most medical centers are located in zones 2, 3 and 4. However, improper dispersion will hinder timely transfer of victims to these centers. Significant urban uses including hospitals, clinics, urban utilities, military bases and schools are scattered throughout the city.

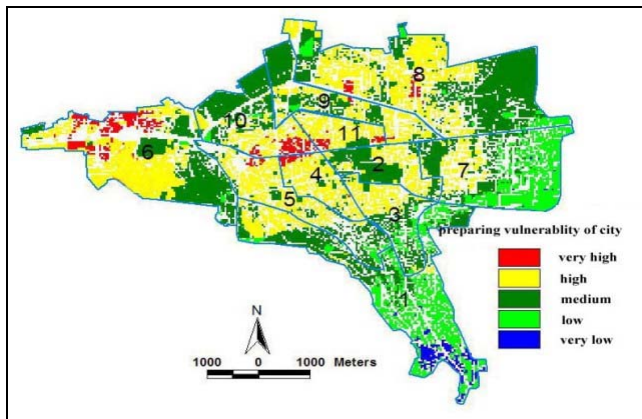
*2.3. Merging the maps*

Columns of scores pertinent to each information layer are added up using Calculator Raster tool. This way, the total of seven columns related to the seven information layers of about each part of score, for each building unit is specified from the perspective of vulnerability and stability; while compared to the other units. It should be mentioned that algebraic operations of the data were accomplished in one stage.

*2.4. Preparing the final map of vulnerability in Gorgan*

In this stage, the final map was prepared in 5 different levels including very low, low, average, high and very high, from the perspective of vulnerability to earthquake. In other words, the scores related to each building unit from the 7 indices and corresponding levels were added up and the map of vulnerability to earthquake was developed.





Picture 13. Map of Preparing the final map of vulnerability in Gorgan

## VI. CONCLUSION

In order to delineate the seismic vulnerability level of Gorgan, 7 indices namely, degree of enclosure, land use, building density, population density, quality of structures, access to medical centers and PGA (Peak Ground Acceleration) were selected and the city has been divided to 11 zones of vulnerability. The final outcome of this process is the seismic vulnerability map of Gorgan, with zones 6 and 10 representing having the highest vulnerability of buildings – mainly in the old textures of the city. Regarding the vulnerability map of Gorgan, the areas enjoying streets with adequate width and convenient access to the rescue centers with lower population and building density are in better conditions from the perspective of seismic vulnerability. In other words, according to the map, these zones have been placed in very low or low levels of seismic vulnerability. These districts are mainly located in zones 1 and 7 which include the southern and eastern parts of Gorgan i.e. Naharkhoran Boulevard, Golshahr, Modarres, Kashani, Soroush and Dokhaniaat neighbourhoods. In general, the buildings in the southern parts of the city are less vulnerable compared to their counterparts in the north. Moving from the south to the city center, vulnerability will increase. The reason is that the northern part of Gorgan – compared to the south – has wide enough streets, resistant buildings and the southern areas have old textures with narrow streets and time-worn buildings.

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