Politecnico di Torino

Master course in

Architecture for the Sustainability Design

The concept of sustainable city and eco-city in Iran

case study the third district of Isfahan municipality

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Abstract

This thesis investigates the current situation of cities in Iran and the consequences due to the rapid urbanization process of the last decades from the point of view of sustainability and ecological factors.
The topics of *sustainable development* - and its implications on an urban scale - are studied here about the Iranian case with particular attention to Isfahan, the third largest city in Iran. The planning policies that Iran has proposed and the relationship with the components of the sustainable city are considered, to examine possible suggestions for the creation of an eco-district in Isfahan according to the Gaffron classification of eco-cities.
In detail, the work started with examining ongoing phenomena: the increase in the urban population, the increase in energy consumption from fossil fuels, and the ongoing climate change. The process that - starting from 1993 - in Iran discusses sustainable developments with the Committee for Sustainable Development is retraced.
Isfahan is studied here according to four important sustainability issues: *land use, water, energy, and mobility.* While in the recent action of Isfahan municipality, it joined the network of smart sustainable cities.
One of its specific districts has also been the subject of comparative analysis with the logic of eco-urban policies and possible actions are proposed to reflect on the environment, the city, structure (green spaces, architecture of houses, and mixed-use of the territory), mobility, energy, economic and social issues according to the classification provided by the scientific studies of the Gaffron model of eco-cities.

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Introduction

Statement of the problem

Today, urbanization has created many problems for many developing countries such as Iran. In the past, Persian cities were compatible with nature and were sustainable. But nowadays, these cities are faced with many problems. As was stated in the chapters of this thesis, among the sustainability indicators, those concerning environmental and economic issues are the most important ones in Iran. It states the fact that policymakers should pay attention and take action seriously on these factors. Because of these, this thesis is focused on environmental factors.

Moreover, By increasing the population, the need for energy consumption was enhanced. The most common sources of energy in Iran are oil and gas. Increasing the consumption of fossil fuels led to the emission of GHG (Greenhouse gases) and this led the global warming. As a result, environmental problems have grown and, associated with the ongoing climate change process, mean that the environmental issue in Iran is a priority today, with particular emphasis on the largest cities.

Although Iran has done some actions to decrease the environmental damage in the cities, the cities have changed due to the modern lifestyle which leads the cities to be unsustainable. For examining one of the cities, as the case study, Isfahan (one million nine hundred and sixty thousand inhabitants / 2016 census for an urbanization rate which from 2006 to 2011 was equal to 85%[1]) can be exemplified which is the third populated city of Iran. This city had an important role in the agriculture sector in the past and it has changed as an industrial city in recent years. This change and destruction of the agricultural lands for constructing buildings, marginalization, excessive growth, and other factors make this city unsustainable and, consequently, it is particularly significant in the process of formulating urban policies today aimed at reducing environmental necessities and, consequently, it is configured as particularly significant in the process of formulating today's urban policies aimed at reducing environmental emergencies to govern the transformations of Iranian cities according to a process which - while not slowing down ineffective investments, is aware and protection of environmental and ecological conditions.

Aim and Objectives and main questions

The aim of this thesis is the investigation of the current situation of sustainable and ecological planning in Iran. Moreover, it is examined the actions of Iran and in the case study part, the city of Isfahan, to achieve sustainable and ecological cities. It analyzes the solutions for making a district of Isfahan more eco-friendly.

[1] https://knoema.com/atlas/Iran/Isfahan/Urbanization-Rate

In the first part, stating the prior issues of sustainability in Iran, The urbanization process and the subsequent increasing consumption of energy is expressed that this phenomenon has a great influence on the environment. Furthermore, it examines the factors that caused urban planning to be unsustainable during that time. These factors are such as the modern lifestyle, the appearance of cars in the city, and the current need for urban masterplan to be updated. Moreover, in the case study part, it is surveyed the changes in the urban form of Isfahan and the subsequent problems of excessive growth. The situation of the most important sustainability issues such as land use, mobility, energy, and water are examined and In the last part, solutions for making a district of Isfahan more ecological are analyzed based on Gaffron classification for eco-cities.

The main questions of this thesis are:

What is the situation of Iran, in terms of sustainable and ecological planning?
What actions has Iran (and especially Isfahan city) taken for having sustainable and ecological cities?
What we can do to make a district of Isfahan more eco-friendly?

Methodology

This study is the type of analitycal_descriptive. At first, the information was collected from the journals, books, and archives of the relevant executive bodies, and then by visiting the site, photography, and documentation, the data was analyzed.
In the first part of the thesis, it was investigated the sustainable and ecological planning and policies of Iranian cities in the current situation and in the scientific resources
In the second part, the case study, for studying the Master plans of Isfahan and the AutoCAD maps of the district, it was obtained from Isfahan municipality and engineering consulting organizations. The report of sustainable issues of Isfahan was gathered from the local authorities and all news websites to review the least actions of Isfahan municipality in addition to the international search engines.

For analyzing the district in the case study, after reviewing the scientific resources, I visited the site many times. The suggestions were presented according to the five keys of eco city's Gaffron classification, Which are environment, city structure, mobility, energy and water, and the economy and social factors. This information was reported by photography and documentation. I visited the selected area, where I lived for many years, and wrote about what I saw, what I perceived, and what I analyzed, in order to prepare some suggestions for improving it in terms of ecological aspects.

Part 1. Sustainability in current Iran and relationships with Urbanization and city planning

.1 Sustainable development, sustainable urban development, and sustainable city, a general overview

Sustainable development: The notion of sustainable development has changed over time, beginning in the early nineteenth century. Between 1900 and 1980, this concept was presented more fully and during this period, many definitions were presented for it. In 1972, Harrington published an article called Limits to Growth, Rome Cube and stated that: The use of natural resources associated with an uncontrolled growth population on a planet having finite resources was reaching an alarming level .(Herrington 2020).

In this article, he stated that it is not possible to have unlimited growth in the coming years on the planet with limited resources. Following serious issues such as air and noise pollution caused by the concentration of industries and motor vehicles, uncontrolled and unlimited development of cities horizontally and vertically, deforestation and increasing the rate of species extinction, production of waste materials, and greenhouse effects of islands. Due to the increase in the temperature of the globe, the issue of sustainability became doubly important. (Golkar .2000).

The first foundations of sustainability on the world stage were proposed at the UN meeting in Stockholm in 1972 with the participation of 113 countries on the topic of the human environment. At this conference, all the participants insisted on cleaning the environment and, most importantly, paying attention to the process of environmental problems on a global scale. (Newman. P. &. Kenworthy. J. 1999). In this regard, various theories were proposed to define sustainable development. One of these definitions that is the most appreciated is the definition of Brutland in 1987:

“Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs” (Development 1987).

This theory is founded on three principles. The sustainability of social, economic, and environmental justice should be the foundation of sustainability. (Brundtland report, 1987). In this way, the notion of sustainable development was demonstrated in the latter two decades of the twentieth century by being presented as an agenda item in international conferences. (Bahreini, 2005: 266-257).

The concept was improved in 2001 by UNESCO: "As a source of exchange, innovation, and creativity, cultural diversity is as necessary for humankind as biodiversity is for nature. In this sense, it is the common heritage of humanity and should be recognized and affirmed

for the benefit of present and future generations". (UNESCO, 2001) ¬ Cultural diversity becomes the fourth pilaster of sustainable development, so the pilasters became: economy, ecology, social equity, and cultural diversity.(Tulliani .2021)

In 1987, the discussion of sustainable development was officially put on the political agenda by the Global Commission on Environment and Development through the statement titled "Brundtland Report "(Norwegian Reps of the Summit) under the title "Our Common Future". Also, in 199 during the " United Nations Summit "in Rio de Janeiro under the title of Rio Earth Summit, a document in this regard was signed by 178 countries, which was published as Agenda 21. According to the mentioned document, all countries are obliged to develop strategic and practical plans to implement the provisions of the 21st Agenda .The national scale of their country became 21 under the title of local agenda. (10)

Based on the explanations given in the Local, Agenda 21, the system of planning and design for cities is introduced as one of the important tools and mechanisms for pursuing sustainable development and in this direction, that is, in the framework of the topic of sustainable development Planners, urban designers and architects put the issue of sustainable city and architecture on their agenda. (Golkar. 2000).

One of the effects of ignoring environmental concerns in cities is the production of greenhouse gases, especially carbon dioxide, which leads to global warming and melting glaciers in the North and South as well as the occurrence of natural catastrophes like hurricanes and floods.(Tulliani. 2021)

Sustainable Urban Development: The term "sustainable development" has many different interpretations and is thus controversial. Sustainability is associated with the preservation or enhancement of interconnected natural systems, which encompass all forms of life on Earth, on a summary and subjective level. The human population is the center and main element that determines these structures and their sustainability since human dominance and activities have had a major impact on the environment globally. The inherent limits of the planet and human decisions about the environment, economics, and culture—including values, laws, and population—determine how long people can live there. As a result, the earth's ability to support human life is dynamic, unpredictable, and varied. (Cohen .2006).

At first, Peter Hall proposed the main conception of sustainability development of cities. He defined this concept as follows: "Sustainable urban development is a form of today's development that guarantees the continuous development of cities and urban communities for future generations." (Hall,1993). A dynamic and ongoing process, sustainable urban development adapts to shifting social, environmental, and economic forces. (Haughton., 2004) The concept of a sustainable city can take a variety of shapes based on the history of

the area, cultural backgrounds, economic basis, climate and environment, and regulations. (Gharakhloo. &. Hosseini. 2007).

Sustainable Cities Program: As the 11th goal of sustainable development (United Nations) is defined: The eleventh goal is to make towns and communities equitable, secure, resilient, and sustainable. Since the SDGs were implemented in 2015, significant progress has been made, and the proportion of nations having national and localized disaster risk reduction initiatives has more than doubled. (.https://www.un.org/sustainabledevelopment/cities/)

The Sustainable Cities Programme (SCP) is a realistic solution to the global quest for sustainable development for the future. The SCP is a joint effort of the United Nations Environmental Programme (UNEP) and the UN Human Settlements Programme (UN-Habitat). Its primary goal is to enhance capacity for city environmental planning as well as administration. Since its foundation, the SCP has been working in the development of local capacity for city environmental planning and administration in cities all over the world. (The UN Human Settlements Program (UN-Habitat) and the UN Environmental Programme (UNEP). 2001).

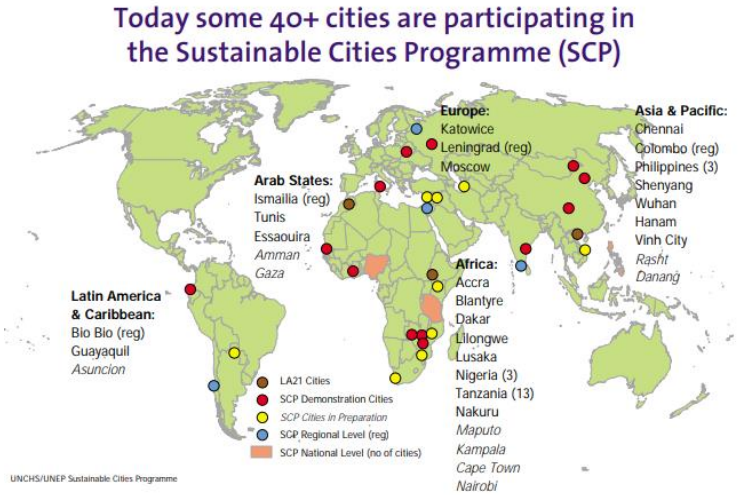

Figure1.Cities participate in sustainable city programs. Source: (The UN Human Settlements Program (UN-Habitat) and the UN Environment Program (UNEP). 2001).

The United Nations General Assembly has charged UN-Habitat with promoting ecologically and socially beneficial towns and communities. UN-Habitat is the UN system's center of attention for all urban and construction issues. In order to create cities that are welcoming, safe, resilient, and sustainable and groups, UN-Habitat collaborates with partners. Urbanization is encouraged by UN-Habitat as a force for change that benefits

both individuals and societies by lowering poverty, prejudice, and inequality. Through data. suggestions for policy, technical support, and collaborative action, UN-Habitat collaborates with more than 90 nations to implement transformational change in cities and settlements. (https://unhabitat.org)

The Sustainable Cities Program is a joint UN-HABITAT/UNEP initiative that began in the first decade of the 1990s to assist both UN-HABITAT and UNEP's city environmental aims. The Sustainable Cities Program's goal is to help localities achieve more ecologically sustainable expansion and growth. Its foundation is a wide-ranging, inclusive process of local decision-making that uses environmental planning and management (EPM) to advance the sustainability of nations. At the local level, SCP primarily collaborates with local government entities to enhance their capacity via the adoption of environmentally sound planning and management (EPM) practices and a process of building agreements. (Shaalan. 2013).

The manager of City Development (in the Ministry of Lands, Accommodation, and City Development) thought that a new Master Plan could relieve the difficulties that were now in place. UNDP assigned UN-HABITAT the task of addressing the Government's demand.. (Shaalan. 2013). UN-HABITAT assessed the Environmental Planning and Management (EPM) method of the Sustainable Cities Programme (SCP) as suited for addressing Dar-es-Salaam's ecological and development issues. Additional information on this subject, it can be studied in the paper " Sustainable Dar es Salaam Project Overview and Evaluation a New Approach to Town Planning in Sub Saharan Africa" written by Mario Artuso.

Sustainable city: According to Elkin and partners in 1991, sustainable urban development should result in a city that satisfies the demands of its users, not just in terms of energy savings but also of function and a comfortable place to live. A city can be sustainable if it is capable of its natural and artificial use, is easy for its residents, and encourages social justice Also, the criteria by which decisions can be made are included. (Williams.&. Jenks.& .others .2000)

Turner reported a sustainable city is a city that is able to continue its existence due to the economic employing resources, avoiding excessive production of recycling of garbage as much as possible, and adopting useful policies in the long term. (Turner,2014).

Selman lists seven areas of effort to develop a sustainable city in his book **Local Sustainability**: (Selman, 1995).

1. Complete safeguarding of vital natural resources

Protection of air quality (pollution, transportation, planning, and CO2 fixing)

protection of water quality (pollution prevention and planning, adherence to watershed management plans);

protection of important ecosystems (coastal zone planning, planning and environment conservation);
Minimum depletion of non-renewable resources (renewable energy, energy-efficient structures, mineral planning, recycling, and reuse).

2.preservation of a steady supply of natural capital that may be substituted

Utilizing planning requirements in natural resource compensation;
maximizing the powers of reclamation and restoration;
assuring the continued viability of established retail, residential, and employment zones or coming up with new uses for them;
participation in plans for additional woods or woodlands

3.Futurity of decision

Long-term planning horizons
Incorporation of all-natural capital values into decision-making processes;
Use of suitable discount rates and time horizons in decision-making processes;
Application of impact assessments for policies and strategies.

4.Equity between societies and generations

Taking into account the ecological footprints in places beyond the local authority's municipality, including abroad;
Local government dedication to international relations;
Relentless pursuit of "quality of environment" goals;
Participation in the European 'urban environment' programs;
Local government green audits that take trash destinations and product sources into account.

5.Circle of Virtuous Development

Optimal application of environmental assessment methods in project evaluation; • development planning's usage of policy consistency analysis;
Using thresholds and capacities-based environmental planning strategies; and supplying decision-makers with high-quality environmental information; The municipal government has set a good example for energy, materials, and transportation policy.

6. Encouragement of citizen views and actions

Decision-making that is transparent
Imaginative function for elected members; Establishing representative local forums;
Acknowledging the subsidiarity concept;
Development strategies that maximize their "communication" role. Adoption of a robust

7. Procedure that results in widely "owned" and dependable products

Green auditing practices used by local authorities;
"Exit strategies" for acceptable, self-sustaining efforts by local authorities;

Consensus-building and conflict-resolution procedures. (Selman, 1995).

A sustainable city is a city that has such an economic base that not only does not have the least adverse effect on the environment but is also effective in reviving and improving its quality. In other words, a sustainable city is a city that pays attention to social and environmental issues beyond limited and conventional solutions and looks at them with a comprehensive view. (Bahraini 1997).

A sustainable city naturally requires a different framework. In the sense that the physical and social form of land consumption and resources and principles of administration and exploitation are affected by the needs and wishes of future generations. Such an ethical framework also provides other fields for the development of social spirit, for example, geographically and spatially, a sustainable city will pay attention to the effects of its activities and policies on neighboring cities and regions, as well as on continents and the whole world (Beately. 1994).

Successful examples of sustainable cities: Some of the successful examples of sustainable cities will be expressed in the following referring to the main aspect of sustainability in these cities. These cities are introduced as the 10 best practices in this field. These 10 successful cities which were stated in the website (www.sempergreen.com) included: Humburg (using green roof construction to reduce flooding), Basel (obligatory green roofs), Bristol (generating emissions that are zero), Dubai (Making eco_cities), Helsingborg (an innovative circular system), Medellin (improved air quality thanks to green corridors), Melbourne (fighting the effect of the metropolitan heat island), The Hague (gaining points for sustainability by constructing green roofs), Barcelona (reduced traffic in superblocks), Washington, DC (locals' access to sustainable food). (https://www.sempergreen.com/en/about-us/news/10-of-the-best-sustainable-city-plans-in-the-world)

Preserving the environment and expanding green spaces is one of the goals of making cities sustainable. To achieve this goal, creating green roofs on the buildings can be a practical strategy. This approach can reduce pollution and has many advantages such as consuming less energy for cooling the building, making a living place for the residents of the apartments to relax increasing biodiversity, etc. Among the successful cities, Hamburg and Basel are two examples that follow this strategy. Humburg has used this solution to prevent flood in the city and consume the water in the green roofs properly.

Humburg (using green roof construction to reduce flooding) : Germany's Hamburg is putting a lot of effort into being an environmentally friendly, climate-adaptive metropolis Flood control has long been one of the most important green initiatives. The Rain Infrastructural Adaptation strategy (RISA) has been implemented by the city to mitigate this specific impact of climate change. Local government officials collaborate closely with

companies and scientists to develop strategies for providing sustainable and future-proof rainwater control.(https://www.sempergreen.com/en/about-us/news/10-of-the-best-sustainable-city-plans-in-the-world)

The city must effectively transform into a sponge, ensuring that massive volumes of rainwater do not quickly escape into the sewage system, but are held back for a period before being released by evaporation or gradual release. Hamburg is implementing this, among other things, using its Green Roof Program. By collecting rainfall and limiting its discharge into the sewage structure, green roofs operate as water separators. The metropolis has already realized over 140 hectares of green roofs during the plan's adoption, and it is aiming for at least 100 more. The city is financing the construction of roof gardens until at least 2025, providing landlords with up to 100,000 Euros for regenerating their roofs, ensuring that the incentive remains in place. (https://www.sempergreen.com/en/about-us/news/10-of-the-best-sustainable-city-plans-in-the-world)

Figure2. Artist impression of the greening of Hamburg by BLUE TH. Photo: Matthias Friedel. Source: (https://globaldesignnews.com)

Basel (obligatory green roofs): When the topic turns to green roofs, the metropolis of Basel (Switzerland) is adamant. The Construction and Development Law has mandated green roofs on all newly built or modified properties with flat roofs since 2002. The results are readily apparent in satellite photos. With this regulation, the city hopes to lower temperatures, save energy, and save the surrounding ecosystem. A total of days with

temperatures exceeding 30 °C in Basel is expected to increase from 10.5 (1981-2010) to 24.7 in 2035, considering this initiative a wise investment. Green roofs help reduce air quality, emissions of greenhouse gases, and disasters in addition to enhancing the region's biodiversity and making the city more habitable during high temperatures. (https://www.sempergreen.com/en/about-us/news/10-of-the-best-sustainable-city-plans-in-the-world)By studying other references, it is possible to be deep into this topic and learn about other successful sustainable cities.

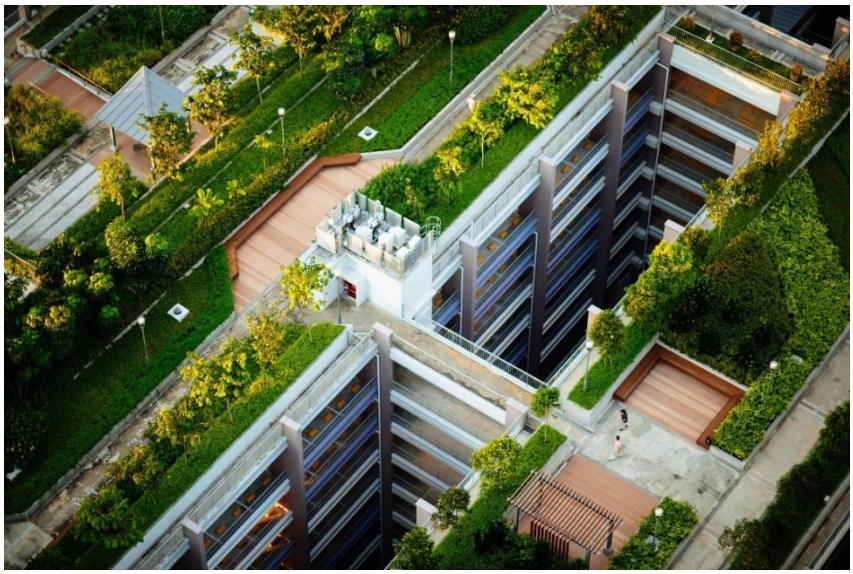

Figure 3. Green roofs in Basel. Source:(https://www.warpnews.org/)

2. Sustainability in the current Iran urbanization process: climate, energy, urbanization

Iran now has an inhabitants of 70.4 million people, up from 18.9 million in 1956. And the number of people in Iran increased by 6.9, 7.9, 15.7, 10.6, and 10.4 million each decade. (Assari, & Mahesh. 2011).

Table 1. Increasing of the population in Iran. Source: (Assari, & Mahesh. 2011).

YEAR	RURAL	URBAN	TOTAL POPULATION
1956	12952082 (68.6)	6002621 (31.4)	18954704 (100)
1966	15992912 (62.0)	9795810 (38.0)	25788822 (100)
1976	17854064 (53.0)	15854680 (47.0)	33708744 (100)
1986	22600449 (45.7)	26844561 (54.3)	49445010 (100)
1996	23237699 (38.7)	36817789 (61.3)	60055488 (100)
2006	22235818 (31.5)	48259964 (68.5)	70495782 (100)

The percentage of people living in cities worldwide has grown in recent decades. Over the last few years, Iran has seen significant urbanization and a rise in urban population. Considering Iran's urban dwellers in 2006, the country's urbanization rate was 68.46%; this figure showed an upward trend when compared to 1955 (31.67%). Furthermore, it reached 71.37% in 2011. (Enayatrad, Yavari., Etemad., Khodakarim.& Mahdavi,. 2019).

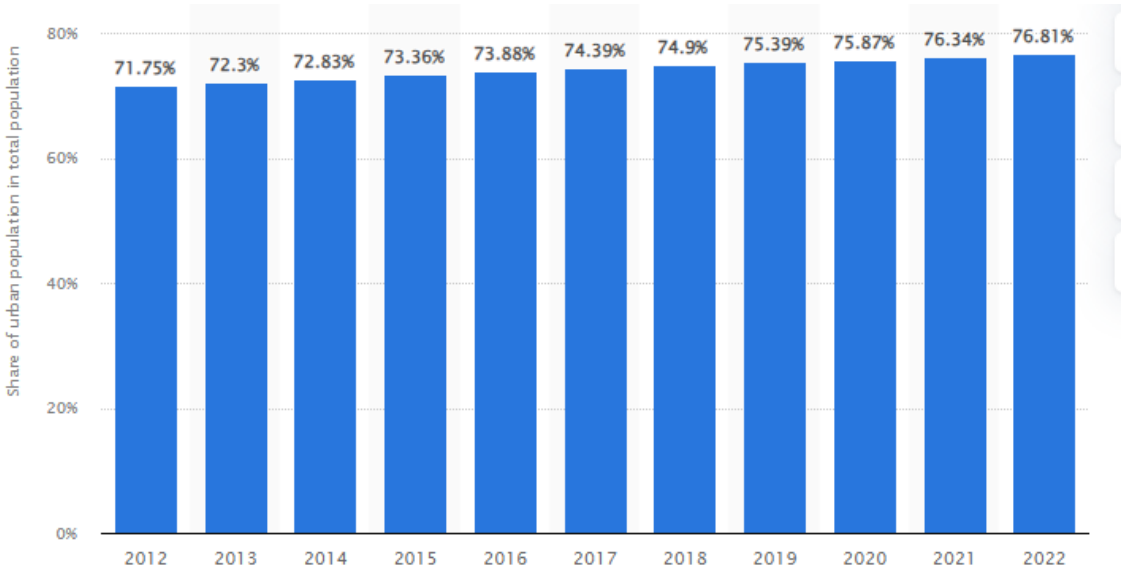

Figure4 .Iran Urbanization,from 2012 to 2022.Source:(https://www.statista.com/statistics)

The movement of rural people to urban regions, which results from the income gap between these two areas, and the creation of factories and production companies in cities are two of the factors contributing to Iran's increasing urbanization.; Consequently, the likelihood of employment and obtaining a job is greater in metropolitan than in rural locations. (Enayatrad,, Yavari., Etemad., Khodakarim., & Mahdavi,. 2019).

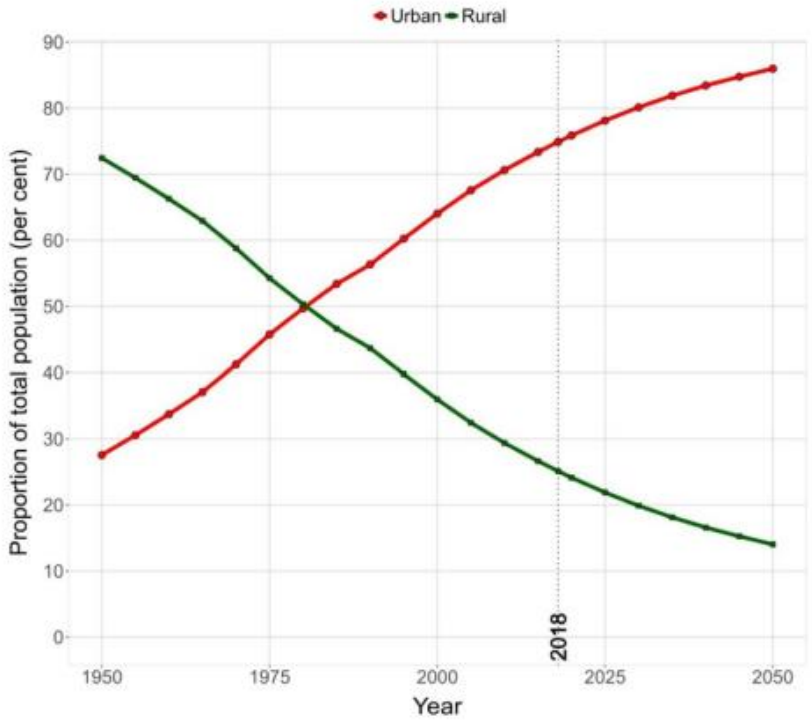

Figure 5. Percentage of Iran’s urban and rural population in 1950–2050.Source: Pilehvar, 2021)

The chart shows Iran's proportion of urban and rural people between 1950 and 2050 Iran's rural and urban patterns have been changed since the 1980s. .In the official Census of 1986, urbanization surpassed 51% for the first time, and this tendency has maintained until this day. Source: United Nations (2018). Department of Economic and Social Affairs, Population Division, and World Urbanization Prospects: The 2018 Revision.

In Iran, the rise of urbanization has resulted in a significant social divide in metropolitan regions. Development-oriented governments may play a significant position in dealing with growth and urbanization issues in this respect. These issues are particularly visible in the socioeconomic, urban planning, and city ecological sectors. Furthermore, climatic and environmental dangers, migration from the countryside to the city, and marginalization have exacerbated national-regional and regional issues in Iranian metropolitan areas. (asghar Pilehvar. 2021).

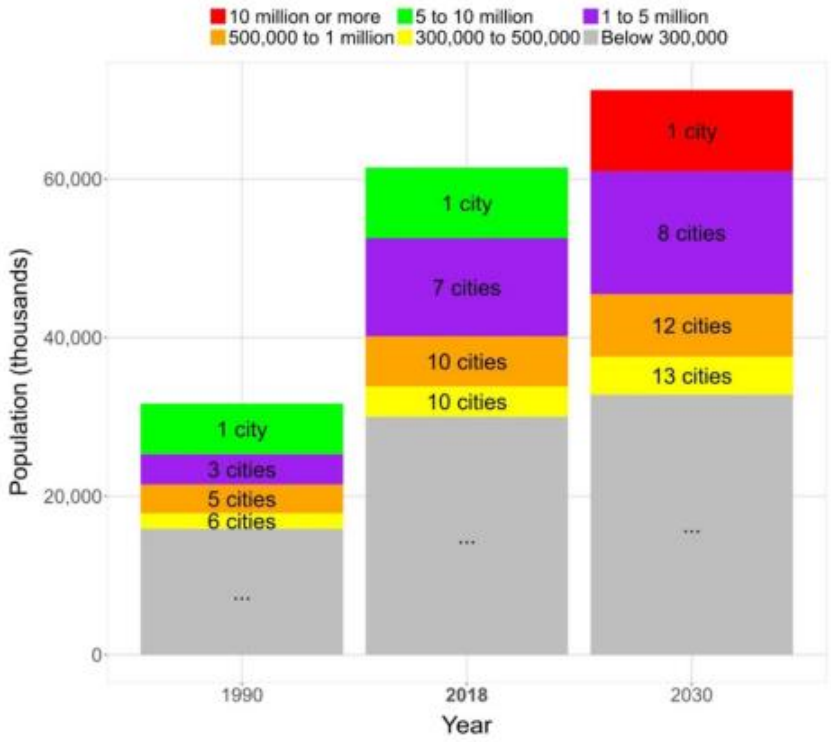

Figure 6. Classification of Iran's urban population by 2030. Source: (Pilehvar.2021)

Iran's capital city, Tehran, experienced an inhabitants of 10 million in 2018, as seen in the image. The proportion of cities with inhabitants of up to 5 million people is expected to grow by 2030. As a result, Iranian cities are experiencing an increase of residents and urbanization. In 1990, 2018, and 2030, city dwellers is classified based on the dimensions of the neighborhood and the number of metropolises The remaining regions are shown by the gray area, and they comprise all urban communities with fewer than 30,000 residents. Source: United Nations (2018). Department of Economic and Social Affairs, Population Division, and World Urbanization Prospects: The 2018 Revision.

Iran's structural-functional changes, along with skeletal-spatial and socioeconomic transforming cities, have given rise to an emerging social class (low-income individuals), typified by informal companies and informal settlements on the periphery of cities, particularly urban areas. This has resulted in unsustainable urban growth indices such as safety, construction density, risks to the environment, and centralization, among others. (Asghar Pilehvar. 2021).

2.0. Introduction

As stated, due to many reasons, the expansion of urbanization in Iran has accelerated in recent decades. As Daneshvar stated in his article, "Urbanization has caused more energy consumption. The increase in the consumption of gasoline and oil in cities causes an increase in greenhouse gases in cities. These greenhouse gases have made the weather of cities warmer". (Mansouri Daneshvar,2016). Iran's national climate change project states that the country's energy and trash industries are the primary producers of greenhouse gas emissions .50% of the GHG emissions in these sectors are attributed to urban-related resources including transportation, commerce, and housing. Therefore, Iran's urbanization is a major factor in the country's GHG emissions as well as their aftereffects, which include rising temperatures and more precipitation (Sarvari, 2019).

In other words, the economic growth and the growth of urbanization, which brings with it the ever-increasing need for energy, will lead to an increase in environmental issues. Since economic growth has been considered a desirable goal, The issue of environmental destruction has become the focus of attention of nature lovers., it is also believed that the needs of the growing population are the main cause of environmental destruction; The most important reason for proposing such a hypothesis is the limited absorption capacity of the environment (Asafo, 2005).

Furthermore, climate change is a hot topic in the Middle East, particularly in Iran. In the next decades, Iran will see an increase in mean temperatures **of 2.6 degrees** Celsius and a **35% decrease** in precipitation. Conversely, Iran ranks seventh in globally and top in the Middle East for climate change-related GHG emissions, with a total of over 616,741 million tons of CO2 Iran's considerable role in GHG emissions is based on considerable extraction of oil and gas as well as growing urbanization. (Mansouri Daneshvar, Ebrahimi, & Nejadsoleymani, 2019).

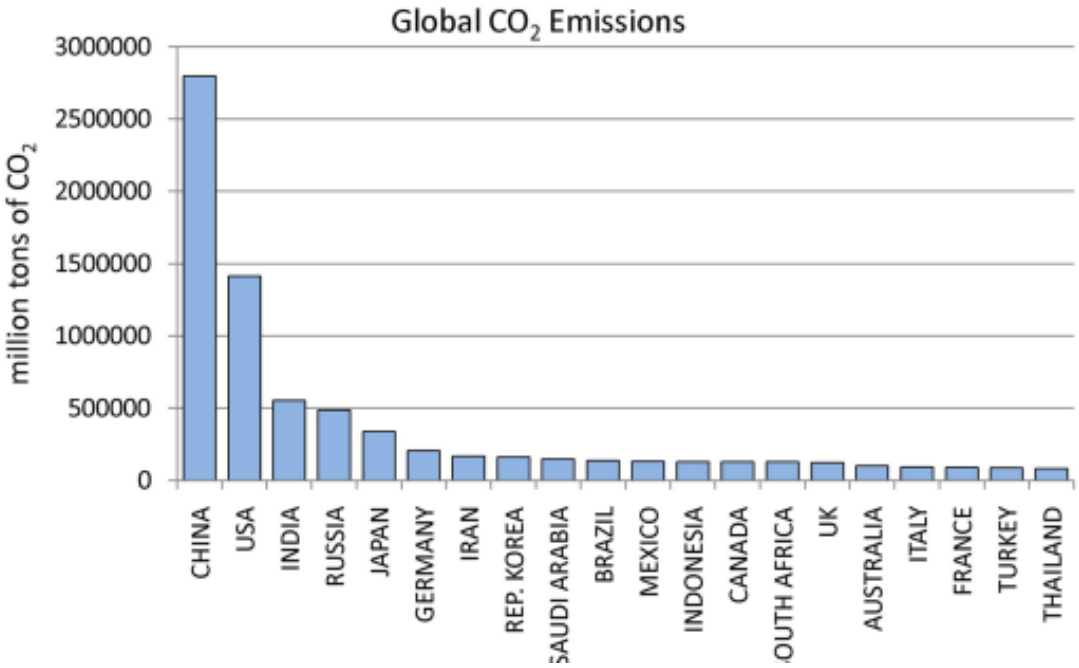

Figure 7. Following CDIAC (2014), the following ranking of the world's nations added to the overall release of carbon dioxide (in million tons of CO2) in 2013.Source: (Mansouri Daneshvar, Ebrahimi, & Nejadsoleymani, 2019).

Iran attended the United Nations Framework Convention on Climate Change (UNFCCC) 21st Conference of the Parties (COP21) in France in 2015, signed its accord on 12 Dec. 2015 in the French capital, and signed the convention on 22 April 2016 in the United States of America. As a result, according to the idea of Common but Differentiated Responsibilities, Iran has supported global attempts to lower greenhouse gas (GHG) emissions and react to the effects of climate change. Iran's national climate change strategy have to be centered on reducing greenhouse gas emissions from the energy industry. For this goal, Iran's energy agency has created projects involving renewable energy such as solar cells. In this context, future research and development ought to propose unique approaches to investigate renewable energy solutions and reduce Emitted greenhouse gases in order to minimize the growing danger of climate change consequences. (Mansouri Daneshvar, &. Ebrahimi, & Nejadsoleymani. 2019).

To summarize, the rise in population and urbanization leads to increased energy consumption, which is harmful to the environment and causes climate change, and thus requires policymakers' attention to develop solutions that make cities more sustainable.

2.1. Climate in Iran

In terms of climatic division, the plateau of Iran is situated in a parched area of the globe, and the dry desert of North Africa and Arabia, which starts from the coast of the Atlantic Ocean in West Africa, continues to Iran, and finally Afghanistan and Turkmenistan. the climate in most parts of Iran is dry and the average rainfall is much lower than the average rainfall in other parts of the world, despite this general rule, different weather conditions in Iran are observed.(Ghobadian1998:34)

Foreign and Iranian scientists and geographers have done a lot of research on Iran's climate, and among them, the principles presented by the Leterishian scientist (Coupon) are more accepted by the experts, divided into seven different regions and Dr. Ganji divided Iran into twelve climatic regions based on the coupon division and considering the problems in the coupon division in terms of different climates in each of the regions. In terms of housing and residential environments, engineer Morteza Kasmai has divided the country of Iran into eight climatic zones in the climate zoning map of Iran that was made for the Building and Housing Research Center. In this thesis, the division of Behrouz Pakdaman for Red Halal has been used in Iran separated into four primary areas. Regarding how the climate affects the structure of cities, building form, and type of materials, common characteristics can be observed in each of the four regions.(Ghobadian1998:34)

These four climatic zones are respectively:

1. Moderate and humid climate (southern shore of the Caspian Sea)
2. Warm and rainy weather (northern coast of the Persian Gulf and Oman Sea)
3. Cold and dry climate (western mountainous areas)
4. Hot and dry climate (central plateau plains)(Ghobadian1998:34)

Climatic classification based on the energy label standard in Iran is as the below:

In this classification, Iran's real climate is divided into 8 categories:

Tabel2.Climatic Classification Cities of Iran, Source: (Rezaian. &KanariDil. 2015).

city	average relative humidity in winter	average minimum of temperaturein winter	average relative humidity in summer	average maximum of temperature in summer	climate
sarab	65-75	(-5)to(-10)	42-55	25-30	very cold
tabriz	65-75	(-5)to(-10)	25-40	35-40	cold
rasht	more than 60	0 to 5	more than 60	25-30	humid and rainy
moghan	more than 60	0 to 5	more than 50	30-35	semi humid and rainy
tehran	40-60	0 to 5	20-45	35-40	semi dry
zahedan	35-50	0 to 5	15-20	35-45	hot and dry
ahvaz	60-70	5 to 10	20-30	45-50	very hot and dry
Bandar abbas	more than 60	10 to20	more than 60	35-40	very hot and humid

After determining the climate of the building, the indicator of energy consumption of the ideal building is determined in terms of m/kWh-yr from the table below: (Rezaian & Kanari Dil,2015:74)

Tabel3.Ideal building energy consumption index m/kWh-yr, Source: (Rezaian,.& .KanariDil. 2015).

Energy consumption index	climate
80	very cold
80	cold
64	humid and rainy
64	semi humid and rainy
74	semi dry
64	hot and dry
86	very hot and dry
91	very hot and humid

In today's buildings, using modern technology and mechanical facilities, attempts have been made to deal with these climatic factors, but in the past, this equipment did not exist, Traditional builders had to contend with the adverse and erosive elements of nature by using local materials and equipment. and in order to provide comfortable conditions in urban areas and inside buildings, the optimal use of climatic factors has always been an important issue in design and implementation. The direction of the sun, favorable and unfavorable wind direction, temperature fluctuations during the day and night, and access to water, plants, and suitable land have always played a decisive role in the shape and characteristics of the building. (Ghobadian1998:35).

In general, it can be said that Iran's buildings, unlike most of today's buildings, were not in accordance with natural conditions, but by using these conditions, they were in a logical coexistence and productivity in the heart of nature (Ghobadian1998:35).

2.2. Energy crisis and renewable resources

Due to the energy crisis in the world, many countries have reduced the use of fossil fuels and turned to the creation and usage of renewable energies to reduce the influence on the environment. But unfortunately, in Iran, the share of production and usage of renewable energies is still low. The government and decision-makers in Iran have been forced to adopt renewable technology due to the country's predominance of conventional fuels and

growing worries about their negative impacts, both economic and environmental. (Oryani. & Koo. &.others, 2021)

In 2015, the total energy production in Iran was 3411.5 million gallons of crude petroleum equivalent. The composition of primary energy carriers of the country includes 40.2% crude oil, 59.0% rich gas, 24% traditional fuels, 0.8% coal, 0.40% hydroelectric, wind, atomic, solar, biomass, and others (0 .01 percent) of new solar energy becomes thermal. (http://jhome.ir/index.php/renewable-energy/424-14-mehr-energy.)

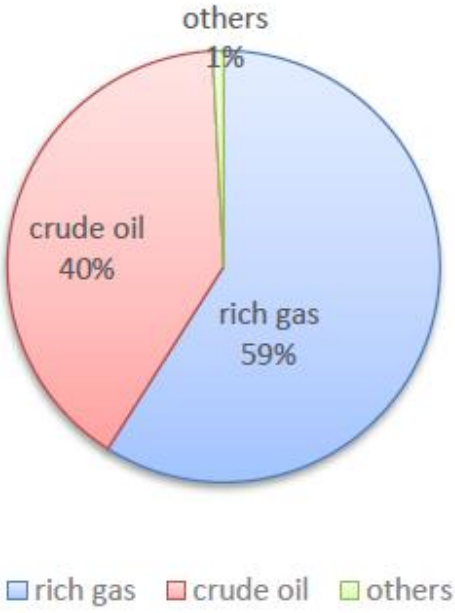

Figure 8. Production of primary energy in Iran in 2016

Source:(http://jhome.ir/index.php/renewable-energy/424-14-mehr-energy.) Specialized journal of energy consumption optimization, where is Iran's global position in the field of energy consumption?

The major suppliers of energy in Iran are natural gas and crude oil. In the near future, it will thus be necessary to use renewable and sustainable energy sources. In Iran, the proportion of renewable sources of energy in electricity production is minuscule, around 1%. The nation has an excellent opportunity for harnessing solar and wind power and has the potential to be one of the main producers of renewable energy in the nation since it has numerous windy locations and at least 2800 hours of sunlight annually. Though a lot of work has gone into encouraging the use of renewable energy, not all of its potential has yet been realized. To create energy supplies that are both ecologically sustainable and safe, the government should make plans to use all available energy. (Mohammadnezhad. &. Ghazvini. &. others. 2011).

Research and development efforts should be maintained to reduce prices and boost power-generating efficiency in order to significantly disseminate renewable energy. For instance, photovoltaic power generation has started to spread quickly throughout Europe. Iran should implement these strategies too. (Najafi. &. Ghobadian. 2015).

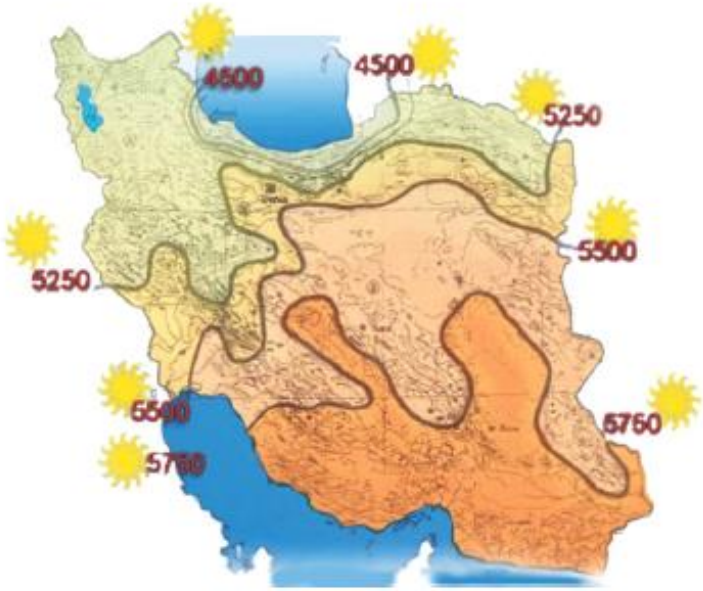

Figure9. The potential of solar energy in Iran
(source :Najafi.Ghobadian..2015)

2.3. The priority consumption: the building sector

Buildings in Iran account for the majority of urban energy use, accounting for over 40% of total energy consumption. Therefore, the household sector accounts for more than one-third of the nation's energy consumption. (Mortazaei.&. Mohammadi. & others.2017). In Iran in 2008, building energy use made up 41.9% of total energy use. Natural gas (66%), petroleum (20%), electricity (2.5%), and other fuels (1.5%) are the primary energy source . Compared to the comparable circumstances in Europe, the average energy consumption in the residential sector is more than 2.5 times higher, while compared to colder regions of Europe, it is more than 3.5 times higher. This demonstrates how crucial this industry is to energy-efficiency regulations. (Rezaei. & Hosseiyni. 2011).

Based on the breakdown of the company's activities and the latest consumption statistics, the overall savings potential is estimated at around 500.3 million barrels of crude oil equivalent per year, of which 263 million barrels of crude oil equivalent are in the industrial sector, 124 million barrels of crude oil equivalent are in the industrial sector. Building and housing and 113 million barrels of crude oil are in the transportation sector.

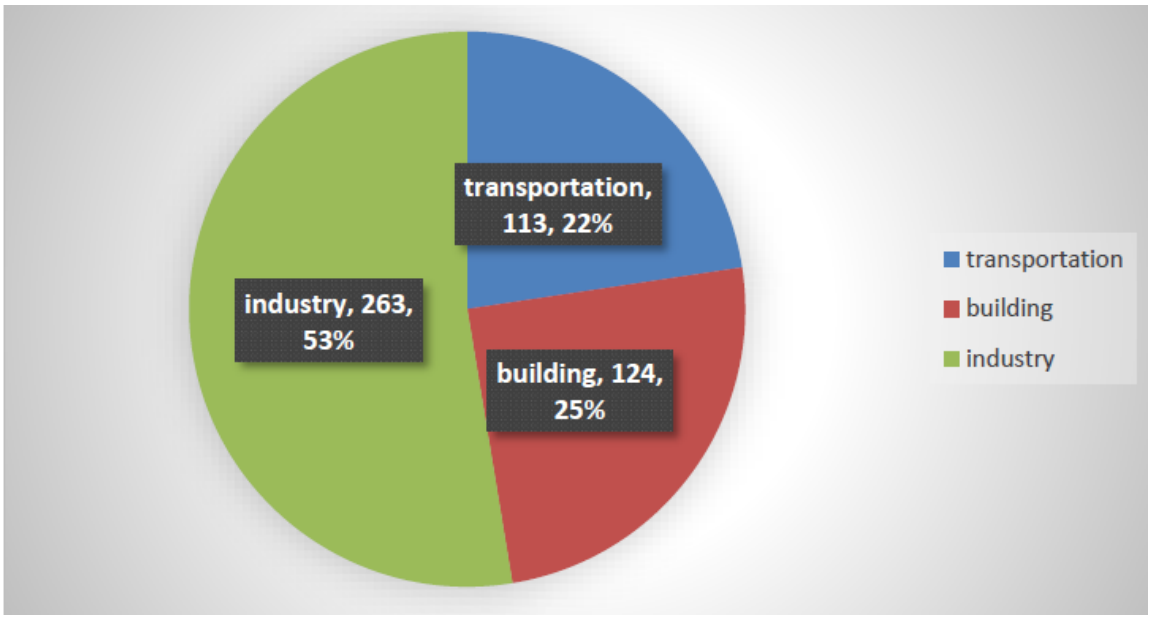

Figure 10. The amount of savings potential possible

Source: (http://jhome.ir/index.php/renewable-energy/424-14-mehr-energy.) Specialized journal of energy consumption optimization, where is Iran's global position in the field of energy consumption?

2.4. Air pollution and fossil fuels

The primary energy-related pollution in Iran's major cities, including Tehran, Isfahan, and Tabriz, is air pollution. The use of older, poorly performing vehicles, a subpar public transportation system, the affordable cost of petroleum products, the fast rate of urbanization brought on by rural residents moving to larger cities, the rapid growth of vehicles and the corresponding petroleum consumption, and inadequate urban management are all factors contributing to significant pollution. (Rezaei. M.& Chaharsooghi. S. K.& others. 2013). Policymakers in Iran must move quickly to transition from the production and use of fossil fuels to renewable energy sources, particularly since the construction industry produces a sizable portion of the country's CO2 emissions (approximately 38%). The percentage of carbon dioxide released in the construction industry is depicted in figure 7.

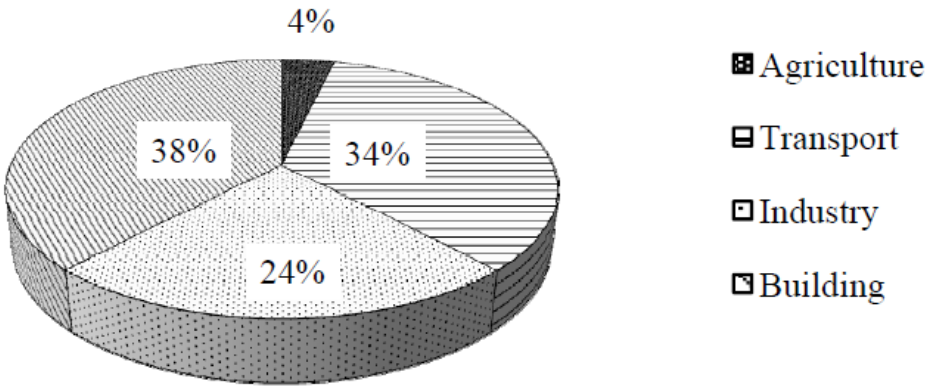

Figure11.Share of CO2 emission resources in Iran in 2008
Source: (Rezaei. &Hosseiyni.2011)

3. Iran and sustainable urban issues

3.1. Economy and environmental indicators of sustainable urban development are the most crucial indicators in Current Iran.

According to studies, the most crucial indicators of measuring urban development in developed nations are energy, supplies and social stability, upgrading, and the environment, while the indicators that matter most in developing nations are transportation, employment, local safety and economy, planning and development of society, and—above all—access to clean water**.** In the case of Iran, the investigation of urban sustainability indicators showed that the most important indicators are located in two environmental and economic dimensions. The reason for this can be seen in the economic situation of the country as well as the increasing destruction and damage of the environment due to natural reasons such as climate and human changes. (Amoushahi. &. Salmanmahini. &. Others.2023).

Most countries in the Middle East, including Iran and Iraq, are located in arid and semi-arid regions. These countries receive much less rainfall during the year compared to the global average, while due to climate changes and mismanagement in these countries in recent years, the rainfall in most of these areas has decreased a lot compared to previous years and in some, it also rained suddenly in parts and caused devastating floods. Also, these two countries both witness huge dust storms throughout the year, which causes severe air pollution. In addition, the economic situation in these countries is worsening day by day, and poverty and unemployment are increasing rapidly. (Amoushahi. &. Salmanmahini. &. Others.2023).

Due to severe sanctions imposed by the US that have severely impacted Iran's oil export rate over the past two years, the country's oil-based economy has collapsed, exacerbating the country's sustainability dilemma. Nonetheless, Iran maintains the Organization of Petroleum Exporting Countries (Opec) fifth-biggest oil exporter. (Opec). Petroleum-based items now account for more than 80% of Iran's exports. (Hakimi Nejad. A. Fu. Ch. &. others.2021). Due to US sanctions, the price of products increased very rapidly and today, the rate of poverty is increasing fast in Iran. Therefore by considering these indicators, city planners should focus on sustainable urban development issues.

3.2. Sustainable urban development changes in Iran in terms of environmental actions

Sustainable development's environmental implications are the main topic of this thesis. Thus, the following shall analyze Iran's conduct in this matter. To protect the environment, the Department of the Environment was founded as early as 1971. The importance of

environmental issues was acknowledged by the revolutionary administration. "a public duty to protect the environment where the present and future generations are to have a thriving social life. Thus, any form of activities, whether economic or otherwise, that causes pollution of or irreparable damage to the environment is prohibited." (Madanipour. 2011) reads Article 50 of the new Constitution Therefore, it is forbidden to engage in any activity—economic or otherwise—that pollutes the environment or harms it irreversibly. (Iran DoE 2009).

The first significant move toward sustainable development in Iran occurred in the early 1990s, following the Iran-Iraq War. This is true even after the DoE was established. The DoE founded the Iranian NCSD. Just a year after the United Nations Meeting on Environment and Development, in 1993, Iran entered the sustainability discussion with the establishment of the Iranian National Committee for Sustainable Development (NCSD). (Agenda 21). (Hakimi Nejad. &. Fu. &. others. 2021).

The selection of a high-profile deputy president for ecological issues and the rise in green non-governmental organizations and activists are signs that the discourses of environmental sustainability have gained traction in Iran since the 1990s, during the normalization duration that came after the revolution and the war. Tehran City Council additionally created an environmental committee, and in 2003, the municipality established an environmentally sustainable development Task Force, which is managed by an appointed adviser to the Mayor. Water and wastewater, energy, garbage, air quality knowledge, and environmental education are the Task Force's six teams. It published a 682-page report named Green Workbook in 2007 that outlines the municipality's initiatives and plans to enhance environmental sustainability. (Tehran Municipality. 2007 and Madanipour .2011).

Furthermore, Tehran New Detailed Plan, a strategy plan for city management modified and authorized by the Higher Council of Urban Planning and Design in 2007, describes the opportunities for sustainable growth. (HakimiNejad. Fu. &. others. 2021).

Thirteen subcommittees of the Iranian NCSD address various topics such as biological variety, schooling, green production and efficiency, urban sustainable growth and supervision, climate change, forest and forest principles, and so forth. Since its founding, the group has possessed 199 commissions (DoE, 2013). Following the June 2012 Rio+20 UN meeting, the NCSD began drafting a strategy to update and reform its core institutions. Early on, this committee was comprised of a number of official agencies, including ministries and governmental departments. However, from an organizational perspective, it is still unclear whether the NCSD, operating under the DoE's auspices, naturally prioritizes environmental issues over social and economic ones (Hakimi Nejad. &. Fu. &. others.2021).

3.3. About today's debate on eco-city in Iran, Sustainability and eco-city relationships. The first eco-city national conference in Iran on 16 March 2013

About today's debate on eco-city in Iran, The first Eco-city national conference in Iran was organized on March 6, 2013, hosted by Tehran Municipality in cooperation with Shahid Beheshti University's Environmental Science Research Institute and Tehran University's Faculty of Environment. In this conference, which was held with the presence of environmental experts, managers of the country's metropolitan municipalities, and those interested in this field, four key lectures were presented about the concepts of eco-city and ecological cities. (Tehran Shahid Beheshti University news, https://www.sbu.ac.ir/fa/w/)

The place of urban agriculture in Eco-city, waste management and recycling in Eco-city and the measures taken in the production of materials and energy from waste (compost production, electricity generation from waste gas), the use of modern technology for wasted management, new technological innovations in the management of Eco-city , the place of green architecture in the management of metropolises and contributing to sustainable development, landscape and urban architecture in eco-city, ecological architecture, development of vertical green space and roof gardens of two-story buildings, modern urban architecture and reducing energy consumption in buildings, integration of natural and artificial habitats in the environment Urban, the role of urban agriculture in economic transformation and increase in gross domestic product, investigating the effectiveness of urban agriculture in the flourishing of related industries and entrepreneurship and new technologies in the management of eco-city are among the focal points of this conference.(Iranian agriculture news agency, http://www.iana.ir/)

3.4. Eco-city, why it is important today?

Eco-city is one of the forms of sustainable city with a difference. Eco-city distinction from other theories of sustainable urban development is the fact that eco-city has three pillars of the sustainability pyramid, i.e. environmental issues, economic issues and social issues, with the difference that they are linked to each other and their feedback is always seen. Another difference between the city ecosystem and other sustainability theories is the prioritization of the pillars. In the city ecosystem, environmental issues are the biggest issue. The result of this idea is against the modern way of living, which covers all economic issues and environmental issues at the last level of importance. (Sharifian Barforoush, & Mofidi Shemirani,. 2015).

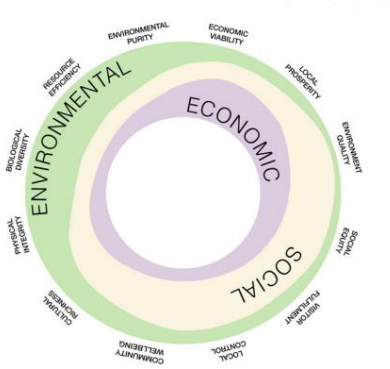

Figure 12. Eco-city ring. Source:(Wong. & Yuen. 2011).

Lester Brown believes: that the challenge we are facing is that humans should reverse these trends before the deterioration of the environment and downfall of previous civilizations. Humans face one challenge. This challenge is the fact that he should reverse the trends before these challenges Lead to his world collapse. These trends which are more and more, show the fact that if the function of the economy(sub_system) is not compatible with the greater system of the planet, both systems will hurt. (Brown, 2002). The bigger the economy is compared to the ecological system and the more pressure it puts on the natural limits of the planet, the more destructive this incompatibility will be. Eco_city concepts end the conquest of the economy over the environment and the definition of the economy extends from short-term, individual, and group interests to those of future generations and all the inhabitants of the biosphere. (Sharifian Barforoush, & Mofidi Shemirani,. 2015).

With the intention of putting cities back in harmony with nature, Richard Register established the Urban Ecology Company in Berkeley, California, as a nonprofit corporation in 1975. (Register.1994) After the publication of Register's Eco-city Berkeley (Register, 1987), an imaginative book outlining how Berkeley may be environmentally reconstructed during the ensuing period of time, and The Urban Ecologist, an organization's new journal, urban ecology began to gain significant traction. When Urban Ecology arranged the First Worldwide. Eco-city Conference, which took place in Berkeley in 1990, the movement picked up speed. More than 700 participants from all around the world came to this conference to talk about urban issues and offer ideas for reshaping cities based on ecological principles. (Roseland,1997).

As Gafffron explained eco-city the general idea of a city ecosystem is that it should be in harmony with nature. This is through the patterns of residence, sometimes with effective energy and space-saving (optimal use of space) in combination with patterns of transportation, material flow, and water cycles. and achievable habitat structures that are linked to goals for sustainability. (Gaffron.&. Huismans.&. others.2005).

Eco-city is a city that is ecologically healthy, and because every city is unique, there is no single model for the ecology of cities or a specific way to reach it. However, urban ecosystems share basic characteristics that are comparable to healthy ecosystems and vital organisms.

Eco-city is a city with the following characteristics:

A healthy ecological residence for humans, which is built on a self-supporting and flexible structure and the natural ecosystem function. essential living organisms

An identity that covers its residents and the effects they have on the environment.

A subset of environments includes the aquatic parts of the biosphere and finally plants.

A subset of the economic system of the global and national regions(rwww.ecocitybuilders.org).

Eco-city has principles that were first proposed by Register with 10 principles, and Mark Roseland enumerates these criteria in his article like this:

(1) Reorder land-use priorities to develop mixed-use neighborhoods adjacent to transportation hubs and other facilities that are compact, diversified, green, safe, enjoyable, and essential;

(2) Reorder mobility priorities so that transit, bicycles, foot traffic, and carts take precedence over cars and that "access by proximity:

(3) Repair damaged urban landscapes, in particular streams, wetlands, shorelines, and ridges;

(4) build decent, inexpensive, safe, convenient, and housing that is mixed in terms of race and economic status;

(5) Encourage social fairness and improve chances and jobs for women, blacks, and the disabled

(6) Support community gardening, regional farming, and metropolitan greening initiatives;

(7) Reduce pollution and dangerous waste while promoting recycling, resource conservation, and creative, suitable technologies.

(8) Collaborate with companies in order to encourage environmentally responsible business practices while opposing waste, pollution, and consuming and manufacturing of dangerous materials;

9) encourage voluntary modesty and oppose extra use of material products;

10) raise the public's awareness of environmental sustainability issues and the regional ecosystem and ecological zone via activist as well as informative initiatives. (Roseland,1997)

The primary objectives of reviving an e-city are as follows, according to Kenworthy:

- The metropolis has a tightly packed multipurpose urban shape that effectively uses land while safeguarding the natural world, biodiversity, and regions that provide meals.
- The areas of the city are permeated by and take up the natural environment.
- The city, whereas a significant amount of its food needs is met by the metropolis and its hinterland, service for walking, bicycling, and transit is prioritized above that for highways and roads, with a focus on rail in particular. The use of cars and motorcycles is reduced.
- A lot of environmental technologies are used to manage trash, energy, and water in the city; as a result, these systems are closed-loop.
- Human centers, the major city, and its sub-centers absorb a large share of employment and growth in housing and prioritize availability and circulation by means of transportation other than the vehicle.
- The entire city is home to a first-rate public space that embodies equity, community, public culture, and sound government. The whole transportation network and all of its surrounding areas are included in the public area.
- The physical design and urban architecture of the city, especially its public areas, are incredibly readable, flexible, strong, rich, diverse, aesthetically pleasing, and suited to individual requirements.
- Ingenuity, novelty, and the distinctiveness of the regional landscape, civilization, and the past, along with the excellent both environmental and social standards of public spaces inside the city, optimize the financial operation of the town and the creation of employment.
- Future urban planning is not a computer-driven "predict and provide" approach, but rather a visionary "debate and decide" process. (J.R. Kenworthy, 2006)

Register considers the participation of citizens as the main factor in the success of the urban environment and introduces the visual elements of the urban space as the most important perceptible factor for the city's residents. He considered the complete realization of City Day as dependent on the awareness of all citizens in finding the foundations of the theory and how to realize it and believes that creating one or more eco-cities on the planet is not enough because the continuity of the life cycle causes disruption in a part of the biosphere. lead to its destruction. Therefore, he emphasizes the expansion of the theoretical foundations of eco-city and as the creator of this idea, he tries to expand and explain his point of view. (Register.1994)

3.5. Main goals of the eco-city as Gaffron, main scientific study

From this point of view, there are five planning factors in a city ecosystem, which include the body and four parts of urban development, city structure, transportation of material and energy flow, and social-economic factors. The body refers to the natural and artificial environments that are influenced by the city and are connected to each other with the help of the city and create a general framework for understanding the inner workings of the city. The urban structure refers to the physical reality of the city, which is considered an internal system and includes demand, land use, green space, the horizon of urban comfort, public space, and the transportation of personal motorized vehicles and the movement of goods from aspects related to the transportation sector. (Sharifian Barforoush.&. Mofidi Shemirani, 2015) Quoted from (Gaffron. &. Huismans. others. 2005).

The flow of materials and energy refers to the movement or flow of energy and materials in space and through various urban and physical systems, energy, water, waste materials, and construction materials are examined in this section. The economic and social section refers to human activities. which define the social processes and economic life of the city and include social and economic issues and costs. (Sharifian Barforoush.&. Mofidi Shemirani, 2015) Quoted from (Gaffron. &. Huismans. others. 2005).

Moreover, Gaffron in his book Eco-city summarized the main goals of an eco-city as 5 aims:

The first goal: Minimizing the demand for land (visa for barren areas)

The second goal: Minimizing the consumption of raw materials and energy and reactions with urban and regional material flows

The third goal: optimizing and Minimizing damage to the natural environment

The fourth goal: maximizing attention to the natural environment

The fifth goal: Minimizing transportation demand (Gaffron .&. Huismans.&. others.2005)

Also, its result includes the following:

Realizing the basic needs and real structures of human care, Minimizing harm to human health, Maximizing mental comfort and social feeling, Maximizing attention to the human destruction context, Creating a framework for proper monitoring, Maximizing awareness of sustainable development, and also:

Understanding a new, different, and crisis-resistant local economy, Minimizing the total cost of living (maximizing productivity). which must be appointed individually for each development project. (Gaffron. &. Huismans. others. 2005).

Gaffron and others who have been studying the expansion of their vision for years in academic circles and have realized it by clarifying it in several European cities and localizing the idea of the eco-city. In practice, the most successful theorists have been in implementing their approach. In fact, it can be said that the main reason for the success of

Gaffron and others in the implementation of the local platform is implementation examples in which citizens and urban decision-makers have a deep understanding of sustainability issues. On the other hand, the European Union's macro-budgeting in this project and the detailed and organized monitoring of the project process and its feedback can be considered as other factors of the maximum realization of this approach. (Sharifian Barforoush.&. Mofidi Shemirani, 2015) Quoted from (Gaffron. &. Huismans. others. 2005).

In this thesis, analytical surveys will be done according to the 5 principles of Gaffron.

Gaffron explains that Urban areas must be consistent with their historical context. Therefore, ecocity planners must pay attention to cultural heritage and even revive them. for example, the history of the local area can be used to induce regional parameters for the building form and construction methods, the shape and proportion of public squares, the coordinated configurations of the built space, public stairs of the city and even the design of the streets. Such parameters help to maintain or create a specific identity for eco-city settlements based on regional facilities. (Gaffron.&. Huismans.&. others. 2005).

In the essay, Kozowska claims that he separates the ecological techniques that may be employed in historical cities into two types: permanent and temporary, and that alterations made in the city's historical areas should not hurt them. An example of performing temporary strategies is described below.

The project "Green Pergola" is an illustration of innovative activity carried out in old urban settings. It calls for the addition of green walls plus a pergola to the Szczecin neighborhood's semi-public courtyard areas. (author: Klaudia Klimek, Paulian Bartkowska,) (tutor: Agnieszka Rek- Lipczyńska,) The endeavor was created as a component of the course Perception of Composition and Psychology of Architecture. at Szczecin at the western Pomeranian University of Technology, or WPUT Szczecin. The design of the project includes benches and a honeycomb-shaped pergola that can be filled with glass pieces and solar panels to power a makeshift building and recharge individual electrical devices like tablets and smartphones. Vegetables can be grown in the lower portions of green walls for the benefit of the neighborhood. (Kozłowska. 2019)

Figure13.The situation of the "Green Pergola" installation-left, Pergolas and green, vertical walls -"Green Pergola"-right. Source: (Kozłowska. 2019)

3.6. Urban planning issues in the cities of Iran in relation to the concept of eco-city.

Iran is a case in point, where the city's population has expanded from 30% to over 70% in the last 50 years (Statistical Centre of Iran 2012[2]), currently the country faces enormous sustainability difficulties in both rural and urban regions. (Barakpou. &. Keivani.2012).
The urban network and the structure of the country's urbanization in general do not have the dynamics of efficiency and capability to meet the needs and demands of the citizens and to establish the well-being and comfort of urban prospects. On the other hand, The model perspective of sustainable urban development insists on preserving the urban environment, reducing pollution, preserving natural resources, decentralization, using alternative energy, waste recycling, more accessibility, increasing sustainable employment, etc. which lead to suggested theories such as Ecological factors, compact city and etc, it shows the necessity of in-depth study by experts and urban officials to evaluate, analyze and understand this model of the structure of Iran's urbanization. (Salehifard. 2004).
Traditional desert cities, like other cities in Iran, have been exposed to severe physical changes since the beginning of the current period, which has been significantly different from the rhythm of historical and educational changes in these organic settlements. In the contemporary century, superficial and incomplete modernization, whose focus was mainly on creating changes and modernizing the external body of cities, created deep and unwanted transformations in Iranian cities. The aforementioned physical modernization, which was manifested in the form of successive waves, such as the Law on the Development and Widening of Roads in 1933, or the preparation and approval of comprehensive urban plans from 1961 onwards, and the preparation of other urban plans such as preparatory plans in the following decades, has caused a framework transformation in the image of the compact Iranian city. (Golkar .2000).
The physical transformations created in the cities show that the comprehensive plans paid little attention to the local architectural and urban development features and the natural features of the place. As a result of the implementation of the proposals of comprehensive plans (which are mainly in the form of recommendations in the field of road network, land use, and density) during the past few decades, the physical-spatial organization of the cities has significantly lost their environmental compatibility. For example, The phenomenon of uncontrolled expansion of cities, which is on the one hand due to the land and building stock market and on the other hand due to the implementation of the recommendations of comprehensive plans, has put desert cities in an unfavorable position in terms of population density. (Golkar .2000).

[2] [2] Statistical Centre of Iran : https://www.amar.org.ir/english

While urban researchers and developers in Iran and around the globe discuss the merits of conventional strategies and architecture, comparative study of traditional and modern designs allows us to recognize failures and successes, determine lessons from outstanding traditional cities, and adapt them to contexts of today to attain more sustainable societies. (Sharifi, & Murayama, 2013).

Density is an important indicator of improper use of land and substructures and as a result damage to the capacities of environmental resources. In addition to encouraging low-density growth of the city, master urban plans have encouraged the use of motor vehicles and increased energy consumption by imposing zoning regulations and separating the main urban functions such as work centers in residential areas. This phenomenon is also in contrast to the natural state of traditional desert cities; Because in dense desert cities, its human footprint provides ease of movement on foot and minimizes the need to use motorized vehicles. The presence of mixed uses in the centers of old neighborhoods of desert cities prevents residents from making unnecessary trips to meet their needs to different places. The New urban plans, unlike the native tradition of using mixed-use, cause the separation of uses as much as possible from each other and in the form of functional zoning of the city. (Golkar. 2000).

Regarding social sustainability, it may be argued that the urban form, together with its constituent and ancillary parts, has the potential to impact the social dimensions of sustainability. The integrated construction is the most notable feature of a traditional Iranian city that distinguishes it from its contemporary version. This integrated structure has enabled inhabitants to have equal access to utilities and amenities. There were also strong family, religious, and economic links that facilitated a feeling of community and mutual assistance. Conventional urban areas were well-connected by a system of pedestrian pathways and exhibited a compact and mixed layout. Safety precautions and regional features were taken into account throughout the design phase. Due to the combination of these attributes, the traditional city was able to successfully meet demands for social interactions, collective action, housing, work, justice, accessibility, privacy, and consensus-oriented decisions. (Sharifi. & Murayama. 2013).

In modern Iran, new factors and social institutions have evolved that must be incorporated in the planning process. The new components can coexist with the traditional ones; but, influenced by the past's success approach, the resuscitation of the city as an interconnected structure necessitates a network of connections that allows for simple mobility between the city's now dispersed constituent elements. Civic and open spaces should be given special consideration as essential components of socially functioning communities. comparable to traditional designs; During the design procedure, the biological, sociological, and perceptual features of the people, as well as the climatic conditions of each area, should be

taken into account. There are several effective examples of establishing pedestrian-friendly streets by decreasing traffic and developing active frontages that may be replicated in the Iranian environment. (Sharifi. & Murayama. 2013).

3.7. The missing Puzzle of ecological implementations in the cities of Iran, People Participation, awareness, and Education

Participation is the most essential element in achieving development goals, especially urban development. Urban planners try to be aware of citizens' opinions in urban decisions and implement their plans with their cooperation. (Givi.&. Alipoor.&. others .2015).

The participation of citizens in the process of city planning has been restricted by several issues. Some of these constraints have been addressed by researchers and administrators, while others stay unsolved. (Mohammedi, 2010). one of these problems is related to the relationship oof municipalities and residents.

Currently, in many countries, municipalities as social institutions have used the potential of extensive cooperation and attracting the participation of the private and public sector, seeking the participation and attracting the cooperation of non-governmental organizations and non-governmental organizations, but unlike the advanced countries, in Iranian cities, people do not play a role in municipalities plans due to the reduction of the revenue dependence of the municipalities on the government. This issue does not have much history in Iran, which of course cannot be blamed solely on the citizens for this shortcoming. Of course, the institutions of our society, including the municipalities, have failed to create the necessary platform for the social participation of citizens. (Haj Sayed Hosseini. 2020).

Moreover, the participation of people in municipality plans or other projects will result in more efficiency, if the process is carried out at the right time and stage of the project. After all, people's involvement may lead to social sustainability, which is necessary for urban planning initiatives to be suitable. (Mahdavinejad. &. Amini.2011).

Therefore, education and awareness of people about the sustainable planning issues in the city and using their potential and ideas in municipalities projects and others will help efficiently to achieve the goal of designing in the city.

3.8. Investigating the local ecological characteristics of one of the Iranian cities, Yazd city

In the following, the Iranian prior issues of eco-cities which direct the current urban planning of Iran, will be explained. Cities of Iran have different climates and different urban forms and characteristics but as a very big part of the country has dry and hot weather as the city of Yazd, this city was selected for the explanation of the ecological principles of Iran.

The city of Yazd is located at 31 degrees north latitude and 54 degrees east longitude not far from Iran's center desert and has harsh winters and scorching, dry summers. The absolute highest temperature in summer is 45 degrees Celsius with 12% relative humidity

and the absolute minimum temperature is minus 16 degrees Celsius with 73% maximum relative humidity, the prevailing wind direction with some humidity in summer is from the northwest and blows with an average speed of 5.6 meters per second. But in winter, this direction changes to the southeast and west at a speed of 4.8 meters per second. The wind along with the soil mostly blows from the northeast in spring and causes problems. (Ayatollahi .2005).

Now the environmental goals in the city will be described in 2 parts:

The topography and geographical features were taken into consideration when building the entire city. For instance, the subterranean water canals and the ground's slope have an impact on the design of the natural network of pathways, such as passageways and alleys. (Monshizaadeh.A.2008).

The heat caused by sunlight is one of the remarkable features of the architecture and urban development of this region. Sinusoidal forms used in traditional weave alleys, in addition to minimizing sun exposure, from the effects Reduces dusty winds. The orientation of buildings in Yazd according to the sun and wind is northeast-southwest (Khoshbinroodi. 2013).

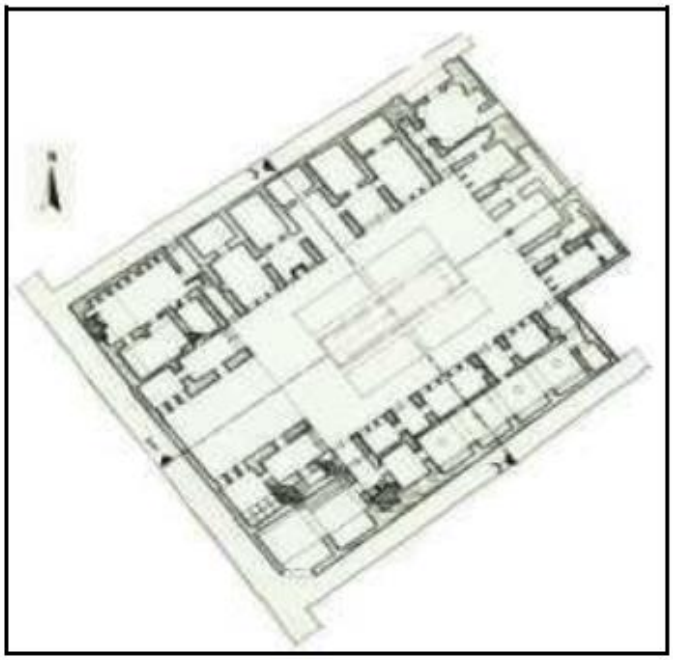

Figure 14. An example of building orientation in Yazd. Source: (Khoshbinroodi. 2013).
The orientation of buildings in Yazd according to the sun and wind is northeast-southwest.

According to the physical similarities of the historical cities of Iran's desert areas, a model can be recognized and proposed under the title of compact Iranian city. (Golkar .2000)

Yazd's gardens and vegetation cover most parts of the outskirts of the city as a belt. It included that it helped to moderate the temperature in hot seasons and also reduce the effects of dusty winds. (Khoshbinroodi. 2013).

In order to lessen the amount of stress caused by the intense heat in the summer days, the design of the residential areas is such that the walking distance between the residents and the children's play is short or trees are provided. From the point of view of spatial distribution, shopping places, schools, and municipal services are also basic services near residential areas. (Golkar .2000).

According to what has been said, buildings are oriented to take advantage of solar and wind movement, this reduces the amount of energy used for heating and cooling during the summer and winter.

The primary practice of this regional building was the reuse and recycling of materials and elements used in the construction of new structures. These days, historic structures may be used for a variety of purposes, including hotels, restaurants, workplaces, and schools, thanks to their adaptability. (Monshizaadeh.2008).

Recycling and reuse of buildings can be considered as one of the architectural and urban planning traditions of Iran. (Golkar. 2000) The tall, clay walls that enclose covered corridors and narrow alleyways provide shade and comfortable temperatures throughout the hot summer months. (Monshizaadeh. 2008).

Figure15. Sabat Passageway (a kind of shaded passway with a roof)
(Source: https://www.hamshahrionline.ir/news/290135/)

Water as a life-giving element, has played and continues to play an effective part in desert cities. The element "water" has not only been able to transform dry deserts into livable

settlements but also plays the role of shaping the skeleton of the metropolis at its size through hidden canals and open streams) and on the scale of residential units through elements such as water ponds. It contributes to the natural cooling system and reduces the dryness of the air. (Golkar. 2000).

The main materials used in the traditional architecture of Yazd are raw clay, baked clay, plaster, and lime. Soil is the most abundant and available material in this region, which at the same time has a good compatibility with the climatic conditions of the region and is widely used. Considering the high thermal capacity of the soil on the one hand and the high thermal fluctuations between night and day as well as winter and summer, this material has responded well to the resulting expansion and fluctuations. (Khoshbinroodi. 2013).

This style of dividing the city into small centers, with appropriate scale and distance, and easy access to facilities has been provided in difficult climatic conditions. In the old city of Yazd, the area served as the various socioeconomic classes' homes., owners of different jobs, and followers of different religions. Close socio-economic relations and workshop production methods have had an impact on the social and spatial order of the city so that in a neighborhood, aristocratic sections, owners of private workshops, and the middle social class have been located together (Tavassoli .2018).

We may benefit from historical lessons by realizing that settlements are, at most, artistic expressions of human ingenuity. The sustainable design derived from Yazd's traditional architecture demonstrated that ancient towns may be examples of a sustainable culture, transferring the responsibility for urban supervision in a relationship of friendship with the natural world from one generation to the next. Even while we cannot simply bring historic methods into the twenty-first century unaltered, future cities can nonetheless benefit much from studying this model. (Monshizaadeh.2008).

3.9. Experiences of Sustainable Planning in Iran: Yung town, the Sustainable City of Hasthgerd, cooperation with Germany (Shahrak Javan) and the desert eco-park in Yazd city

In the previous part, the traditional ecological characteristics of Yazd city were examined. But today, according to the situation of urbanization in Iran, using fossil fuel as the main energy and other economic problems occurred economically like USA sanctions and other factors in different sectors, there are a few new experiences in attaining sustainable eco-urban projects in Iran. Among them, the study of Yung town planning was chosen because it is the only sustainable urban planning that has been done in Iran. While there are some eco-parks in this nation, no eco-cities have been built. So one of these eco-parks was selected as the case study which is Yaz eco-park, the biggest one. It is located in the middle of a desert with a climate of dry and hot, the same as the climate of most parts of Iran. As a result of researching this instance, the right answers may be learned and used in other towns with similar climates.

Yung town planning, the Sustainable City of Hasthgerd, cooperation with Germany (Shahrak Javan): The new city of Hashtgerd is located on the slope of the Range of Alborz mountains in the west of Tehran. It is situated on the road of karaj_ghazvin. It is at a distance of 25 km, 75km, and 60 km from Karaj, Tehran, and Ghazvin respectively. (Raheb. &. Mirmoghtadaei. 2018:3).

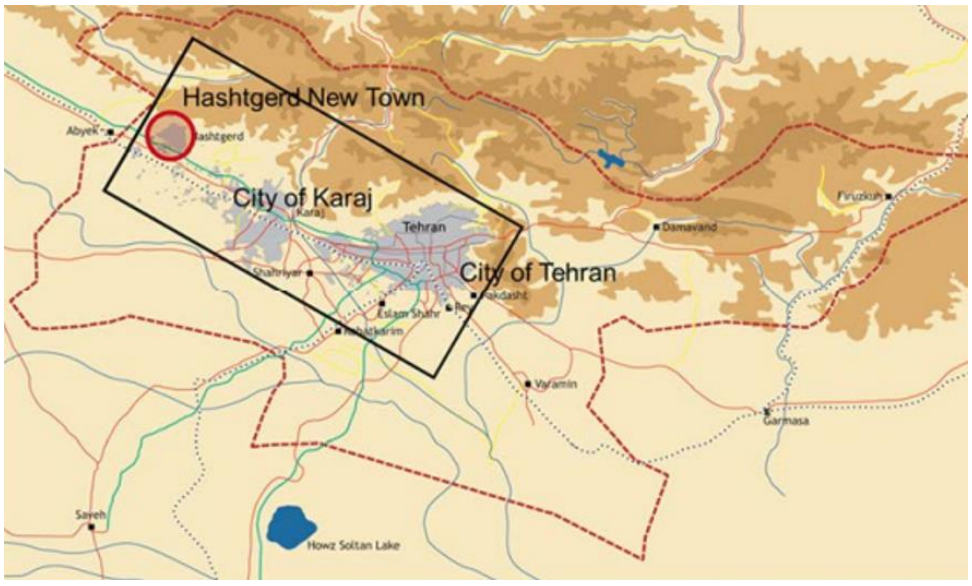

Figure 16. Location of the new city of Hashtgerd

Source:(Pahl-Weber.&. Seelig . others. 2013:130)

Natural features:

Among the natural features of this region are two rivers, Fashand and Kurdan, in the eastern and western parts of the region, Taleghan Valley in the northern part, and Dasht Abik in the southern part of this region.

Important geological features of the region:

1. 5% slope north to south of the area

2. There are valleys with a slope of 20% to 50%

3. Rivers with a very steep slope. (Pahl-Weber.&. Seelig . others. 2013)

Green space per capita:

The young town is considered to have an area of 35,000 hectares, of which 9,000 hectares are dedicated to green spaces and open spaces, and about 2,000 residential units are planned for the residence of 8,000,000 people. (Pahl-Weber.&. Seelig . others. 2012)

Figure 17. The location of the 35-hectare site in the new city of Hashtgerd.

Source:(Jahanshah.2013)

Sustainable strategies in the design of this project:

The achievement of this part of the work was the design of a residential neighborhood with an area of about 35 hectares and considering the following principles.

- Residential model with suitable urban density to reduce soil wear and save energy
- Horizontal and vertical mixing of uses through the creation of a compact urban form in order to reduce travel distance and thus reduce energy consumption
- Compact urban form in order to reduce energy consumption and pay attention to microclimates
- Creating urban open spaces with maximum climate comfort through adiabatic cooling and increasing green space
- Orientation of the building according to the direction of the sun to provide comfort and shade the public space
- Climate simulations and the use of an integrated design process to reach the goal of reducing energy consumption. (Raheb. &. Mirmoghtadaei. 2018:7).

Moreover, the following sustainable strategies was considered for this project:

1. Paying attention to climate and topography in determining the urban context of street orientation

2. Landscaping and green space widely according to the climate

3. Sustainability in the energy supply of the settlement

4. Sustainability in water consumption and recycled water management

5. Sustainable Transportation. (Pahl-Weber.&. Seelig .&. others. 2013)

Figure 18. Placement of residential building blocks on the site. Source: (Raheb. &. Mirmoghtadaei. 2018:6).

Sustainability in the energy supply of young town project:

Although energy management is considered the most important part of this plan and the main goal of the plan is based on it, it cannot be planned independently of other aspects of the project. This part of the plan seeks to optimize the production and distribution of cooling and heating energy, and the overall goal of the plan is to reduce Fossil energy consumption and CO2 emissions in Iran's construction sector and replacing them with resources renewable energy. (Raheb. &. Mirmoghtadaei. 2018:17).

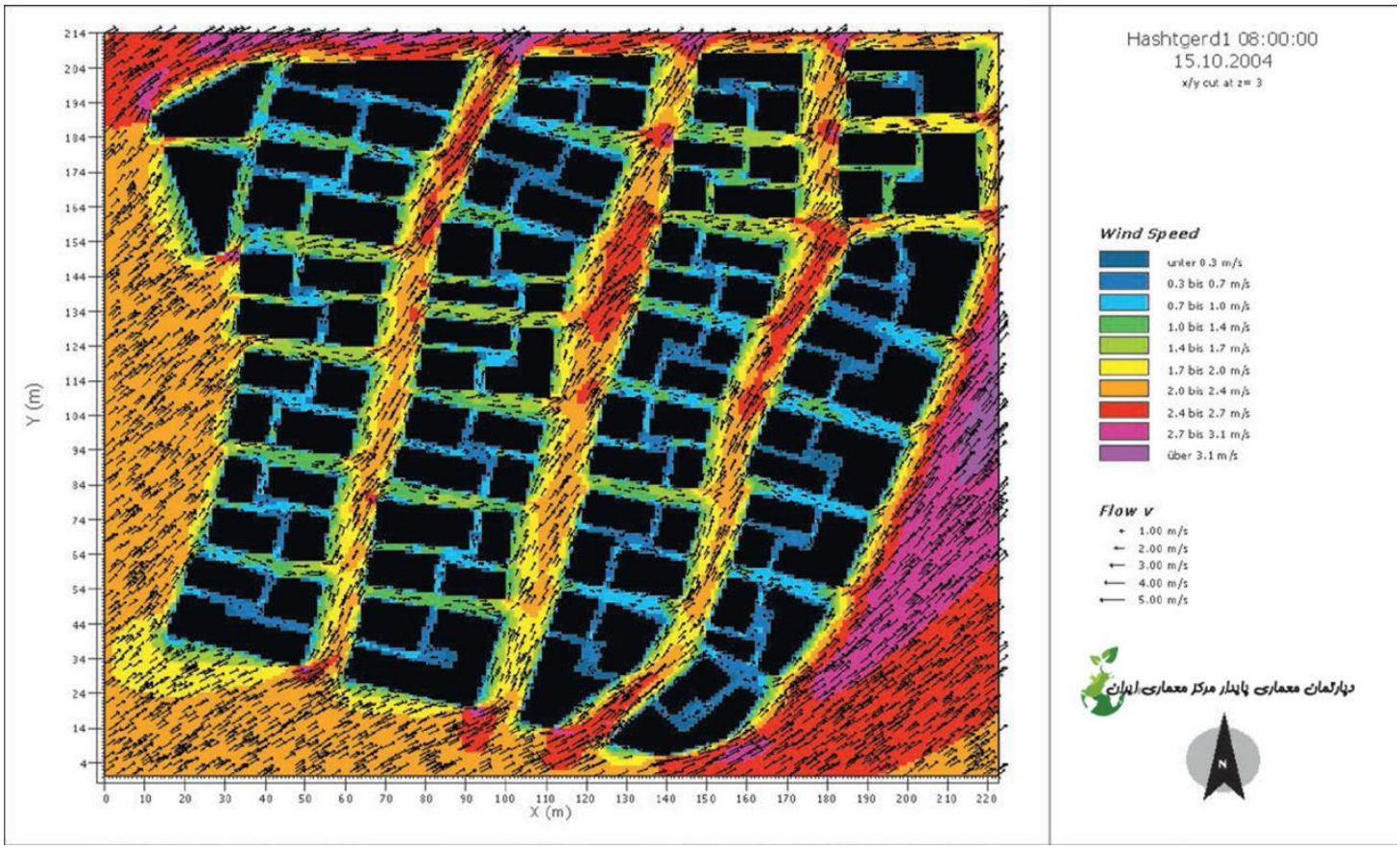

Figure 19. Simulation of wind speed in blocks

(Pahl-Weber. Sebastian.& .others. 2013:137).

Another goal of this project is to develop transferable planning and design practices for energy storage systems at the local level and compatible with semi-arid climates. The third is the use of renewable energies. The horizontal emission of solar rays in Tehran is very high compared to many European countries, so the use of solar cooling technologies for ventilation systems will be investigated. In line with the above goals, the following actions are foreseen in the project plan. (Raheb. &. Mirmoghtadaei. 2018:18)

Examining common installation systems in the region and evaluating other systems and finally introducing the optimal and efficient system according to the region's climate.

Improvement of the common system in the region

1. Water cooler + air return channel to save energy

2. Placement of photovoltaic cells on the roof to supply hot water consumption + insulation of existing pipes in the building. (Pahl-Weber.&. Seelig .&.Others. 2013)

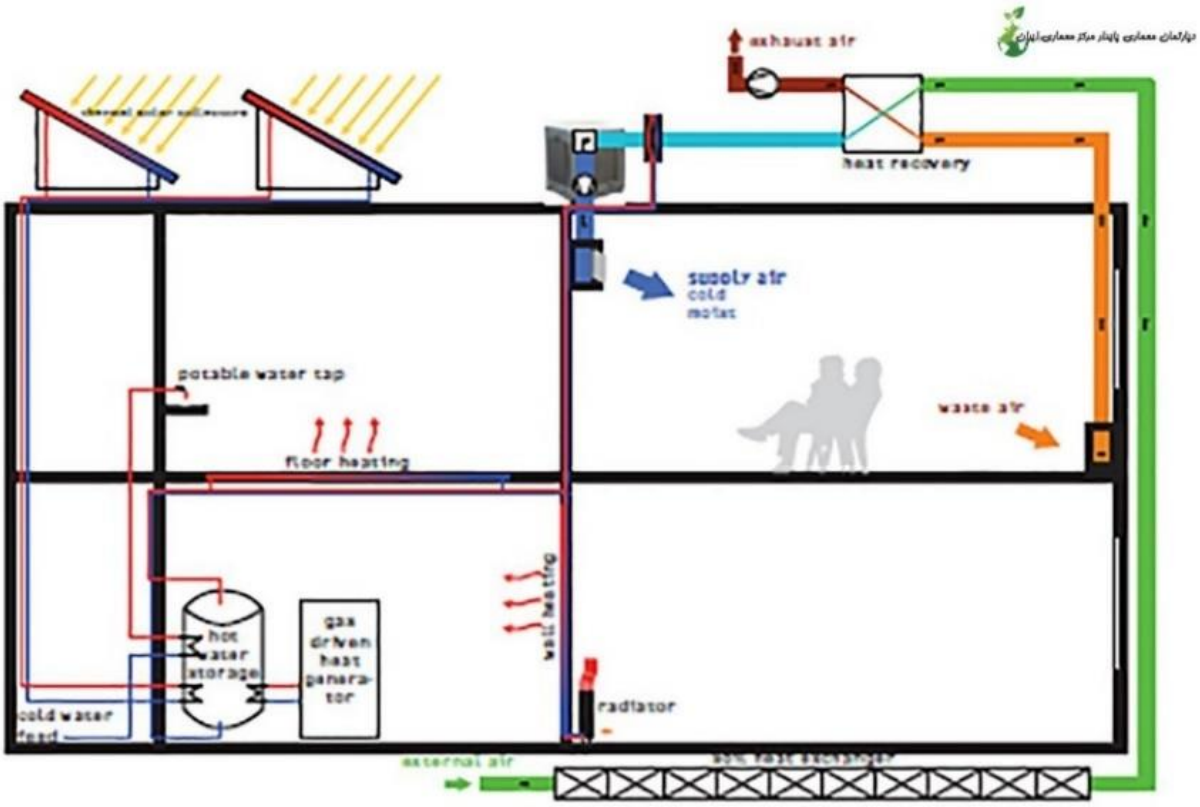

Figure 20. Sustainable energy Supply in Shahr Javan. Source: (Weber.&. Seelig .&.Others. 2013:153)

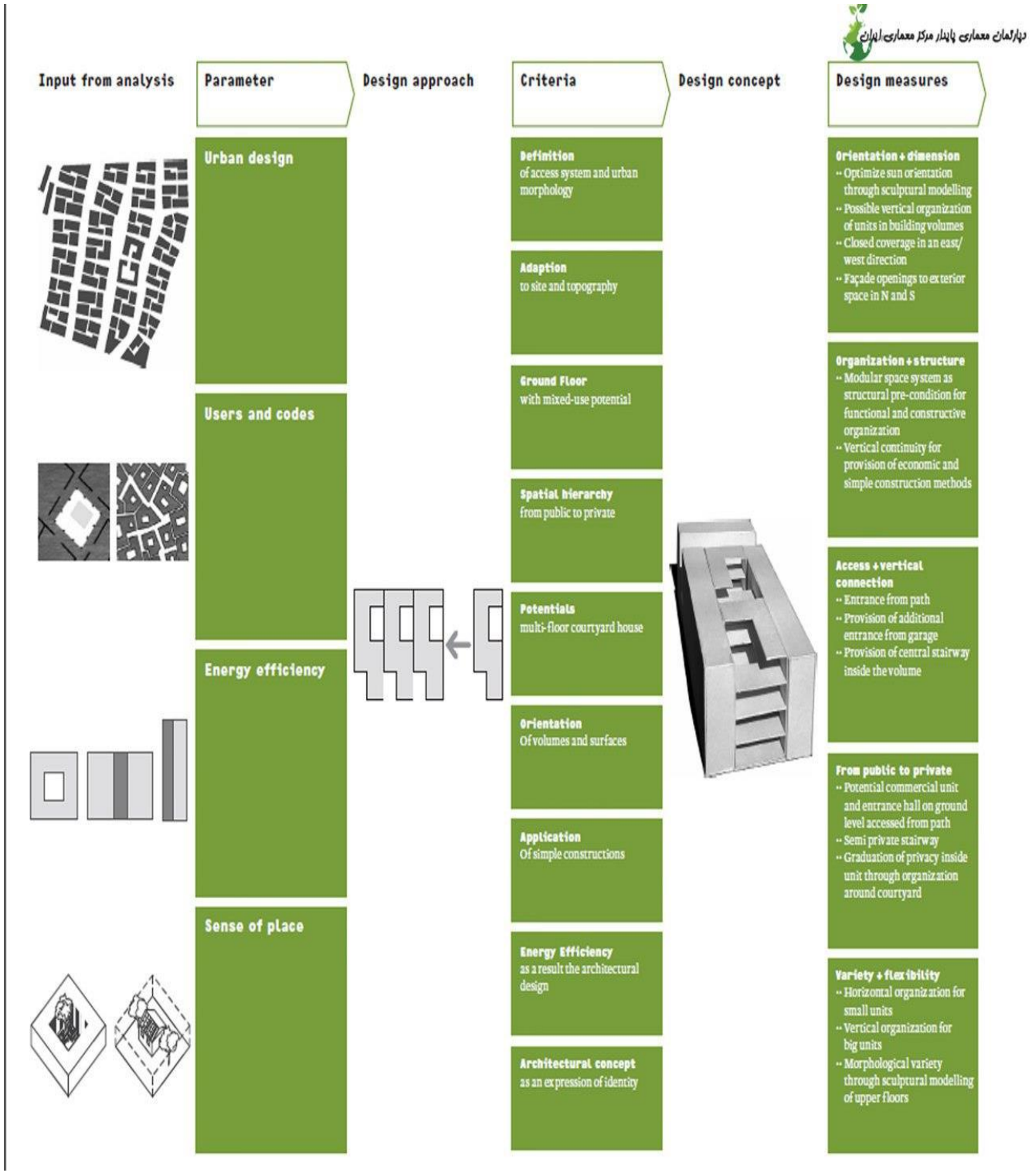

Figure 21. The Process of design

Source: (Pahl-Weber. Sebastian.& .others.2013:144).

Sustainability in water consumption and recycled water management of Young Town project:

The purpose of this part is to develop water and wastewater management solutions in arid and semi-arid areas with special attention to the effects of global warming and natural conditions and social and cultural factors. The implementation of this solution has been using the technology of the separation wastewater collection system in the collection and reuse of gray water and its purification in the artificial semi-concentrated wetlands of the place, as well as the processing of black water for the production of natural gases. Solutions to save water consumption and trying to change the behavioral patterns of consumers are other goals of the project. Therefore the main ideas of water management are as following: (Raheb. &. Mirmoghtadaei. 2018:11).

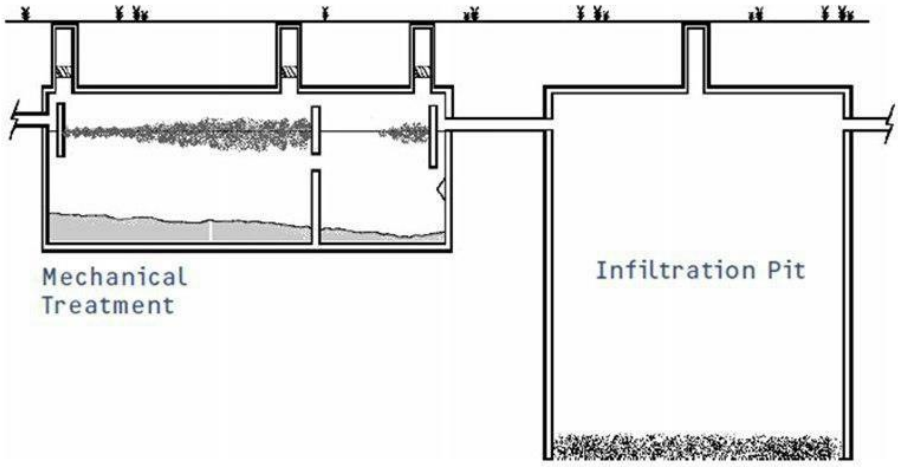

Figure22. Sustainability in water supply

(Pahl-Weber. Sebastian.& .others. 2013:160)

The straegies can besummerized as:

High consumption of air exchange devices - old washing machine - and hig water consumption in the bathroom

Gray water recycling management:

After collecting water in large tankers, its overflow enters the soil and the soil acts as a filter, and then this water is used to irrigate the plants in the urban space. On the other hand, plants with stronger cleaning and disinfecting properties can be used.

Rainwater recycling management:

Collecting rainwater in special tanks to separate materials and sediments in it.

Sustainable transportation of Young Town project:

Designing bicycle paths

Suitable sidewalks to encourage people to walk

Suitable bus and taxi lines to meet every part of the town, so that they can be accessed on foot about 300 meters. (Pahl-Weber.&. Seelig . others. 2013)

Figure 23. Public Transportation Proposal Map

Source: (Pahl-Weber.&. Seelig . others. 2013)

The following items are included in the proposed plan for providing a spatial structure, transportation system and traffic model and consumption pattern related to traffic:

Using the mixed land use model by predicting suitable transportation systems, accessibility of social and local issues)

Support for the approach of traffic planning according to the environmental conditions (vehicles and public transport)

The filtered permeability of spaces and the appropriateness of means of transport according to their environmental effects, flexible and adaptable transport

Avoid coming and going in residential areas

The mobility safety management, the participation of all the related people Design based on topography and considering the crisis management (Raheb. &. Mirmoghtadaei. 2018:8).

The desert Eco-park in Yazd, Iran: Yazd city is located in the center of Iran, near a desert. its climate is dry and hot like most parts of Iran. It has too hot weather in summer and cold weather in winter. The number of rainy days is low and the wind carries desert sand to the city when it blows. In this hard climate, people have made a lot of affords from the past to build compatible buildings with the climate. Nowadays, because of the special climate and lack of water, some ecologically friendly projects have been done in this city. One of the projects is the construction of the biggest eco-park in this city. In Iran, some eco parks have been constructed but this is the biggest desert one. This eco-park is about 150 hectares.

Figure 24. Sadra eco-park in Shiraz City, Iran

Source: Islamic Republic News Agency (https://www.irna.ir/news/83006760/)

Yazd desert has a different feature compared to other deserts in Iran and is the most accessible desert in this country (https://yazdportal.ir/n/RlYKO1) .According to this characteristic, the design of this park has been done. This eco-park is situated in the north of the Yazd outside the city and also a water pond and eco-camp are constructed near this eco-park as is obvious in the pictures.

Figure 25. the location of Yazd eco park
Source: google map

Figure 26. Yazd eco park
Source: Iran students news agency (https://www.isna.ir/news/1402061610205)

The designers considered the shortage of the water in design of this eco-park and this park do not have any problem of supply of water because the trees and plants need low amount of water and are drought resistant. Moreover, it is considered to be used the wastewater for watering the plants (Iran metropolises news agency, (https://www.imna.ir/news/667042/))

By equipping the pumping station, the water network of the green area of Eco-park is completely irrigated by wastewater. For the greenery of this desert garden, a total of 4500

Figures 27 and 28. drought resistant plants in the eco-park
Source: IRIB news agency (https://www.iribnews.ir/fa/news/2213937)

7-year-old trees and saplings have been planted. Sewage transfer infrastructure has been completed by digging and laying pipes for a length of 6,500 meters from Al-Ghadir Bridge to the aforementioned park and the construction of two water sources of 500 cubic meters. (https://www.tolooeyazd.ir)

In the first phase of this plan, 12 native canopies have been made by using desert architecture, and seats, sanitary facilities, and lighting is completed in this phase. (Iran student news agency, https://www.isna.ir/news/1402061610205)

Figure 29. use of the traditional architecture of Yazd in the eco-park
Source: Iran news agency, (https://www.irna.ir/news/85221868)

Yazd wastewater pond: The wastewater lagoon of Yazd was created from the release of water from the sewage treatment plant of this city in the desert. The presence of this lagoon has created a beautiful scene among the flowing sands of the desert. The length of the lagoon is 3 km, its width is 1 km at its maximum, and it is 1145 meters above sea level. The vegetation surrounding the lagoon is large bundles of reeds. The Yazd Lagoon stands out in the middle of the land with a lot of water poverty and has become a watering hole for desert wildlife. This wetland is also a temporary destination for winter migratory birds. The lagoon water is also used to irrigate the green belt of Yazd city. The successful implementation of this belt can completely solve the problem of dust and litter due to low rainfall in this region. Yazd sewage lagoon has recently become a tourist destination. Many desert enthusiasts come to this lake to spend the night and enjoy the beautiful sky of Yazd. (https://safarzon.com/mag)

Figure 30. water waste pond in Yazd, source: (https://safarzon.com/mag)

Figure 31. wate water pond in Yazd, Source: Iran student news agency, (https://www.isna.ir/photo/94052815972)

Moreover, there is an eco-camp for tourists near this pond which is created according to the traditional architecture of Yazd.

Figure 32. Eco-camp in Yazd, Source:(https://gotoyazd.com/place/216/)

Figure.28and 29. Eco-camp in Yazd, source:(https://gotoyazd.com/place/216/)

3.10. Results obtained from the experiences of the Two case studies

Yung Town approaches to planning were evaluated and classified as attaining sustainable water, energy, and mobility. The planning of this town was supposed according to the topography and slope of the city. The alleys were designed sinusoidal (like the traditional alleys in Iran) and the blocks were created in different forms(not cubic) according to the topography and the direction of the wind and the sun. Energy and environmental factors played a key role in this project. The notion of a compact city was developed in order to make the city a suitable area for walking. The bus lines were developed to cover small distances within the area. Yung Town project was purposed for a dry and hot climate, Therefore, other architects and urban planners can be inspired by this sustainable town in order to make other cities of Iran more sustainable with the same climate.

In the other case study, Yazd desert is the closest desert to a city in Iran. By assuming this reality, the notion of designing a site to profit from the desert's potential was formed. In

order to accomplish this purpose, the Yazd eco-park and the wastewater pond were built. The usage of the kinds of plants that need a low amount of water, using wastewater, constructing residences with traditional architecture, etc are the main policies of this project. Moreover, planning a lake in the middle of the desert makes the environment more humid, and also it has caused beautiful scenes in the desert. This led to an increase in the number of tourists who were attracted to this place. Although there are some critics about finding the right place for making this lake, the main ideas of this experience can be carried out in ecological projects in other cities of Iran.

Part 2. The city of Isfahan as a detailed case of study

1. The city of Isfahan

1.1. Reason for the choice

Isfahan is Iran's third most populated city, located in the country's heartland and characterized by dry and hot weather. It is the most important city of Iran in terms of historical buildings. It is an important city in the industrial and agricultural and tourism sector of Iran. Moreover, Most of Iran has a same climate like Isfahan, a dry and hot climate. Nowadays, this city faces a bad environmental situation. To specify, air pollution and other environmental issues have increased in this city and need the urgent action of the policymakers. These days, many news talk about the fact that decision-makers in Isfahan have the aim to make this city more sustainable. The historical city which was sustainable in the past and nowadays due to the modern lifestyle and technologies loses its sustainable characteristics. I am familiar with this city's characteristics from my childhood as I live there, and I have access to the local information. Due to these reasons, I chose Isfahan to do a survey about the situation of sustainability and ecological issues in this city in my thesis.

1.2. Location, population, Urbanization rate and analytical data of Isfahan

The capital of Isfahan Province, Isfahan City, is the 3rd biggest city in Iran, spanning 551 square kilometers and rising to a height of 1,574 meters. It is situated in the center of Iran, around 420 kilometers south of Tehran.(https://use.metropolis.org/case-studies/revitalizing-sick-buildings#casestudydetail)

The city of Isfahan has a longitude of 51 degrees 39 minutes and 40 seconds east and a latitude of 32 degrees 38 minutes and 30 seconds north. (https://web.archive.org/web)

Figure 35. location of Iran and Isfahan province and the city of Isfahan in the world

Source:(https://www.rugman.com)

The population of Isfahan province was 5120580 persons as the third populated city according to the statistics in 2016. Isfahan City has a share of 1961260 persons of this population (https://plan.isfahan.ir/sites/default/files/statistics_content/)

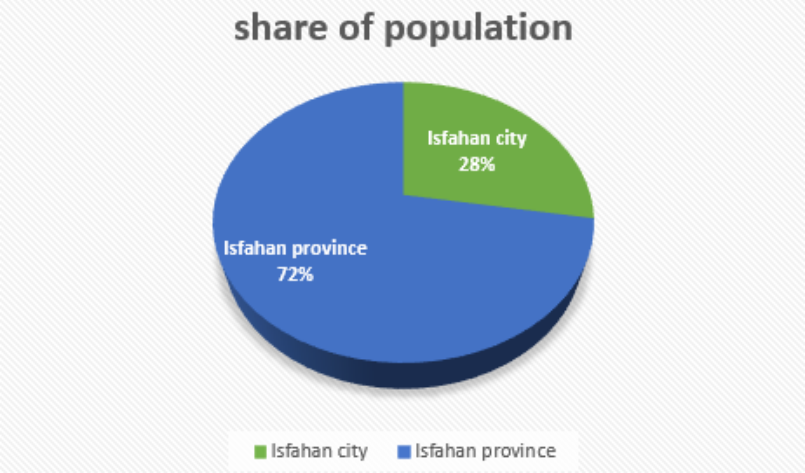

Figure 36. Share of population of Isfahan city in Isfahan province.

Source: (https://plan.isfahan.ir/sites/default/files/statistics_content/)

The urbanization rate of this city from 2006 to 2011 was equal to 85%[3], the physical size of Isfahan in 2006 was 18228 hectares, having grown about 9 times since 1956. Additionally, examining the population rate of increase revealed that it has increased 7.8 times during the previous 50 years. Figure38 shows the expansion of Isfahan during six successive time periods. Causes for this rise include immigration from countryside to cities, local industrial development, and the incorporation of historic districts into cities. (Soffianian, &. Nadoushan, &.Yaghmaei, & Falahatkar, 2010).

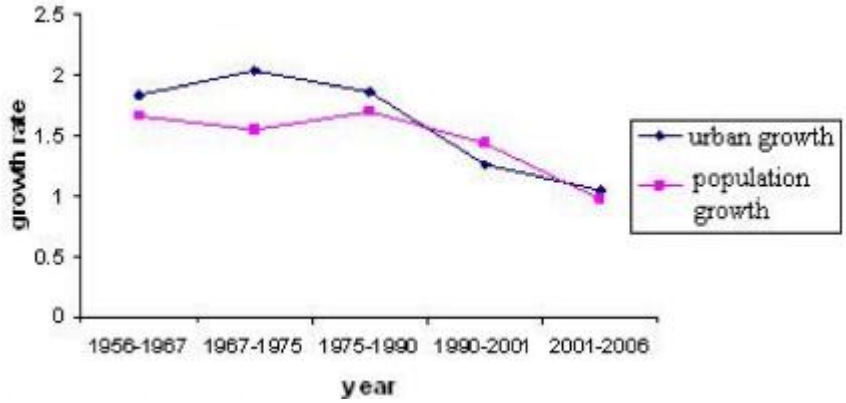

Figure 37. Area and population growth of Isfahan. Source: (Soffianian, &. Nadoushan,&. Yaghmaei, & Falahatkar, 2010)

[3] https://knoema.com/atlas/Iran/Isfahan/Urbanization-Rate

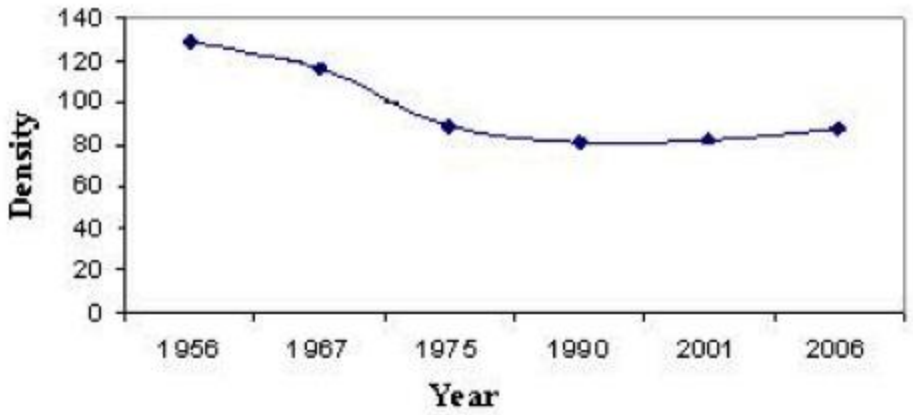

Figure 38. Isfahan population density over five decades. Source: (Soffianian, &. Nadoushan,&. Yaghmaei, & Falahatkar, 2010)

1.3. Climate and geographical features

According to Koppen-Geiger's climate classification, Isfahan has a characteristic dry climate. (Kottek. &. Grieser. &. Beck. &. Rudolf. &.Rubel, 2006). Dry weather and very low rainfall are the prominent features of this classification, where the minimum and maximum temperatures are -10.6 °C and 40.6 °C, respectively. The mean annual precipitation over the city is 116.9 mm. (Eslamian., & Feizi. 2007).

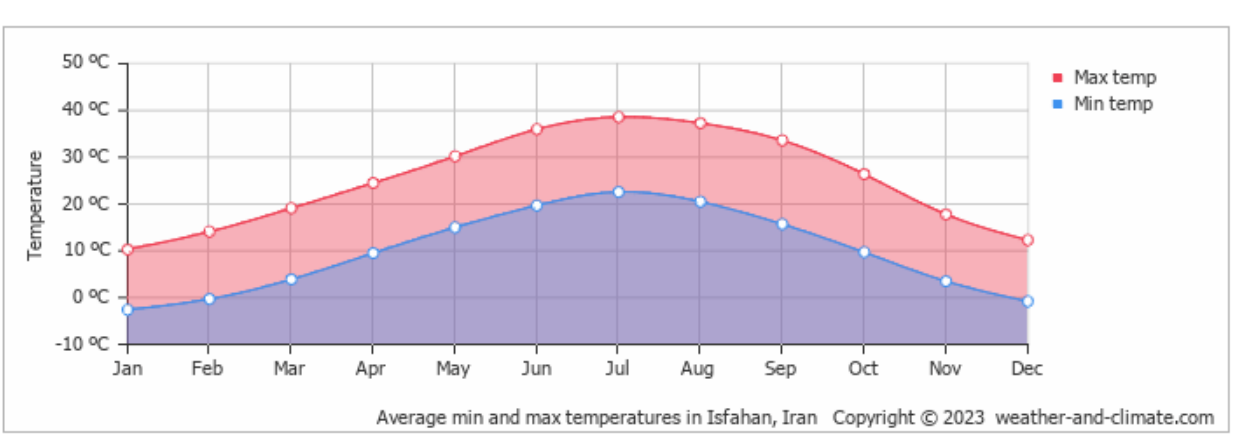

Figure 39. Average day and night temperature over the year

Source:(https://weather-and-climate.com)

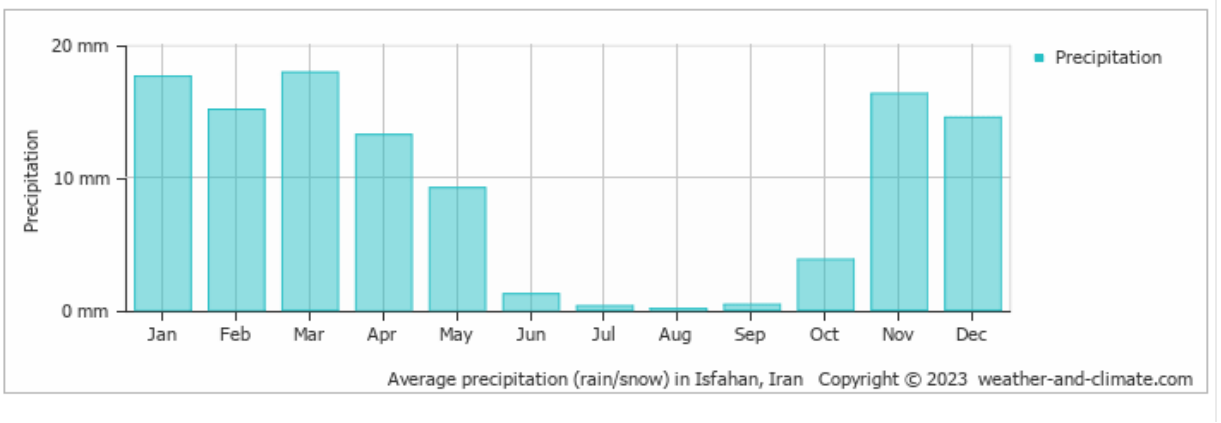

Figure 40. The mean monthly precipitation over the year, including rain, snow, hail etc

Source:(https://weather-and-climate.com)

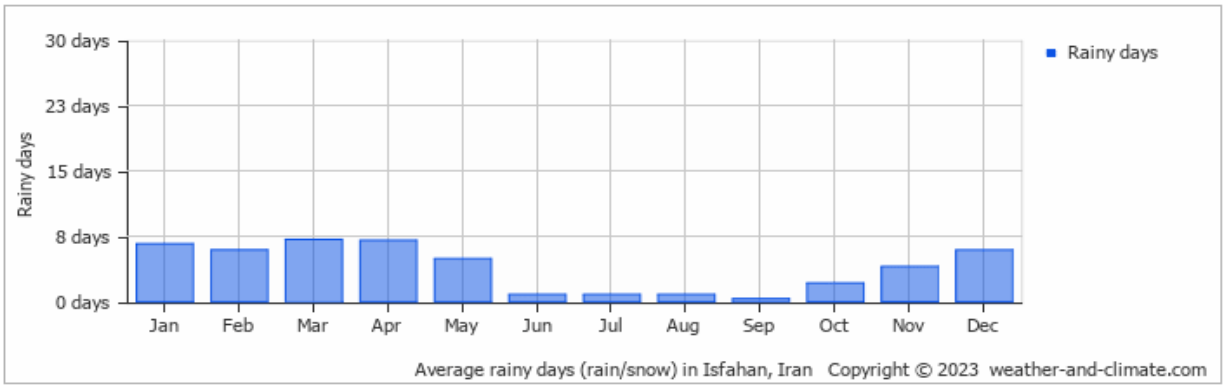

Figure 41. The average number of days each month with rain, snow, hail etc

Source:(https://weather-and-climate.com)

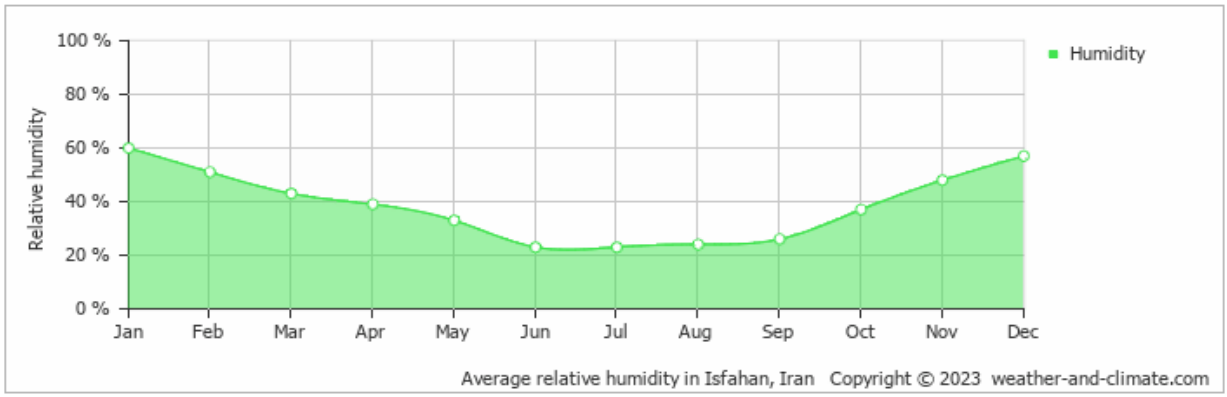

Figure 42.The mean monthly relative humidity over the year.

Source:(https://weather-and-climate.com)

Isfahan is about 1580 meters above sea level and is located in the east of the Zagros mountain range. This city is situated at the intersection of the nation's east-west and north-south routes., and during its history, it has been the place where different ethnicities and cultures came and met. The large area of Isfahan is limited to the desert in the north and east, and the west and south It leads to the heights of Zagros. (Azadkhani. &. Brimipour.&. others. 2017)

The waters that generated the Zayandeh River and sprang from the high peaks of Zagros known as Zardkoh Bakhtiari are the reason this city exists and emerged., It is located on the deposits of Zayandeh Rood and is divided into two halves by Zayandeh Rood.((Azadkhani .&. Brimipour.&. others. 2017).

Mountains of the city of Isfahan: The mountain range of the heights of Shah Kouh Lanjan in the south of Isfahan is connected to two low mountain ranges of Soffe and Baba Saeed, whose direction is from south to east. The height of Mount Soffe in the south of the city reaches 2400 meters. Among the mountains around Isfahan, Soffe Mountain is more important due to its geographical and historical location. There are natural springs in this mountain and it has been a resort for people and mountaineers since ancient times. (Honarfar.1969).

Zayande rood River: The most important river that flows in the center of Iran is Zayandeh Rood. The Chehl Cheshme and Kohrang mountains in Bakhtiari soil are the source of this river and it is covered with snow most of the year. This river has dried up in recent years and its dryness has had many effects on Isfahan.(Honarfar.1969).

The general slope of this city, which is considered one of the most effective factors in its physical development, is decreasing from west to east ,in Isfahan plain from southwest to northeast. But the general slope of Isfahan plain has fueled the expansion of this city along Zayandehrood River, especially before Safavid. Although the urban development plan of the Safavid period turned the linear expansion of Isfahan into a cross, Zayandeh River still plays an important role in determining the direction of the city's development. The slope factor has had an undeniable impact on the development of the city in all historical periods. (Azadkhani .&. Brimipour.&. others. 2017).

1.4. The changes of urban form during the time: Before the Seljuk empire (before1050-1300 AD), The Seljuk Empire (1050-1300 AD), The Safavid period, the flourishing period of Isfahan (1501 to 1736), The Pahlavi period (1925 and 1979), After 1979 Revolution

The form of Isfahan was changed a lot during different historical periods in Iran. In the following, the evolution of its form will be explained.

Before the Seljuk empire (before1050-1300AD): Before the Seljuqs came to power in Iran, the city of Isfahan was limited to its oldest part, namely "Ji". It is also known to us

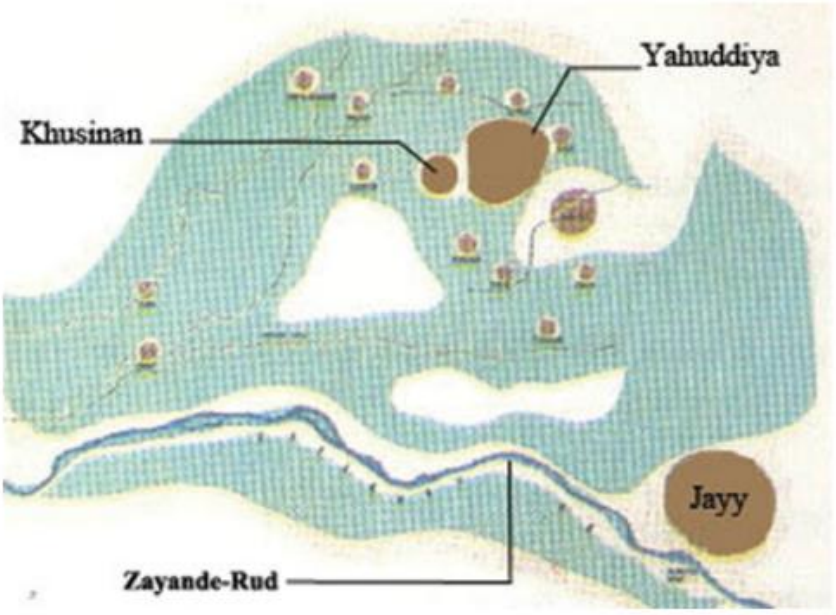

Figure 43. Isfahan's structure in early Islam. The structure is linear-nuclear

Source:(Falahat,.& Shirazi, 2015).

that there were Jews living a kilometer to the west and northwest of Ji, who were moved to that place in the past, and that city was called "Yehudieh", with the passing of many years, these two cities grew to such an extent that They joined together and formed a single larger city; which is called Isfahan today. However, the connection between these two was not realized before the 10th century AD. (Lockhart 2006).

The Seljuk empire (1050-1300AD): During the Seljuk era, with the establishment of the citadel, which was separated from the Jame Mosque by a wide square and was the most affluent part of Isfahan, the gradual development of the city took place along the linear axis of the market towards the south. In the Safavid period, this area gradually changed its position to a place around Naqsh Jahan Square. The development of the city continued towards the river and up to its vicinity. (Hedayat,1994)

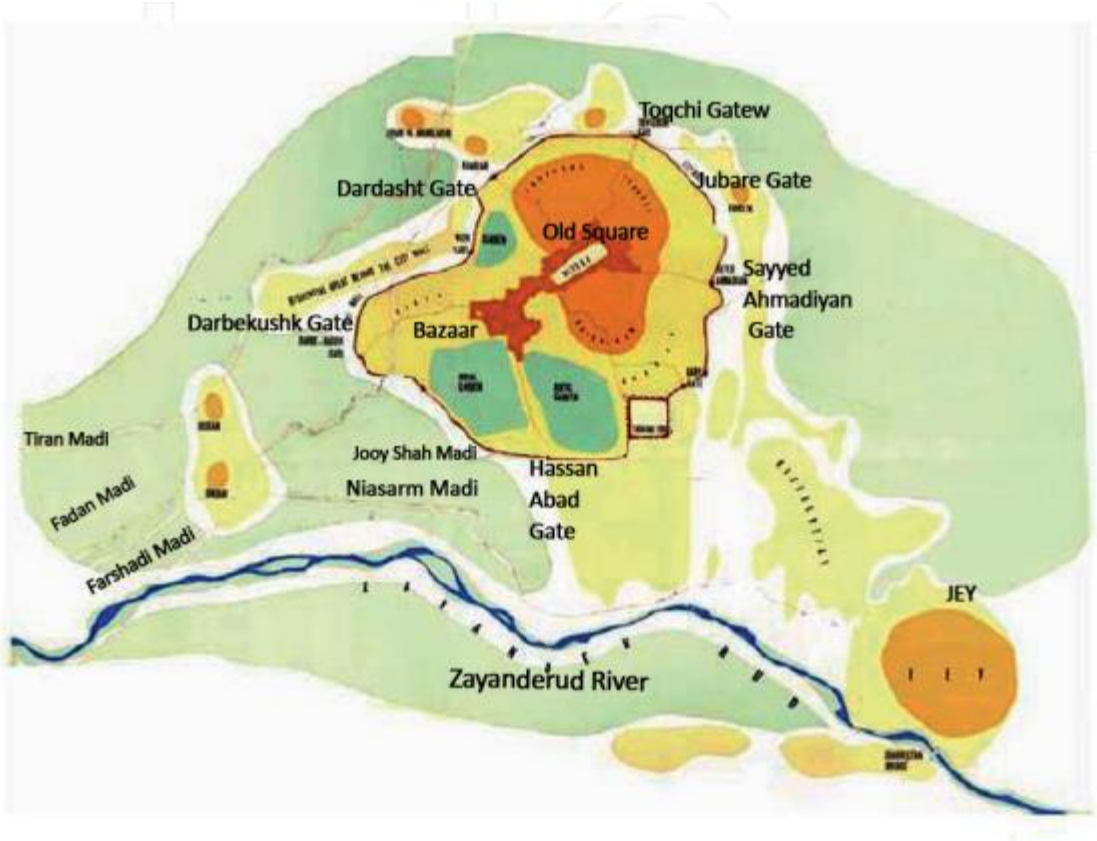

Figure 44. Structure of Seljuq Isfahan
Source: (Farjami, & Taefnia, 2022. https://www.intechopen.com/chapters/)

The Safavid period, the flourishing period of Isfahan (1501 to 1736): The rise and prosperity of the city of Isfahan took place again in the Safavid. During this period, many streets, mosques, schools, palaces, and bridges were built in this city. These buildings were built in the old body of the city and changed the composition of its foundation, which is the central part of the old square and the market. (Shahsavargar. 2012).

From 1591 to 1597, when Shah Abbas chose Isfahan as his capital and settled there, the construction of mosques, and bridges began. Chardin compares Isfahan with London in this era and writes, Isfahan has a population of over one million and one hundred thousand people, and the length of the ramparts and walls of the city is twenty thousand feet. It is reported that Isfahan has 137 royal palaces and 40 neighborhoods. Other Safavid kings continued the works of Shah Abbas. The tourists who visited Isfahan during the Safavid era have all praised the beauty of the streets with its streams and plane trees and cobblestones and its squares and buildings and markets full of people. Chaharbagh Street in Isfahan was considered one of the most famous streets and places for the entertainment and performances of poets. (Sultanzadeh. 1983).

During this period, the main structure of the city was formed. The city center until that time and the development of the city was towards the south of the Jame Mosque and the bazaars of that part, but at this time, another important pole was Naqsh Jahan square in the south of the old city with mosques and royal palaces. created in order to preserve the old part of the city and prevent it from falling, the markets around Naqsh Jahan Square were connected to the old markets of the Jame Mosque. In fact, the market served as a bridge between the old and new fabric of the city. The development of the city in this era was based on two generative axes. The river and the Chaharbagh axis were guided, and these two axes are present as the main axes of the city in all subsequent periods. A style called, the Isfahan school appeared in the architecture and urban planning of this time. (Shahsavargar .2012).

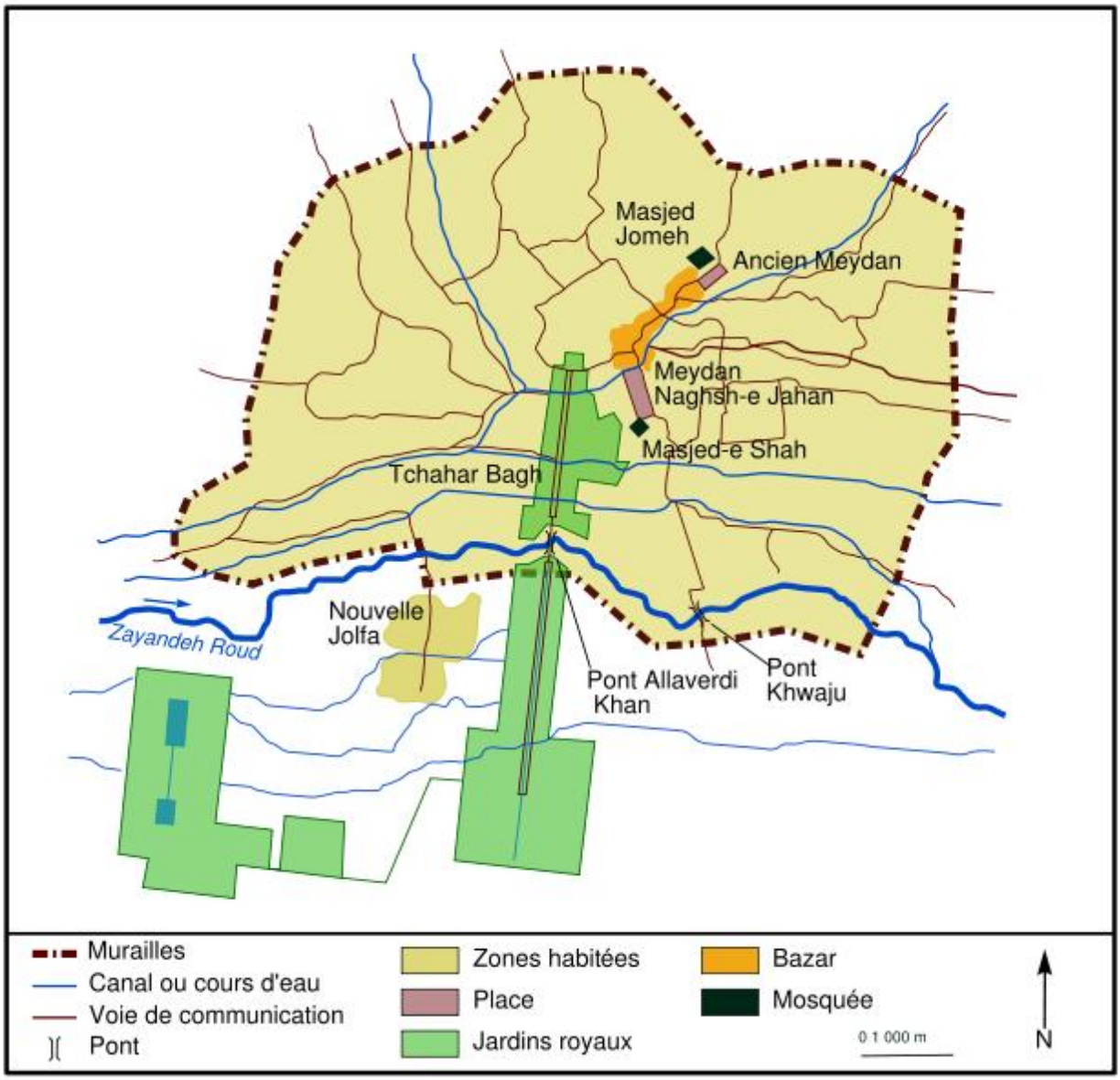

Figure 45.Structure of Isfahan in Safavi era. Source:(Durand-Guédy. 2003).

During the Safavid era, the city of Isfahan consisted of four specific parts:
Its main part is the old city of Isfahan, including the new southern part of the city, namely Naqsh Jahan Square and its surrounding elements
The second part of the large neighborhood of Abbas Abad or Tabrizian neighborhood (southwest of Isfahan)
The third part of the Jolfa neighborhood
The fourth part was the neighborhood of Gabrabad, which was called Gabrabad, and its inhabitants were Zoroastrians. (Shafaghi.2002).
Until the Afaghaneh attack, there was a certain peace and comfort in this city. During the Zandiyeh and Qajar periods, the transfer of the capital from Isfahan to Shiraz and Tehran and the neglect of the Qajar kings to this city, Isfahan, again reduced its prestige and value. (Sultanzadeh.1983).

At this time, many buildings built during the Safavid period were deliberately destroyed by Qajar kings.

Pahlavi period (1925 and 1979): With the expansion of the city on the southern edge of Zayandeh River, this natural element took a special place in the structure of the city. The mountains of Soffe, this natural element has been gradually absorbed into the main structure of the city. From the physical developments of the Pahlavi period, we can see the construction of new road networks and government buildings with various uses, the establishment of recreational and commercial uses on the edge of the main axis of Chaharbagh and the four main axes in the northern and southern district of the city, the construction of a university, the building of a new road system within the city, the presence of many old and new bridges, and the change of the main structure of the city along with the development of the city to the south, especially with the strengthening of the axis of Chaharbagh and Zayandeh Rood. (Sanaei. &. Mazaheri.2014).

After 1979 Revolution: The basis of the city's structure at this historical point had a radial pattern. In this period, the presence of natural elements is not seen in the main structure of the city, but artificial elements were important, such as: Friday Mosque, government buildings and the market, which were concentrated around the square. Access between the main elements of the city has been possible through the old square and also through the bazaar. (Sanaei. &. Mazaheri. 2014).

1.5. The current urbanization process: Master Plans of Isfahan: Cox Plan (1953), Organic Plan (1974), and Master Plan of Isfahan (1988)

Cox master plan (1953): The first development plan for the city of Isfahan was prepared at a certain stage of the country's economic, social, and political developments in 1953. This plan, which is known as the Coxs Master Plan, mainly followed the creation of physical changes in the city. The implementation of some streets proposed in the plan after a time interval of nearly 20 years is proof of the correct diagnosis of the city's physical condition. Although some of the proposals put forward in Cox's master plan, especially the standards considered for welfare services in the city, were not in harmony with the economic, social, and cultural realities of Isfahan society at that time; But as the first experience in preparing urban development plans, it was able to add unique experiences to the urban planning system in Isfahan. (http://hmesf.ir/Item-10209)

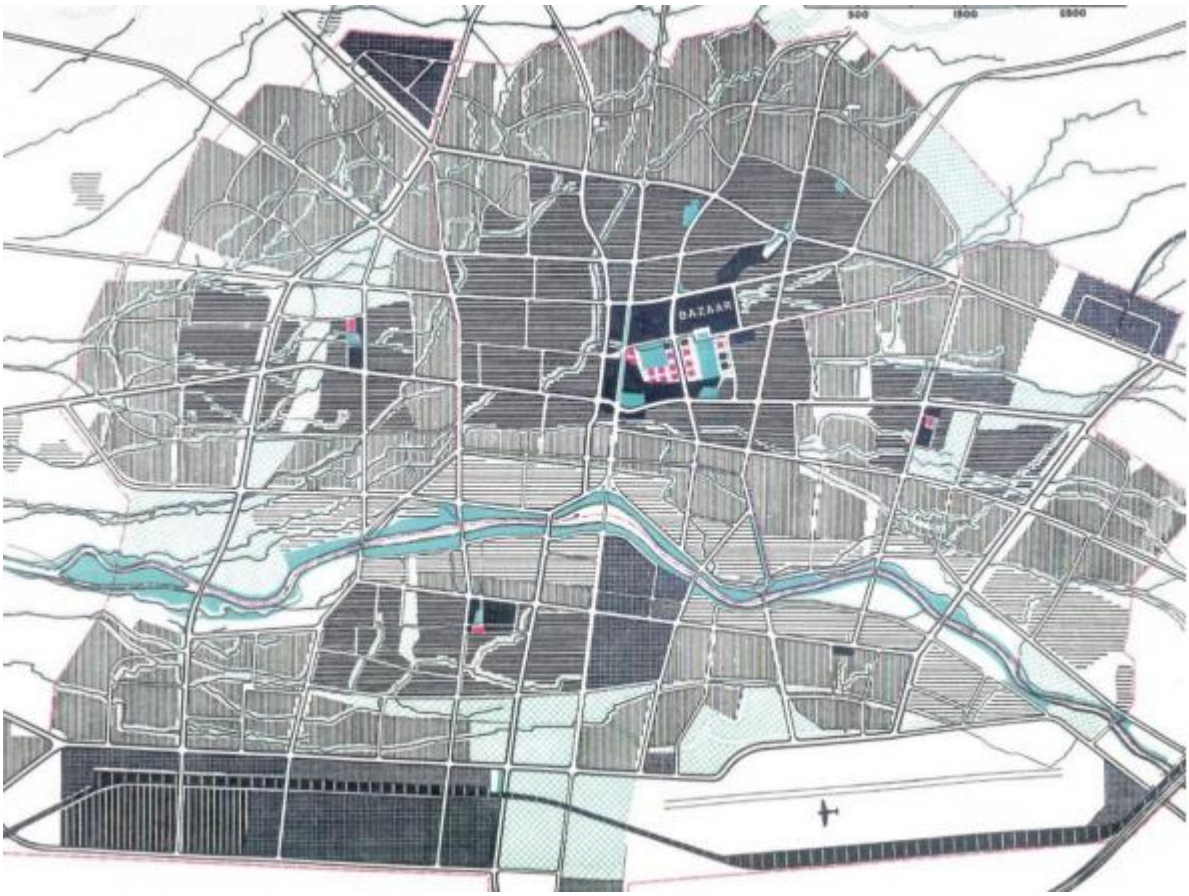

Figure 46. Cox master plan. Source: (Qureshi SAR. 2006)

Organic master plan (1974): After that, the organic master plan (approved in 1974) was proposed; This plan, which was prepared at the same time as the industrialization of Isfahan

and the significant increase in the population of this city, followed the continuous expansion of the city in about eight thousand hectares, mainly in the north and northwest. Also, the creation of a wide network of new checkered streets to respond to the dominance of cars in the city was another project of this plan. (http://hmesf.ir/Item-10209)

In this plan, 140 streets in the master plan were removed. Moderate density in the old context was suggested, the green space of the banks of Zayandeh rood River was recognized up to a depth of at least 50 meters, and the preservation of the main and valuable passages was emphasized. This project succeeded in identifying many defects of the organic comprehensive plan such as the nature of the historical center of the city in the future development and the transportation network and took action to fix them. (Badrizadeh. &Montazer.& others. 1997).

Figure 47. Organic master plan. Source: (Qureshi SAR. 2006)

The development in the organic master plan has chosen the north-west and the north, while there is no strong communication axis in this direction. On the other hand, at the time of the presentation of the plan, there were strong north and south axes such as the Tehran - Isfahan and Isfahan -Shiraz roads, so if the review of the mentioned plan was done more deeply, it would at least suggest the extension of the north and south axes in accordance with the traditional development pattern of the city. In this way, it would be a more successful plan. (Hedayat. 2001).

Master Plan of Isfahan (1988): This plan was prepared in 1988 and the two main axes of the city of Isfahan, i.e. its natural axis (the river) and its artificial axis (Bazaar-Chahar Bagh) were considered the basic lines of the plan and the east was considered incorrect and the creation of new cities in Sepahanshahr, Baharistan, and Allameh Majlisi city was proposed in this direction. (Sanaei. &. Mazaheri.2014).

Some of the points raised in this plan are:

- Organizing of the two industrial urban axes of the region, limiting its growth, and directing its growth in non-cultivable lands
- Creating new industrial hubs in other regions of the province
- Relying on the creation of new self-sufficient cities in barren lands in order to absorb the overflow of the city's population

Figure 48.Master plan of Isfahan approved in 1988
Source: (Qureshi SAR. 2006)

After this plan, the plan to revise the comprehensive plan and the plan to revise the detailed plan of Isfahan were also published later. (Sanaei. &. Mazaheri.2014).

In the master plan of Isfahan, sustainability issues such as land use, mobility, energy, etc are considered to make a more sustainable city. In this plan, the main axes of the expansion of the city in Savaid era which were Chaharbagh Street and Zayande rood were supposed important again. In terms of land use plans, it was considered to emphasize preventing the changes of the agricultural lands and limiting the industrial centers to some specific hubs. For mobility issues, this plan aims to insist on walking its success should be investigated, and the creation of a subway line was predicted. By implementing these strategies and using private vehicles the usage of energy will be decreased.

1.6. Population growth and excessive development in the contemporary century

The city of Isfahan has a population of 1,961,260 persons in 2016. By examining the immigrants who entered Isfahan city, nearly 50% of immigrants are from within Isfahan province. the migrants are the persons who are determined to migrate for work or family support. (https://plan.isfahan.ir/sites/default/files/statistics_content/)

Tabel4 .Area and population of Isfahan in different years

Source: (https://plan.isfahan.ir/sites/default/files/statistics_content/)

Year	Density	Population	Area (hectares)
1956	129.08	254708	1973
1967	116.6	424045	3637
1975	89.04	661510	7429
1990	81.3	1127030	13856
2006	87.9	1602110	18228

Migration in the form of specific provinces during periods of time leads to changes in the composition of ethnicities, and economic and social characteristics. The largest exchange of migration to Isfahan is the neighboring provinces. (https://plan.isfahan.ir/sites/default/files/statistics_content/)

With the physical development of the city, many rural areas and surrounding areas are practically considered part of the city of Isfahan, and due to the wear and tear of the houses, rural materials became less durable, etc. The integration of these areas is one of the main reasons for the formation of suburban cores in the city of Isfahan, which definitely has a great impact on the damage acceptance of the city and its surroundings.(Jalalian. &. Zeaiean.&. others. 2015)

2. The main sustainability issues in current Isfahan

2.1. Land use planning

As mentioned, the rapid expansion of Isfahan and their uneven physical growth and urban creep have caused the erosion of villages and their surrounding lands, the transformation of agricultural lands and the destruction of environmental resources. (Jalalian. &. Zeaiean.&. others. 2015).

The significant and desired point in this field is the growth of cities and the change in the structure and function of the surrounding space, including the change in land use. Land use changes is a complex process that includes changing the shape and land cover to another changeable process. (Jalalian. &. Zeaiean.&. others. 2015).

Also, in this regard, the management of the agricultural jihad of Isfahan province has stated the following issues on its website:

- Unfortunately, in the province of Isfahan, during the last 30 years, about 70 thousand hectares of agricultural land have been destroyed and removed from the cycle of agricultural production.

- Only five percent of the province's lands have agricultural potential.

- The pattern of development in height instead of the expansion of cities on the surface can play an important role in reducing the costs of city management (creating infrastructure services, security, and maintenance) as well as preserving agricultural lands.

- Only in the city of Isfahan, there are about two thousand hectares of worn-out fabric, and with proper planning, this potential can be used to solve the housing problem.

- The average gross population density for each city of Isfahan province is about 42 people per hectare, which is far from the country's standards of 100 to 150 people per hectare.

- Currently, the limits of some cities in Isfahan province is more than 40 times its legal limit, and according to the law, it is stated in the definitions of the border and privacy

that the Housing and Urban Development Organization is obliged to calculate the ratio of privacy to the legal limit of the city when preparing comprehensive plans. adjust between 3 and 5 times. (https://esfahan.agri-es.ir/)

Karimzadeh and colleagues have stated in their research that, by evaluating the suitability of land, it is possible to reach the conclusions that the amount of development is in harmony with the power of the land. Protecting agricultural land, preventing changes in the use of horizontal development of cities, taking into account the sustainability of social ecology and proper urban form is one of the main planning priorities in Isfahan. Population growth has increased the demand for agricultural land and man-made areas, based on which a balanced development plan can be formulated towards sustainable economic growth. Their results illustrate how can decide on attaining solutions for using natural sources in a sustainable way. These strategies should be based on ecological, economic and social issues and the preservation of agricultural lands and expansion of the industrial city. (Karimzadehmotlagh. &. Lotfi . &. Others. 2020).

Also, Dr. Zarrabi and his colleagues in their article, by evaluating the land use of the fourteen regions of Isfahan province, suggest that it is better to pay attention to the distribution and dispersion of land uses in the proposed detailed plan of Isfahan according to the economic and social role of that region. Also, due to preventing traffic and noise pollution, it is better to expand the use of parking in areas that have a higher commercial and administrative per capita.(Zarrabi.&. Mohammadi. &. Others.2009).

2.2. Mobility planning (Pedestrianism, Biking, Bus and high-speed buses service (BRT bus system), Taxi services, Subway services)

Compared to global developments, the city of Isfahan has had a negative movement in the direction of sustainable transportation, the biggest decrease of which is related to its environmental sector.

The growth of the economy aspect of transportation is negative. But fortunately, the social aspect in this sector is positive. The most important reasons for this issue are the longer trips and the increase in their number, the enhancement in the proportion of private cars and the decrease in the share of non-motorized transportation in daily trips. The appropriate strategy in the city of Isfahan is the simultaneous implementation of sustainable transportation policies.(Taghvaei. &. Sajadi2015)

Pedestrianism: Due to the historical, social, natural, and physical characteristics, the city of Isfahan has many characteristics of a citizen-oriented and pedestrian-oriented city. During the Safavid era, Chaharbagh Street was designed and built according to the design of the city garden as a recreational and pedestrian axis. In the next period, especially during the Pahlavi period, many physical-spatial changes took place. During the Safavid period,

the characteristics of pedestrian circulation in the city of Isfahan and Chaharbagh Street due to the formation of the city garden and also the absence of cars were more than in the modern era when industry and cars entered the cities. (pour mokhtar. 2013)

Nowadays, in Isfahan, there is a heavy traffic in the city center which is caused by cars, and it needs the Authorities to take action in order to make the roads suitable for pedestrians and bicycles. Therefore, from the point of view of Vali Beig and others the solutions and suggestions below are significant:

- Education and culture building through public participation, explanation of the comprehensive pedestrian plan in the cultural and historical axes of encouragement.
- Continuity and connection between historical contexts and other parts of the city through pedestrian lines and axes
- Adjusting the distances between pedestrian routes to public transport stations. (Solimanimoghadadam.&. Valibeig. &. others. 2019).

Biking: The suitable topography, mild climate and cultural structure of Isfahan makes Isfahan a suitable place for biking. Statistical studies show that the share of bicycles in the city trips of the citizens of Isfahan today is about 8.37% of the total trips, While this ratio was around 15.4% in the 90s. Although during the past 5 years, relatively favorable activities have been carried out in Isfahan city by the organizations in charge of urban transportation in order to improve the status of citizenship culture, it must be acknowledged that these actions are not enough and should be done in a more comprehensive way. (Mokhtarimalekabadi. 2011).Currently, in the new urban plan of the city, the street are not suitable for bicycles.

According to the survey of Mokhtarimalekabadi, there is a significant relationship between better access to bicycle stations and the amount of its use as a means of transportation, but the number of bicycle stations, the design of special bicycle routes, and other planned arrangements are still not enough, and the bicycle in Isfahan city is more of a leisure vehicle. It is a sport and has not gained a suitable position as a means of carrying out city trips and reducing the traffic load. (Mokhtarimalekabadi. 2011).

Bus and high-speed buses service (BRT bus system): using public transportation is one of the main solutions in managing supply and reducing traffic. The bus is considered as the most important form of public transportation in Isfahan city, the share of people's transportation by bus in Isfahan city in recent years is about 20%. (Allahdadi.&.Shamaei. &. others . 2020).

In order to increase citizens' acceptance of the bus system, it is necessary to move in the direction of solving its problems and increasing its usefulness. According to Mahdi Alahdadi and others' survey, from the point of view of bus passengers, there are problems

such as long waiting times at stations, delays and uncertainty about the exact arrival time of the bus, overcrowding, and inappropriate ventilation and cooling and heating systems of buses for the normal bus system, and from the management point of view In urban areas, the problems of the bus fleet, such as noise and environmental pollution, lack of reception and low efficiency and less than the capacity of the bus system, are usually evident, which shows the need to change and optimize the current system. Many of these problems could be reduced by providing a special route or, in other words, by converting regular bus lines to high-speed buses (BRT buses) (Allahdadi.&. Shamaei.&. others . 2020).

However, surveys show the lack of communication equipment in the express bus system of Isfahan city. However, the results show the high level of satisfaction of citizens with the express buses(BRT) in Isfahan. The most important reasons for passengers to use high-speed bus(BRT) lines are speed, well-scheduled buses, and comfort. (Allahdadi. &.Shamaei.&. others. 2020).

Taxi services: The taxi network in Isfahan City has provided good service, but it seems that the economic situation has lowered the level of satisfaction with the appropriateness of the fare of this means of transportation. Finally, investing in this sector in the quantitative and qualitative development of the public transport network will lead to the citizen's satisfaction. (Saghaei.&. Shahsavari. &. others .2019).

Subway services: The function of large-scale rail systems such as the subway is to move a large amount of citizens in a short period of time; For example, in the early morning time when people start work, in a densely populated city like Isfahan, which has more than two million people, there is a lot of traffic. according to estimates, about four million trips are made in the city of Isfahan every day. (Iran Metropolitan Agency News, https://www.imna.ir/news/681267)

Currently, half of these trips within the city of Isfahan are made by private vehicles. The average trip length of about eight kilometers shows that a large amount of gasoline is consumed and a large amount of air pollution is produced. Studies of Isfahan railway lines were conducted in the 1990s, and by the end of 2000, three urban train lines were supposed to be in operation, while we have one line in operation and the second line is under construction.

Reduction of energy consumption, pollution, and congestion of road surface, movement of more than 100 thousand people underground, reduction of load of movement of road surface, higher safety, and easier provision of cooling and heating in different seasons are the advantages of Isfahan metro. (Iran Metropolitan Agency News, https://www.imna.ir/news/681267)

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Figure 49.On the map of Isfahan subway, currently, only line 1 (blue) is working. Source:(https://www.tinn.ir)

2.3. Energy planning

Structures in Iran consume the greatest amount of energy in metropolitan areas; almost 40% of all the use of energy in this industry is attributed to structures. Therefore, the household sector accounts for over thirty percent of the nation's energy consumption. This industry is one of the primary producers of pollution, as buildings in Iran rely on petroleum and natural gas for over ninety-eight percent of their energy needs. (Mortazaei.&. Mohammadi.& others.2017).

We can see the negative environmental effects in the design size of building components as well as the spatial organization of the cities by contrasting the historic cities with the contemporary urban development. Cities have historically provided excellent models of

energy-efficient urban planning that take ecological constraints into consideration. The shape of urban tissues is one of the greatest effective elements in determining how much

energy buildings consume. (Farokhi.& .Karimnia.2023).

2.3.1. Urban morphology

Four distinct types of tissues make up the physical structure of Isfahan's historical core today: the inner tissue, the intermediate tissue, the outer tissue, and the particular tissue that remains from the Seljuk, Safavid, Qajar, Pahlavi, and (current) eras. The historical region authorized by Iran's Supreme Council of Urban Planning and Architecture is part of the inner tissue and specific historical tissue, which is the city of Isfahan's historical core. This area itself is a part of the three Seljuk, Safavid, and Qajar eras. (GhasemiSichani. &. Memareyan. 2010).

After that, there is the middle tissue, which was formed during the Qajar and Pahlavi eras and simultaneously with the expansion of urban constructions with a structure similar to

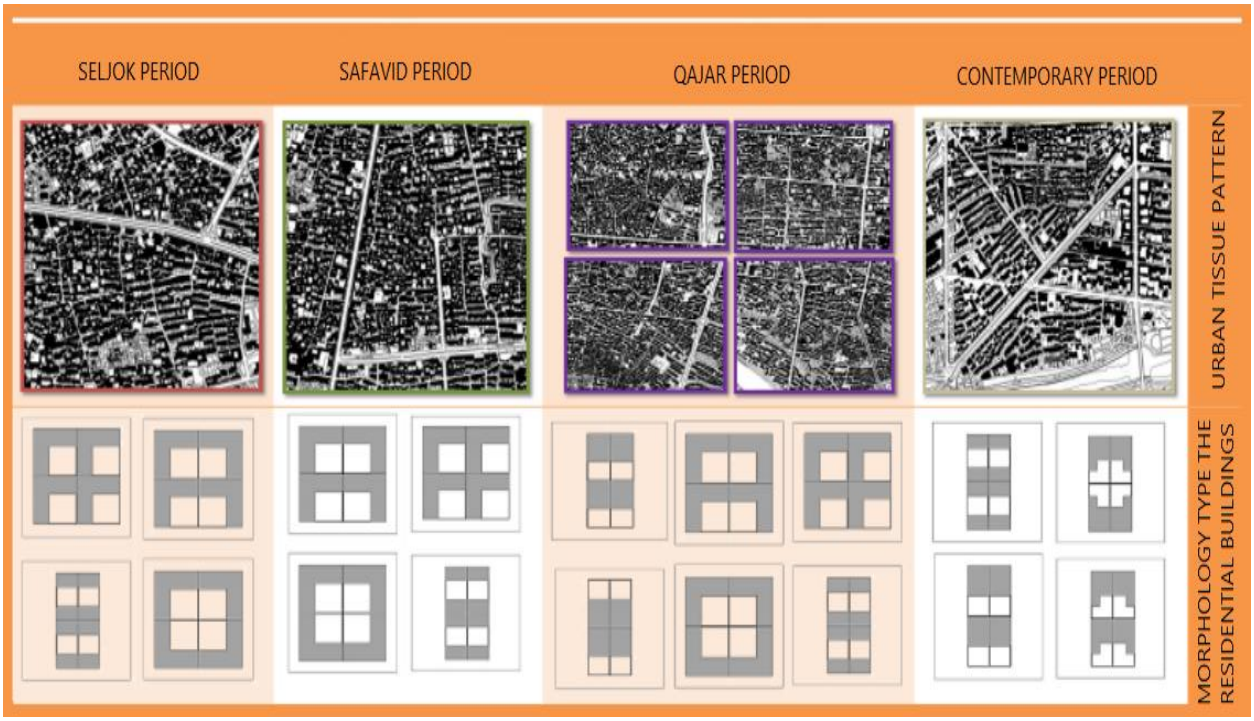

Figure 50. Morphological types of residential buildings in different historical periods

Source:(Farokhi .&.Karimnia.2023).

the inner tissue. The dominant type of surrounding tissue, which in the past surrounded the residential tissue with the use of gardens, today forms the outermost layer of the historical

center of Isfahan in the form of a residential fabric with a checkered structure as a fabric of the contemporary period. (Farokhi .&.Karimnia.2023).

The forms of Qajar period are more sustainable forms from the point of view of energy and climatic issues, compared to the others forms. Moreover, the forms which are connected in a proper way, respond better in terms of thermal comfort indicators.(Farokhi .&. Karimnia.2023).

City and climate are two man-made and natural systems that closely influence each other. In such a way that nowadays, with the change of the natural characteristics of cities in the process of urban development, we are witnessing significant and specific climate and weather changes at the micro or local scale, medium scale, and even the metropolitan scale, the geometry and cross-section of the city, the configuration of buildings, including the classification of height and direction Measuring the dimensions and size of buildings and their relationship with each other, the direction and pattern of streets and urban blocks, the level of open spaces, the distribution of activity areas and building density, are all factors that determine the micro-city climate. Therefore, the form of the city and its constituent elements can not only affect the quality of the city and urban spaces but can also change the quality of the city's air. (Farokhi. &. Izadi.2022)

Urban blocks: developing specific instructions regarding the relationship between the form of urban blocks and buildings and its effect on the amount of energy consumption in the city due to the existence of high-influencing variables, is a very complex matter that requires more research in this field to In addition to reducing energy consumption, it is possible to create comfortable climatic conditions in the masses and urban spaces and provide an operational definition of a sustainable urban form to achieve energy efficiency in the hot and dry climate and cultural context of Iran.(Farokhi. &. Izadi.2022).

Orientation of buildings: The determination of the position of the building depends on 2 main factors; First, the amount of thermal energy radiated to the vertical walls, and second, the direction of disturbing winds. The most appropriate design is to place the building in relation to the sun in a direction that receives the most heat on cold days and the least heat on hot days. (Jahanbakh. &. Ghafarzadeh. 2017).

As a result, in order to reduce the cooling and heating the building's load in Isfahan city, the best way of the structure orientation is towards the south between the angles of 0 to 15 degrees east, so that the tension of the building is in the east-west direction and the southern body has a wider surface. Among the advantages of the optimal orientation of the building is its low cost, which the initial stages of the plan are feasible. Also, the optimal use of solar energy reduces the need to use complex passive systems. While increasing the performance of passive and mechanical systems. (Jahanbakh. &. Ghafarzadeh. 2017).

Passages: In the region of Isfahan, the location of the footpath facing south-west and south-east is the most optimal mode for the operation of the footpath and its adjacent uses due to favorable temperature conditions. The presence of elements such as water, trees, shadows, etc. helps to create thermal comfort in these spaces. (Chelongarian. &. Khanmohammdi. &. others. *2016).*

2.3.2. Climatic solutions:

Chelongaran and his colleagues in the article titled″ Optimum climatic orientation of sidewalks in the hot and dry area of Isfahan"(Chelongarian.&. Khanmohammdi. &. others. 2016) suggest some climatic solutions such as:

The best climate design approach uses the most local resources possible while putting the least amount of strain on the environment. This is derived from a long-term viewpoint on potential environmental effects, and it is crucial to consider the following crucial points:

How solar energy is used;

make full usage of rain water and drainage networks;

Use wind energy;

Utilize the earth's capacity for heating and cooling; and lower energy consumption.

According to the findings and analyzes carried out on the metropolitan areas of Isfahan, we conclude that in the design of many urban spaces, the principles and rules of climatic design have not been followed, and as a result, special issues have been brought about in relation to every component of the climate, among them. These can be mentioned:

Installing some openings on their western side of several structures

Building separate tall skyscrapers in the city will cause a storm around them

The difficulty in guiding the runoff caused by precipitation on urban roads and highways

Moving incompatible uses that cause noise, smoke, heat, etc. to other suitable places.

Protection of historical buildings and monuments by considering the coordination of the materials, scale and orientation of the building as specified by the initial idea of the cit climate. Also, tall structure should be oriented in such a way that their shadow on the public and semi-public space is as minimal as possible.

Buildings that are close together and tall enough to allow sunlight to reach open areas should be designed and built with the right volume and height.

Utilizing appropriate vegetation and paying close attention to environmental aspects while designing green and outdoors to improve the quality of the surrounding environment

Selection of south-facing slopes for building construction.

The extending and growth of construction components along the east-west axis

Avoiding the construction of constructions on negative incline and concavities.

Planting shady trees to use their shade on the building and cool the space in the summer season Avoid choosing slopes facing east or west to build a building.

(Chelongarian.&. Khanmohammdi. &. others. 2016).

2.3.3. Compilation of energy consumption management and sustainable architecture criteria for buildings(14 February 2023)

These criteria have been compiled based on the climatic conditions of Isfahan city and the economic conditions of Iran, so that the basis for deciding on the application of some of these criteria, in addition to reducing energy consumption and economic productivity, leads to a short-term return on investment or achieving the lowest lifetime cost. These rules have been developed separately for different uses and forms of residential buildings. The development of a bill to support the optimal management of water and energy consumption, the development of green surfaces and waste management in order to reduce the energy consumption of buildings in Isfahan are result of this. Based on these indicators, the evaluation and rating system for environmentally friendly buildings has been developed for existing and new buildings. The allocation of special incentive packages for sustainable buildings in the near future is predicted. (https://isfahan.ir/node/)

2.3.4. Feasibility of zero energy buildings in Isfahan

Considering the construction of buildings with low efficiency and high energy consumption in the country because low-efficiency equipment and materials were used, the lack of renewable energy and the mismatch of architectural parameters with the region's climate, the construction of zero energy buildings, which due to technical reasons include all factors mentioned, it is the essential need of the construction industry in the country**.** (Sayadzade.& Sadeghi. &. Others.2016)

The city of Isfahan as a metropolis due to its characteristics such as high population density, high volume of construction, the country's economic hub, the presence of key industries, especially the construction industry, stable climate, suitable potential for using renewable energy, especially solar energy, is a suitable area to design and build zero energy buildings, which is one of the first technical and specialized measures in this field of locating this type of buildings. (Sayadzade.& Sadeghi. &. Others.2016)

The deputy of environment and urban services of the mayor of Isfahan (30 may 2023) said: The first double energy building in the country with an annual production of 180 thousand

kilowatt hours of electricity worth 330 million tomans has been established in the 13th district of this metropolis(https://www.imna.ir/news)

Figure 51.Iran first zero energy building in Alborz province constructed in 2012

Source: (https://civil808.com/gallery/picture)

2.3.5. Isfahan is a leader in producing electricity from solar energy in Iran

In Isfahan province, according to the manager of the consumption management office of the province's electricity distribution company, so far 23,700 kilowatts of rooftop solar power plants and 10,000 kilowatts of large-scale solar power plants have been put into operation in the cities of the province other than Isfahan city, which is covered by the Isfahan Province Electricity Distribution Company. A large power plant of two and a half Megawatts has also been set up in the province.
(https://www.farsnews.ir/isfahan/news/14020802001058/)
contrary to the public opinion, the conditions for installing solar power plants are better in the west of Isfahan province because solar panels in the west of Isfahan province have higher efficiency due to being located in a cool and moderate climate. And in total, they produce more energy than similar panels located in the east of the province. (https://www.farsnews.ir/isfahan/news/14020802001058/)

2.4. Water planning

The attitude of Iranians towards water has always been like a sacred element, and wherever Iranians have found water, they have recognized its value correctly and sought to use it

optimally and thy did not waste it. It can be seen in Iran, that water has played a role as an element of urban design in the old urban planning. (Majedi. &. Ahmadi.2008).

2.4.1. Zayandeh Rood River which is dried now

During the Safavid period, the city gradually moves towards the river and includes it, which was one of the most important factors in the creation of the city garden. The Safavid government identified the potential factors of Zayandeh Rood, and by settling the new city in the surrounding environment, it placed it in full harmony with nature, and they created internal courtyards, squares and gardens, nature penetrated into the city. At this time, the river is located in the middle of the city and divides the city into four parts with the help of Chaharbagh. (Jadidi. &. Motififard.2016).

But today, Zayande rood river, as the most important ecological factor of Isfahan plains, due to the various reasons such as climatic changes, drought, the traditional view on dam construction, population insisting on traditional agricultural patterns Water industry is faced with water shortage and drought crisis due to indiscriminate withdrawals and unplanned separation of integrated management and non-expert and illegal decisions. This issue has caused the interruption of folw of water in the river, and as a result, deficiencies in the cultural, social, economic and tourism aspects of the city. (NahreForouzan. & Mansouri.2021).

Figure 52. Zayande rood river which is dried now.Source: (https://www.yjc.ir/fa/news)

To solve this issue, the neglected relationships of people and responsible institutions must be reviewed and ecosystem processes and the role of social components in macro decisions should be investigated and this balance will be returned to the system with a planned, multi-level, timely and strategic implementation. (NahreForouzan.&.Mansouri. 2021). Other effects of the dryness of the river are such as, the decrease of the humidity of the air, the appearance of dust in the air, the reduction in the underground water level, dryness of vegetation and the gardens, the reduction of agricultural business and the increase in the poverty and unemployment. (Kavehzadeh. 2017).

2.4.2. The streams (Madi), the structural role, the influence on the architecture of buildings, the problems and the solutions

The man-made streams branching from Zayandeh River are called Madi River. The certain point is that the first function that can be considered for materials was the use of the share of Zayandeh Rood seals. In fact, in the past, they built the streams (madi) with the aim of being able to take branches from Zayandeh River and use them to irrigate the fields and agricultural lands around the city. (Mehyar. 2003).

The structural role of streams (Madi) in the city: The streams play key roles in the physical structure of spaces in Isfahan. These make city of Isfahan specific from Safavid era,. The streams are the urban edges which make the neighborhoods more qualified. These elements enhance the readability and sense of attachment of the residences. (Ahmadi. & .Laghaii .& others. 2015).

With the increase in the number of streams during the Safavid era, palaces, mosques, caravanserais(inns), markets, hot springs, and many houses of the city's residents were built to use water in the way of the streams. In this way, the morphology of the residential spaces of the city was influenced by the meandering of the streams, the houses that were located next to the streams branching from them, and they were built according to the direction of the movement of the rivers, east- west. A clear example of which can be seen in Charkhab neighborhood on Madi Niasarm. (Majedi. &. Ahmadi.2008)

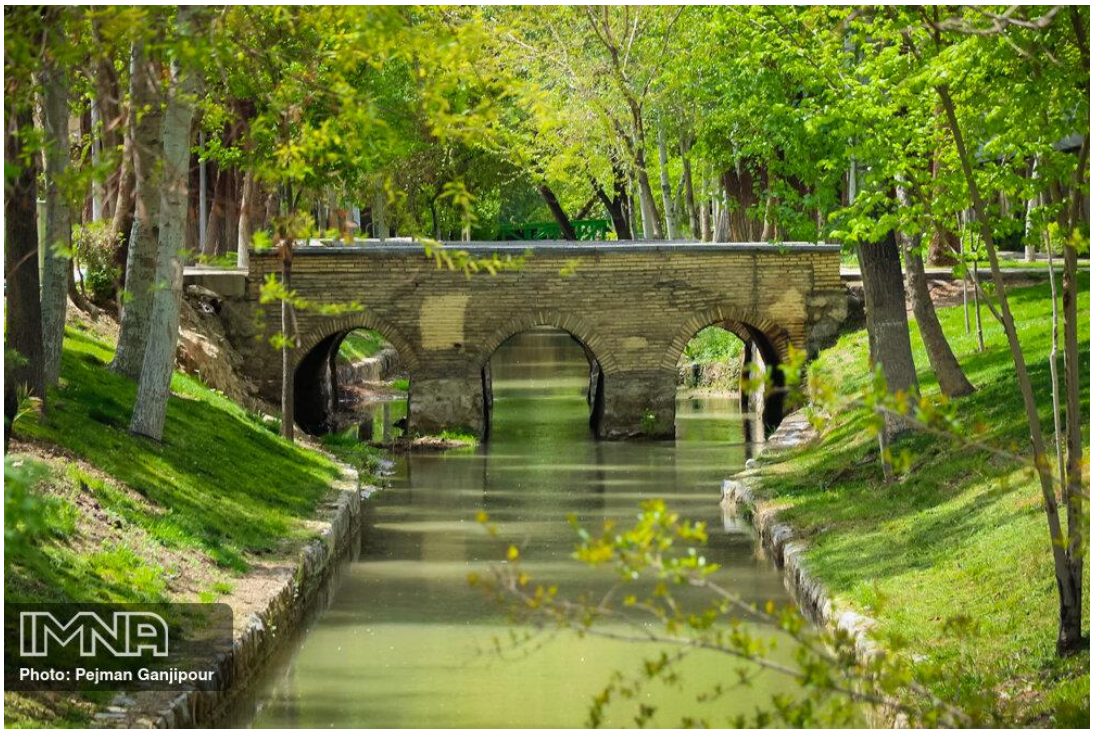

Figure 53. Niasarm stream in Isfahan, Source: (https://www.imna.ir/news)

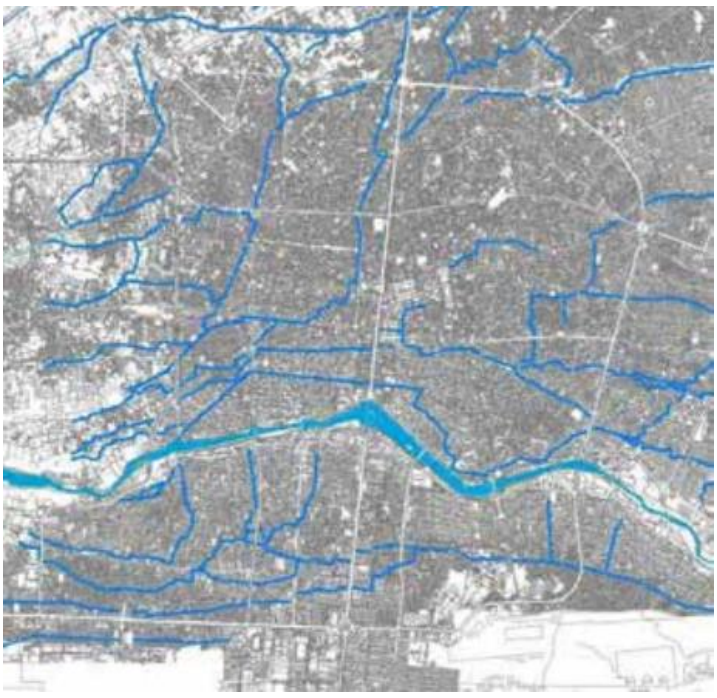

Figure 54.The general location of the streams (madi) in Isfahan city, Source: (Keshani Hamedani, 2012).

Because these streams are structural, historical and environmental (natural) elements in the fabric of Isfahan city, Paying attention to their revival and organization will have a significant effect on the improvement of the city of Isfahan. Streams affect the structure of the city of Isfahan in two ways: one in the axis of Chaharbagh, which has been completely designed and brought the urban space of linear geometry in other passages such as the alleys that flow in a spiral way and go out of the city (Ahari. 2006). This special feature, along with the evergreen features of the streams, the tree-filled atmosphere, the refreshing and cool shade, also in the hot and dry climate of Isfahan, strongly strengthens the idea to make the most of this opportunity. (Kalantari.&.Mohammadi 2012).

Currently, due to many reasons, the roles and functions of the streams have been weakened and challenged in various dimensions. Most importantly, with the introduction of automobiles and the influence of today's urban planning from Western models, not only, the old fabric did not adapt to it, but this issue caused damage to the structural-physical system of the old fabric, and following it caused the cultural system and structure to be shaken. Following such actions, the network of streams underwent many physical and semantic changes. The physical-spatial separation of the rivers and the encroachment on their privacy is the result of such developments. (Naebie. &. Talebi.2017)

The influence of streams (Madi) on the architecture of buildings: The streams play an important role in the formation of the Safavid city and has a main role as an element of urban design. In the city where there are introverted house, this is the water the flows inside the building. (Ahari. 2006).

The form of the stream in different buildings completely follows the function:

A clear example of this example is in Chaharbagh School and Mather shah inn, which, although both are located in the same stream (Farhadi) path, but in Chaharbagh School, the stream appears with more strength and emphasis. (Ahari. 2006).

Perhaps the most important reason for that is the role of water, in the school which is calm and soothing, mixing with the calm and spiritual life of the students and giving them the mood to stay and think. While in the inn, the rapid flow of water, suitable for a happy, active, and vibrant life, fulfills the functional and aesthetic needs and encourages the desire to go. (Ahari. 2006).

Figure 55. Farshadi stream in the form of ponds in Mather shah complex (Abbassi inn)

Source: (https://www.isna.ir/news)

The streams problems in the present century: When the economic infrastructure of the city was changed from agricultural to industrial, this caused the streams to be destroyed.

Many reasons, including the lack of water and the consequent reduction of greenery around these streams and the lack of use of them as a public urban space, as well as the darkness and the creation of dangerous spaces around some of them at night caused the space near them be unsafe and silent. (Ahmadi. &. Laghaii .& others.2015).

Figure 56. Dryness of the streams in current Isfahan

Source: (https://soroosh-travels.com/maadi)

Also, in the last few years, due to continuous droughts, these vital vessels of the city have also been disabled. The presence of insects and reptiles, and environmental pollution caused by the drying of streams have reduced the desire of people to settle down near the roads. On the other hand, giving permission for low-density construction in these areas has made people reluctant to buy in these areas. Therefore, it is necessary to pay attention to the streams, which are also considered historical infrastructure in Isfahan in addition to the ecological aspects. (Arsiya. &. MehrabaniGolzar .2018)

Solutions to improve the bodies of streams (Madi): According to the article of Ahmadi and others about the steams of Isfahan, these suggestions can be implemented to improve the situation of the streams in Isfahan:

- Make the axes of the streams alive as much as possible, for pedestrian
- Promotion of the tourism industry through the design of urban walking tourism tours on the outskirts of the stream.
- Creation of native vegetation in the form of a strip park on the outskirts of the stream.
- Holding different Friday markets and numerous exhibitions such as industry fairs on certain days of the year
- Creation of various passages such as passage, music passage, painting passage, health passage, garden water passage, educational and informational passages, on the sidelines
- Granting tax discount loans municipal fees and other facilities to the residents of residential houses adjacent to the buildings to encourage them to create attractive and needed uses such as the city theater, water museum meeting hall, which the city of Isfahan suffers from a lack of.
- Using the passage of streams as social-educational communication spaces
- Reconstruction measures include:
- The operation of freeing the boundaries and preserving the legal boundaries of the rivers
- Paying attention to the criteria of desirability of the banks of streams. (Majedi. .&. Ahmadi.2008)

And Naebi and her colleagues suggest also:

- Creation of recreational and leisure activities and its furniture such as coffee shops and restaurants near the stream.
- Creating commercial and administrative arcades that attract the population around the stream

- Creating parking lots around the intended plan for the users and guests of the neighborhood
- It is mandatory to provide lighting in the neighborhood at night.
- All historical places and mosques should be illuminated at night.
- The necessary facilities for the presence and continuous activity of children, elderly women, etc. should be strengthened.
- The entrance of the local street should show the attractions of the neighborhood well and be inviting. (Naebie. &. Talebi.2017)

The streams network has principles and values that by applying and paying attention to them, solutions and ideas derived from ancient values can be achieved. With the dominant function of pedestrians in combination with other axes, they can contribute to the completion of the hierarchy of the central roads, the city, the physical spatial coherence of the old neighborhoods and the creation of rich urban spaces. (Kalantari. & . Mohammadi .2011)

2.4.3.The use of waste water in agriculture and industry in Isfahan

In recent years, climate change and drought have affected Isfahan province, and the weakness of water resources management also lead to make Zayandeh rood river be dried. The water requirement of the greenery of Isfahan city during the year is on average nearly 1800 liters per second, which will increase to about three thousand liters per second in the hot months of the year. Zayandeh rood River, underground water sources have provided nearly 60% of this water demand, and about one-third of the wells at the disposal of the municipality have dried up and have little water flow. (https://www.khabaronline.ir/news/)
In the current situation, about 15% of the water needs of the green space of Isfahan City, equivalent to nine million cubic meters per year, is provided through sewage effluent, which according to the climatic conditions and the condition of the Zayandeh Rood watershed, this amount in the "Isfahan 2026" program is close to fifty percentage. (https://www.khabaronline.ir/news/)
currently, 30 wastewater treatment plants are in operation in Isfahan province, and thousands of liters per second of the wastewater produced in the province are now available to industry and agriculture. (https://www.mehrnews.com/news/)
According to the contracts concluded with industrial units, 2 thousand liters per second of wastewater have been allocated to the industrialists and 2 thousand liters per second to irrigate green spaces and use in non-productive agriculture. Director of Isfahan Province's Wastewater said "By using wastewater in industry, we can hope for the revival of Zayandeh Rood River, because the more the exploitation of Zayandeh Rood River for industrial

purposes is reduced, the more likely it is to revive the river bed." (https://www.mehrnews.com/news/)

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2.44. Collecting rainwater

Due to the intrinsic nature of the drought phenomenon in Iran, optimal use of available water and control of runoff and using them for specific purposes is a basic strategy to solve water shortage in this country. The increasing demand for water not only for agriculture but also for other purposes due to the changes and distribution of precipitation in different seasons shows the importance of water extraction in arid and semi-arid areas including Iran. (Noori. &. Zare Chahouki.2018).

In Isfahan province, in the winter of 2012, there was a lot of rain and floods. And in a project this year, the municipality managed to collect a large amount of rainwater. With the implementation of watershed projects, 70 million cubic meters of rainwater were collected and used in the development of 16 thousand hectares of farms and gardens in Isfahan province. With the construction of 170 earth dams, 45 flood dams and 1900 stone mortar structures in the province, with the implementation of these projects, 400 million cubic meters of rainwater will be harvested annually and 17,500 farmers of the province will benefit from their benefits. (https://www.imna.ir/news/102022/)

Despite the implementation of this plan in 2012, rainwater collection in Isfahan is still not widely implemented and needs more attention and investment. One of the most important factors in the success of rainwater collecting projects is attracting people's participation and aligning them with the relevant organizations in order to implement the project. On the one hand, the limitation of financial resources and government credits is one of the important challenges in this field; Because the implementation of rainwater harvesting methods usually requires a lot of labor. Another important challenge of the sustainable implementation of rainwater harvesting systems is (Soler. &. Moss. & Papasozomenou. 2018) organizational and institutional problems; Lack of coordination between the relevant organizations and trustees, lack of written planning, as well as lack of infrastructure and measures to facilitate people's participation can disrupt the performance of these projects. (Noori. &. Zare Chahouki.2018).

3.Urban policies in Isfahan

3.1. The urban administrative organization of Isfahan

The council-manager approach is used to run cities in Iran. Citizens' own votes were used to elect municipal council members. The mayor is appointed by the municipal council, but the appointment shall be granted by the Interior Ministry. The mayor is the administrative leader in Iran, and the municipal council has no say in these matters. However, the mayor is answerable to the municipal council. 1%

Currently, the responsibility of municipalities can be generally classified into three areas:

1- Policymaking, including Decision: adoption and policy-making and coordination of urban affairs, Laws and regulations of the city, Monitoring and control.

2- Planning tasks include Urban planning and economic and financial affairs.

3-Executive affairs include urban development, Urban infrastructure, and equipment.
City Services, Cultural and Social Services. (Sayafzadeh.&. Badrifar. 2017)
The main players at the local scale are the municipality, the city council, NGOs, and the populace. Furthermore, central government agencies at the city, county, and provincial levels have a significant impact on the urban management structure. The Interior Ministry, the Real Estate and Cities Ministry, the Planning and Management Organization (PMO), and its provincial and county associations have the largest impact on Iran's urban management structure... (Rasoolimanesh, Jaafar, & Badarulzaman, 2013).

The municipality of Isfahan is included 15 divisions. Every division has its own mayor under management of the mayor of Isfahan. Isfahan city has the population of 1,961,260 persons in 2016 and the population of each district is presented on the table. district which is selected in this thesis for analysis is located in the third district of Isfahan(https://plan.isfahan.ir/sites/default/files/statistics_content).

Figure 57. Location of Isfahan city in Iran. Source: (Mirbag. & Poursani, 2018).

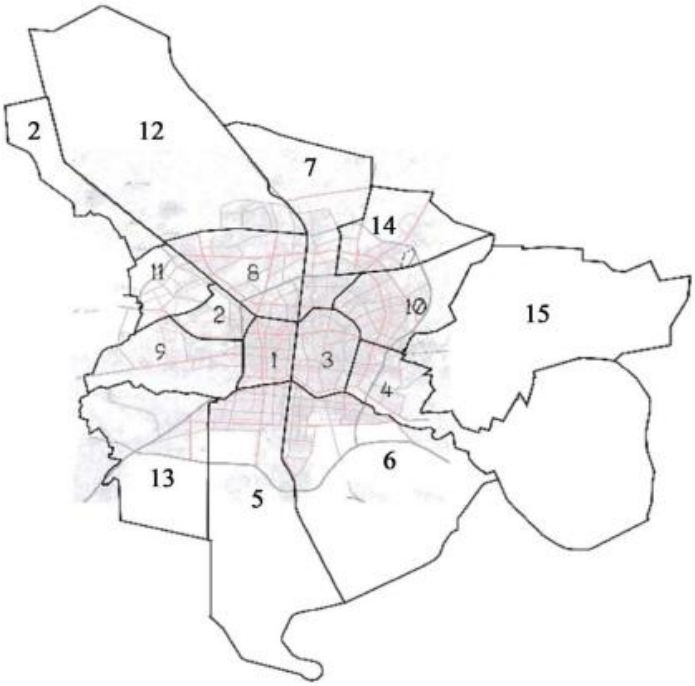


Figure 58. The different districts of Isfahan.Source: (Rozati, &. Kazemzadeh, & Vaseghi, 2015).

Tabel 5. The population of Isfahan districts

Source:(https://plan.isfahan.ir/sites/default/files/statistics_content)

Growth rate	The year 2016	Districts of Isfahan
0.3 %	79091	1
1.3	69120	2
0.1	110368	3
1.2	133731	4
-1.6	150865	5
0.1	112129	6
2.6	168732	7
0.2	239756	8
0.5	75168	9
-0.4	207803	10
-0.1	58841	11
1.6	136376	12
2.3	132469	13
-0.3	164850	14
1.6	121961	15
0.5	1961260	SUM

3.2. Isfahan main sights

As it was explained in the previous chapter, Isfahan is located in the center of Iran, with a dry and hot climate. The case study district is located in the center of Isfahan, in the historical part of the city. This area is located in the heart of Isfahan, near the famous river (Zayande rood) and the famous traditional square of Isfahan (Naghshe Jahan).

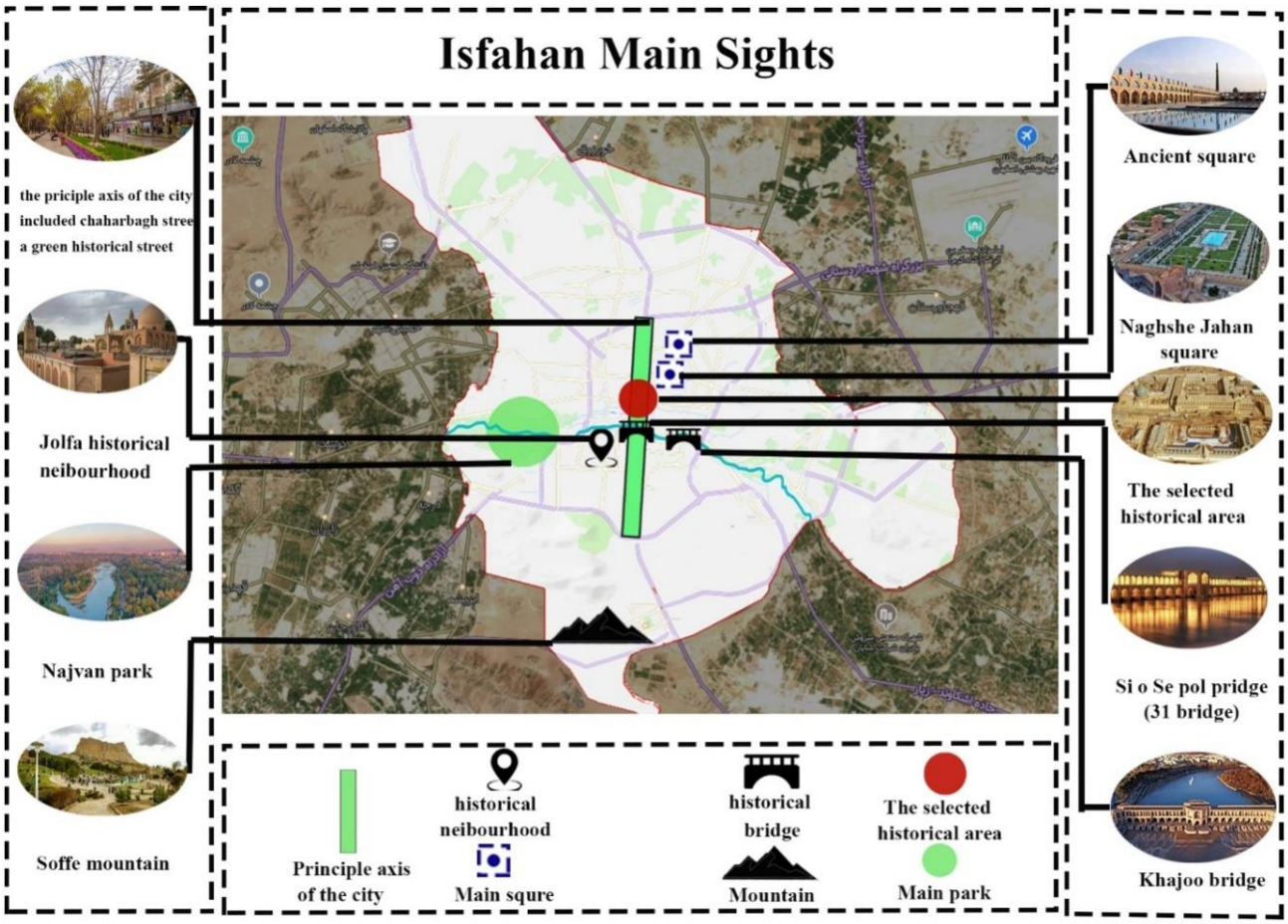


Figure 59. Isfahan main sights source: produced by the author

3.3. A detailed district analysis: The third Municipality of Isfahan

For surveying ecological aspects, a part of the third district of Isfahan municipality is selected. District three is one of the main and central areas of Isfahan city, which has in its heart the history of Isfahan city since ancient times, in three periods of capital and tourist city. Historical monuments (the three periods of Diliman, Seljuk and Safavid rule), which are considered important tourist centers of Isfahan city, the concentration of administrative centers, seminaries, the residence of religious and scientific scholars and the existence of most commercial centers and markets and ... has made this area particularly important. In general, the concentration of administrative centers, historical markets and commercial centers, tourist centers and historical buildings, tombs, religious fields and offices of religious scholars and scientific centers has turned this region into a special region with special characteristics. In fact, District 3 includes a large part of the historical context of the city. (https://mun3.isfahan.ir/)

- Population of the region: 110,368 people
- Area of the district: 1,152 hectares

- Area of green space: 693,438 square meters
- Worn texture: 263 hectares (https://mun3.isfahan.ir/)

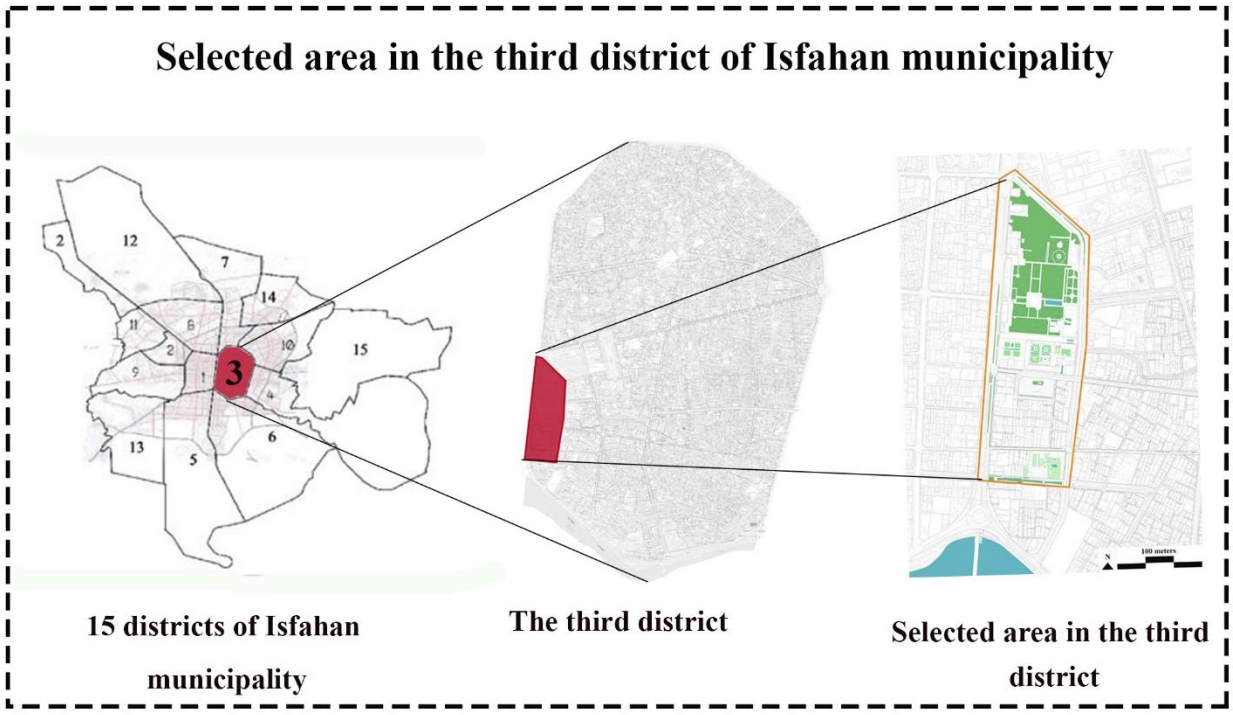


Figure 60. Selected part of the third district of Isfahan municipality, Source: produced by the author

3.4. The selected part main sights in the third district of Isfahan municipality

At first, it can be said that this part of the city is the most important historical part of the city. There are a lot of precious buildings here. The selected part includes chaharbagh street, the historical street of Isfahan, the historical Rajayi Park and Hasht behesht palace (Bolbol Garden) Mother complex (the school and mosque of Chaharbagh and historical Abbassi hotel(inn)), some residential buildings and Niasarm stream.

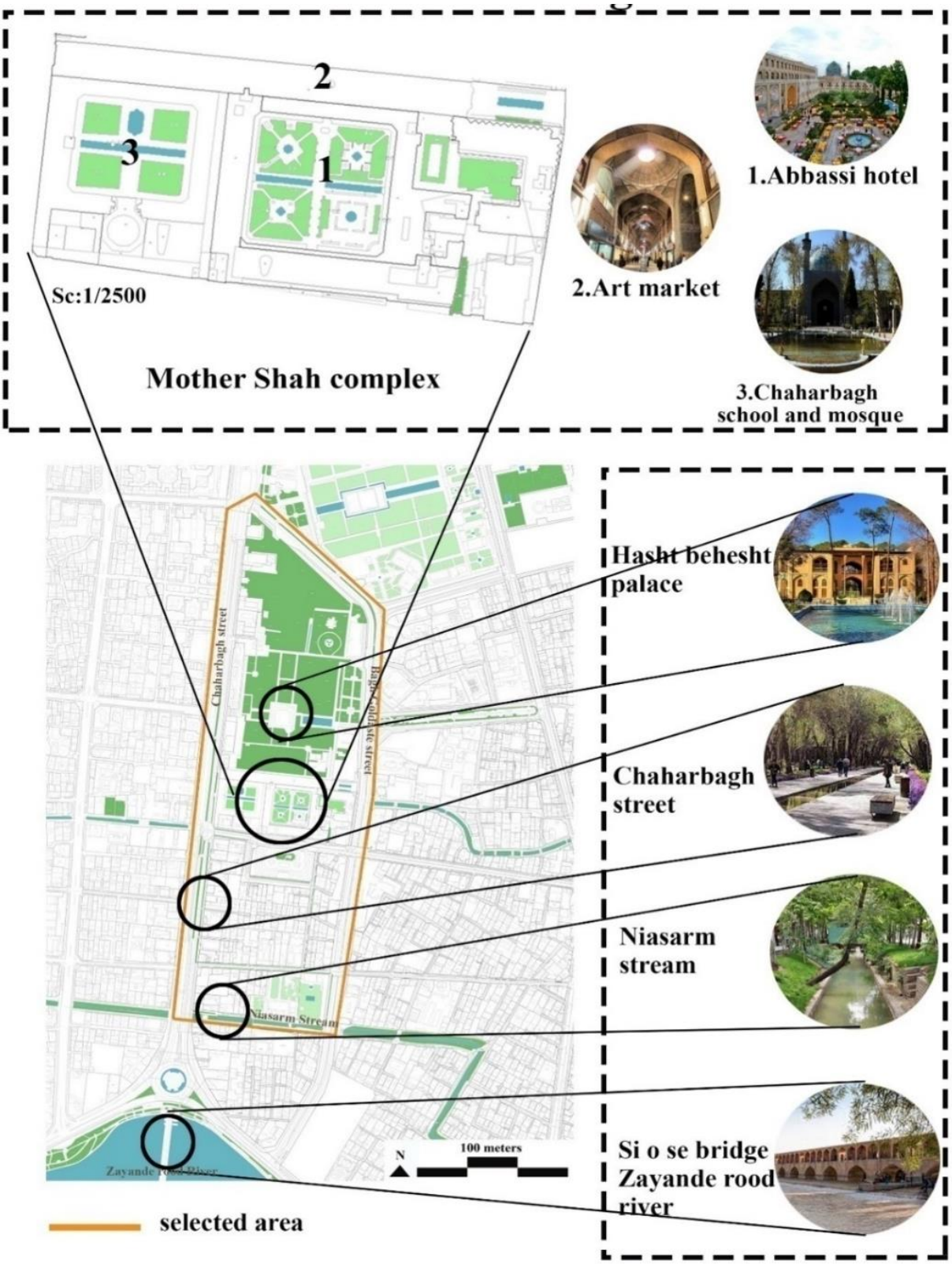


Figure 61. The selected part main sights in the third district of Isfahan municipality
source: produced by the author

The selected part is an urban historical space in which there are precious buildings. These Buildings responded to the different needs of people during the time and were sustainable. In this current era, due to the advanced technology, the needs of people are changed and the function of these buildings should be changed and they should be improved to be responsive to the current needs. For instance, people did not need electricity in the past but nowadays it is a necessity of life. Therefore, it is essential to be capable of producing it everywhere. Moreover, this part of the city is one of the most polluted areas in Isfahan. Except in Chaharbagh Street which is a pedestrian path now, there is always heavy traffic in the streets. The park has an important role in refining the air of this area and has many other ecological benefits. Furthermore, there are green spaces in this part that are interpenetrated into the city and there is much potential for improving this district ecologically

Moreover, I chose this area in Isfahan, because I live in Isafahan and I access the local information. Because of these, this district was chosen to be analyzed and improved in this thesis. In the following, the most important historical and natural elements of this part will be explained.

3.4.1. Chaharbagh street (Four garden street)

Chaharbagh Street was built in 1597 during the reign of King Abbas I. One of the main axes of the Isfahan city garden plan was the wide and long Chaharbagh street, which connected the king area in the north of Zayandeh Rood River to the vast summer resort area of 10000 acres street by crossing the Si o se bridge. And Si o Se Bridge formed a wide field of entertainment and tourism functions in the physical structure of the Safavid city. The urban context around this street consisted of large parcels in the form of green gardens, in which there were palaces. (Omarani, 2005: 264-268).

Chaharbagh street is built based on a plan and geometric design, at the intersection with the axis of Zayandeh Rood, and the four main parts of the city are formed, and royal gardens are built on both sides of the street. It continued to the south of the city and at the end of Chaharagh was the large and unique thousand-acre garden of Khald Sani or King Abbas's Paradise. (Ansari, 2003) and (Pourmokhtar. 2013). What is clear is that this street was for walking and had no commercial function(Pirnia.&. Memarian. 2007).

Figure 62. Map of Isfahan by Russian surveyors.
Source: (Hoeltzer. 1976)mentioned in (Mahdinejad. & Gholipour. 2017).

Figure 63. Old views of Chaharbagh street and wide pedestrian axes in it
Source:(Hoeltzer.1976) mentioned in (Pourmokhtar.2013).

The novelty of the concept of Chaharbagh Street can be found in its various functional, physical and spatial dimensions. Defining the street as a space for sitting and spending leisure time and its design for this purpose added a new function to the functions of the street. The thoughtful and detailed design of the body and floor was unprecedented in the streets before Chaharbagh.(Ahari. 2006)

Although there was integration with nature in the design of the streets before Chaharbagh, the thoughtful use of water and plants to affect all the senses in the face of the urban space was unprecedented. It was new in urban scale and it was so effective that most of the sources of that period have mentioned it. (Ahari. 2006)

Figure 64. A sketch map of Chaharbagh, Isfahan, by Donald Wilber
Source: (Wilber.2005) mentioned in(Mahdinejad. & Gholipour. 2017)

Creating a space to display the national unity and rituals of Iranian Shiie government offered a new concept of urban space. The shows that were performed on Chaharbagh

street, while filling people's free time, provided the basis for creating a sense of unity and integration under the banner of Iran's first independent national government. In the atmosphere created like this, urban life found new dimensions. Chaharbagh Street in Isfahan became a symbol of Iran's power and the manifestation and structure of power desired by Shah Abbas, and it became a model that provided a new concept of urban space in Iran - a model that can perhaps be interpreted in the form of spontaneous modernity. (Ahari. 2006)

For many years his street was used as a car road, but in 2019, it was changed to a pedestrian path, which is used for shopping and entertainment.

Figure 65. Chaharbagh street in current situation
Source: (https://www.imna.ir/news/585592)

3.4.2. Mather shah complex (Chaharbagh Mosque and school, Abbassi inn(hotel) and Art market (long bazarche))

On the eastern hand of Chaharbagh Street in Isfahan, a group of exquisite structures, including a caravanserai(inns), market, and school, were constructed during the Safavid era (1706–10714), and they represent the pinnacle of this era's greatest in terms of both architecture and art. (Kiani.1989:111). Shah's Mother School, also known as Chahar Bagh School, is a school on Chahar Bagh Street that was constructed by the mother of King Sultan Hossein. One of the marvels of Iranian architecture is the dome with its minarets. There are student rooms surrounding the four porches of the campus. There is a medieval Safavid market next to this institution named the Bazarche Boland (Art

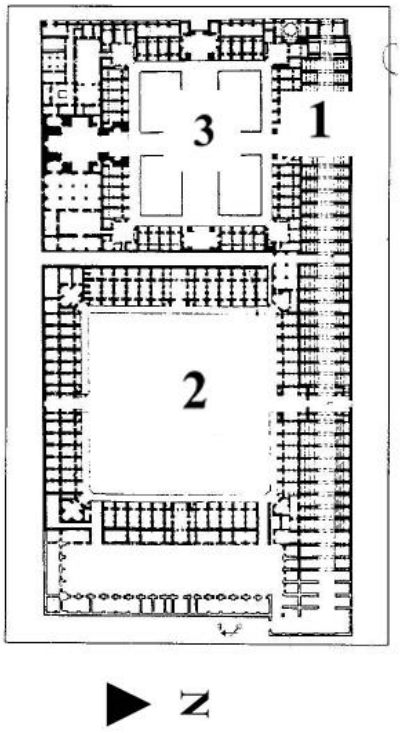


Figure 66. Mather shah complex.1. Art market (long bazarche) 2. Chaharbagh school and mosque 3.Mother shah inn(Abbassi hotel) Source: (Pirnia. &. Memarian. 2007:322)

market). The Mother Shah Inn, which was adjacent to this mosque, is now an Abbasi hotel. (Pirnia . &. Memarian.2007:111).

Compared to other Safavid-era structures in Isfahan, this historical structure is more soulful because of the plane woods inside the school's courtyard and the Farshadi creek that runs

through the center of the yard (Honarfar, 1969:732). and they give off the vibe of a metropolitan resort.2011 (Kianmehr.&.Taghvanejad. 2011).

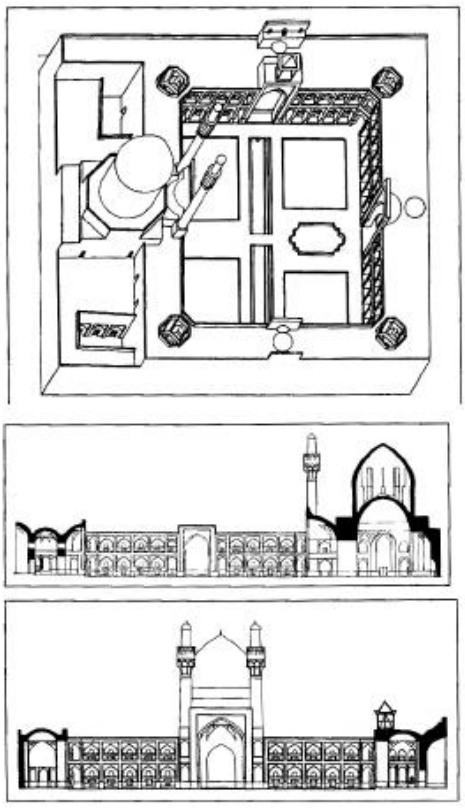


Figure 67. Plan and section and 3D Chaharbagh school and mosque
Source: (Pirnia. &. Memarian. 2007:322)

3.4.3. Bolbol (Nightingale) garden and Hasht behesht Palace (Rajayi park)

This palace is located in the north of long Bazarche (art market). It opens to Chaharbagh street facing Sheikh Bahai Street. (Pirnia.&. Memarian. 2007:112). This palace was constructed in the heart of an eighty-five-acre park known as the (Nightingale(bolbol) park. Hasht Behesht historical palace was constructed in 1080 AH under the power of Shah Suleiman and is one of the Safavid era's most distinctive palaces. The palace contains several marble foundation stones and a high spiritual morans arch in its entry hall and chambers filled with paintings, as well as behind its multiple sides of the building's tiled exterior walls. It displays many animals and birds in extremely appropriate forms. (Honarfar, 1969:622).

Hasht Behesht Garden (literally: Eight Heaven), also famous as Baghe Bolbol (literally: Nightingale Garden) is a garden (Rostami. &. Lamit.&. others. 2016) sorrounding Hasht Behesht palace.The garden was built in 16th century in Isfahan, a garden city with a

quadripartite plan formed by the intersection of two major axes: the Zayandeh-rood river and Chaharbagh Street. The garden is approximately 67,000 m2 in size and is situated in the city's historical core, above the Zayandeh-rood river and its famous Si o seh bridge, close Chahar-bagh street and other ancient gardens (e.g., Chehel-Sooton) and buildings in Naghshe- Jahan plaza and bazaar. (Rostami. &. Lamit.&. others. 2016).

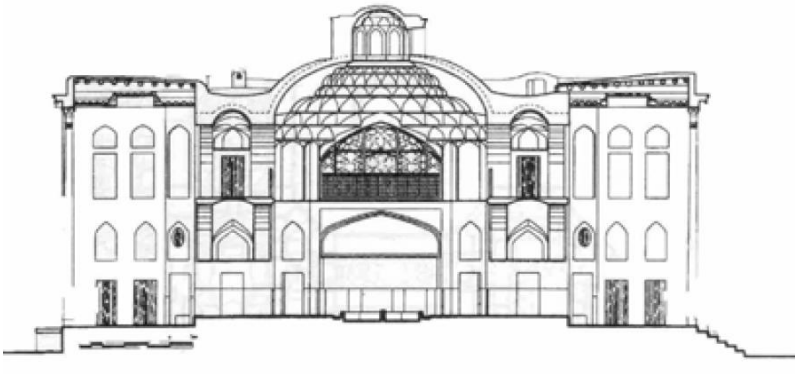


Figure 68 .Hasht behesht palace section
Source: (Pirnia.&. Memarian.2007:113).

Figure 69. Hasht behesht (eight heveans) palace. Source: (https://lastsecond.ir/attractions)

3.4.4. Niasarm Stream(Madi Niasarm)

The man-made streams branching from Zayandeh River are called Madi River. The sure point is that the first function that can be considered for these streams is the use of the share of seals. In fact, in the past, these streams were built with the aim of being able to take

branches from Zayandeh Rood. They were Used them to irrigate fields and agricultural lands around the city. (Ghalehnoee. & .Alikhani. 2014).

After the construction of these streams, other functions for these structures emerged, such as creating movement path, in the heart of the neighborhood and creating a suitable platform for linear parks, but the builders' purpose in building these spaces was to transfer and regulate water. (Ghalehnoee. &. Alikhani. 2014 and Heidari .2000). One of these streams is Niasarm Stream which cross chaharbagh street and flow through a residential district and is a greenway of this district.

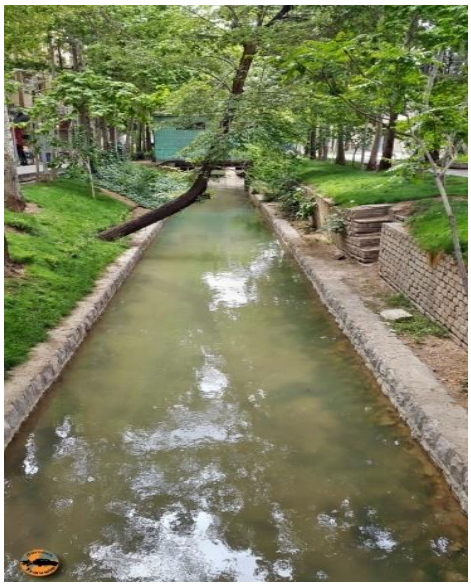


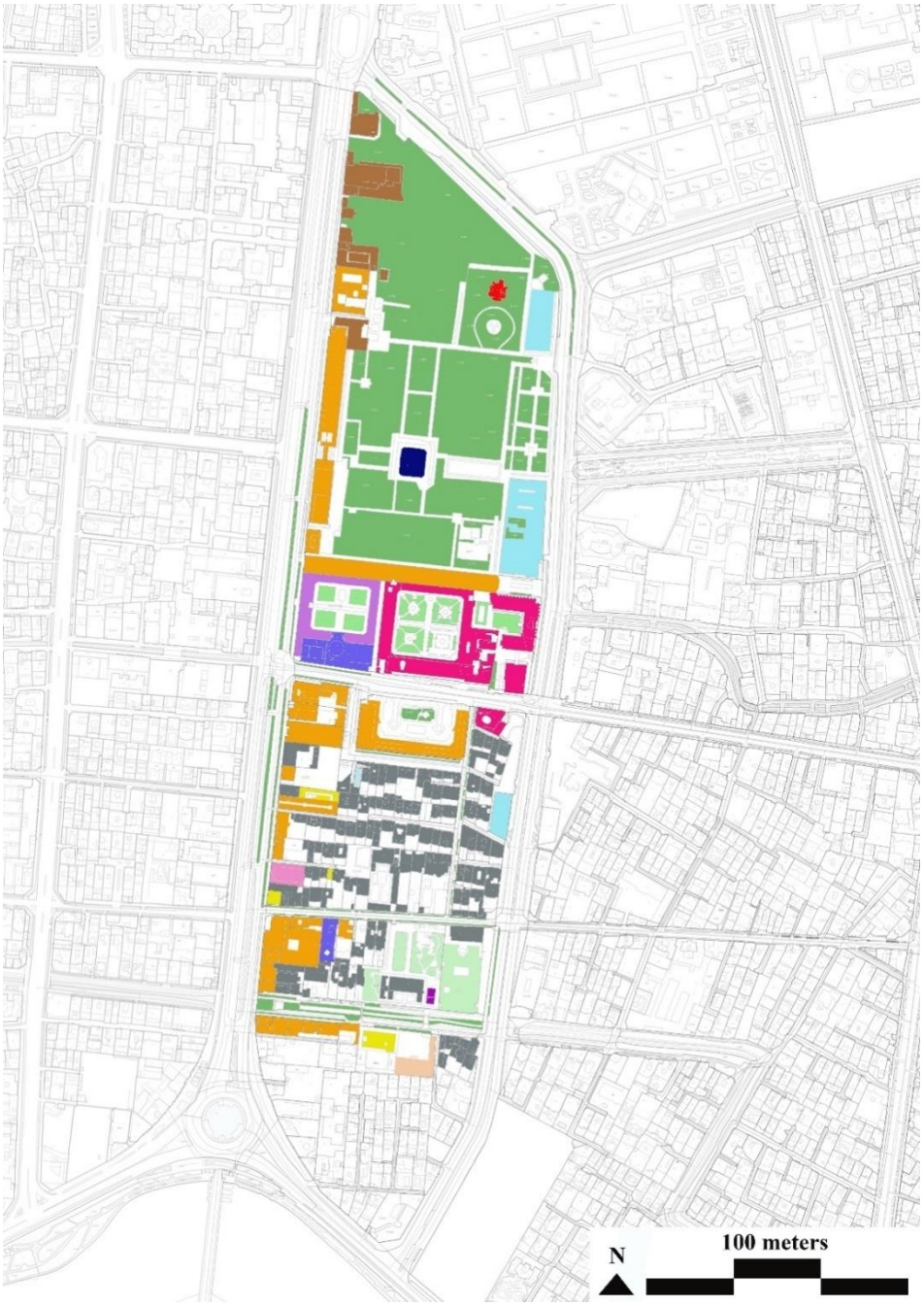
Figure70. Niasarm stream (Madi), Source: (https://soroosh-travels.com/maadi/)

3.5. The district analysis maps

It was stated in the previous part, that Chaharbagh Street is a pedestrian path for pleasure and walking from the past. There are many shops and cafes around it and the Mother Shah complex is located in the center of the neighborhood where all functions are gathered as a compressed district. For illustrating the selected area for the case study, in the third district Isfahan municipality, the maps are represented in the next pages. The selected area includes Mothers Shah Complex Park Rajayi and Niasram Stream and a residential district in the south.

The green street of Chaharbagh, Rajayi Park, and green areas around the streams and the river can be expanded and be connected to each other to be a suitable place for walking and riding bicycles. To specify the area potentials, the maps are represented. Currently, there are not any bicycle lines in the streets of Isfahan. As it was surveyed, the bus and the subway lines covered the whole city and people are satisfied with this. To express more about this topic, the mobility map is illustrated in the following.

3.4.2. Buildings Functions map



As it is clear on the map, in this district, there are many different functions. On the north, there is Rajayi Park and in the south of the district, residential apartments and houses are located. On the north of Rajayi Park, there are some dilapidated buildings that need to be demolished and rebuilt again (which are brown in color). On the south of Rajayi Park, the historical Mather Shah complex is located. Along Chaharbagh Street, it is a proper place for shops and cafes.

Figure 71.Buildings Funcrions map source:produced by the author

3.5.2. Green spaces map

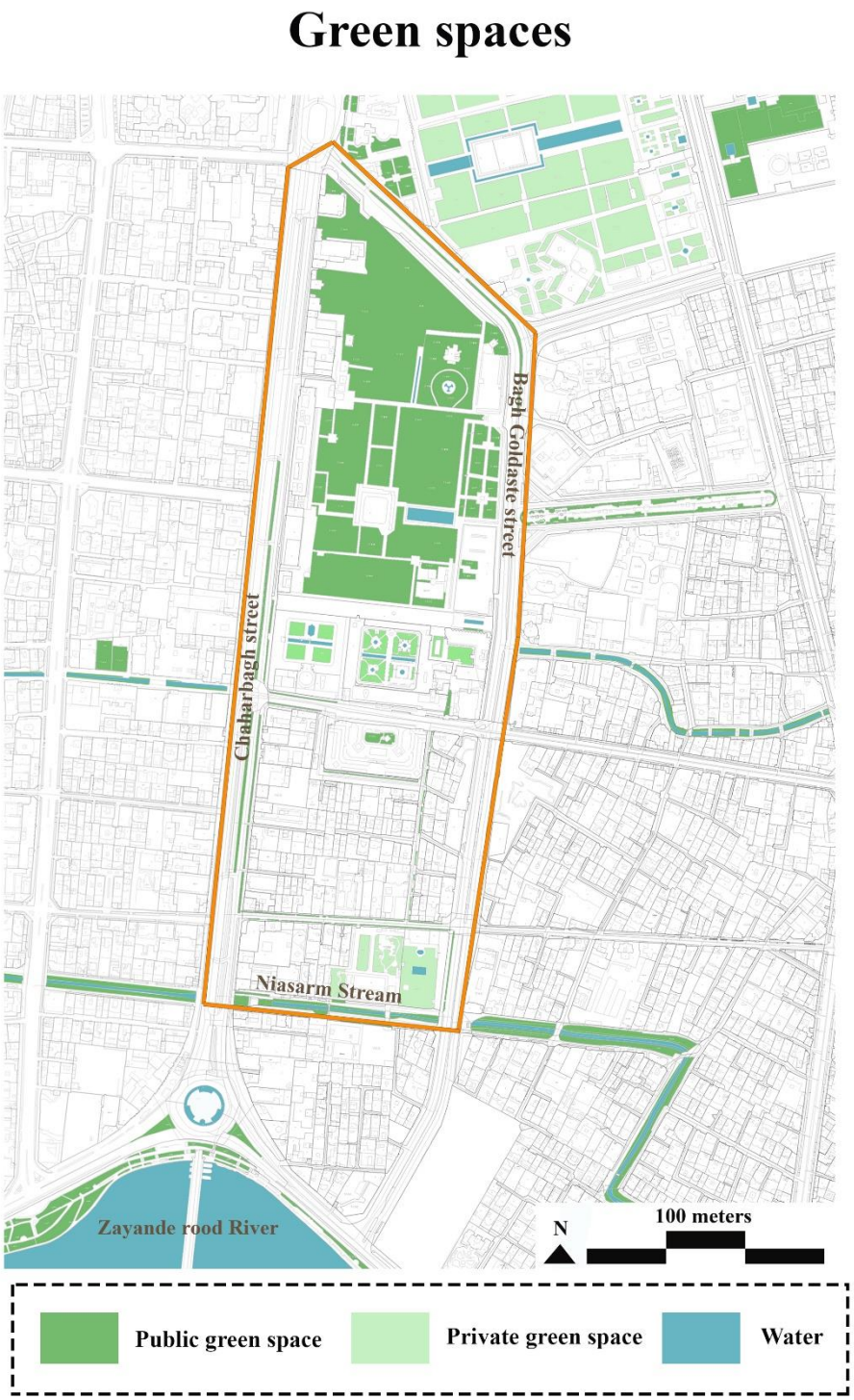


Figure 72 .green spaces map , source: produced by the author

As it is obvious on the green space map, there is a lot of potential for extending green areas in this district and encouraging people to walk or ride a bicycle.

Chaharbagh Street is a green street with many tall trees and ponds and designed furniture that is used just for pedestrians now. In the north, there is Rajayi Park which people cross during the day to go to another part of the city. On the northeast of the map, there is a park that can be connected to Rajayi Park.

There are two streams in this district. One enters to the district and then will change its form to the ponds in the historical Mother's Shah complex and it will be in the form of a stream again, going through the city.

Another stream on the south is Niasarm stream which goes through the residential district as a greenway. And in the south of the district, there is the river and it's green space. By connecting these green spaces with proper pedestrian lines, bicycle lines, and designed furniture, people will be encouraged to walk and ride bicycles in this district

3.5.3.Current mobility map

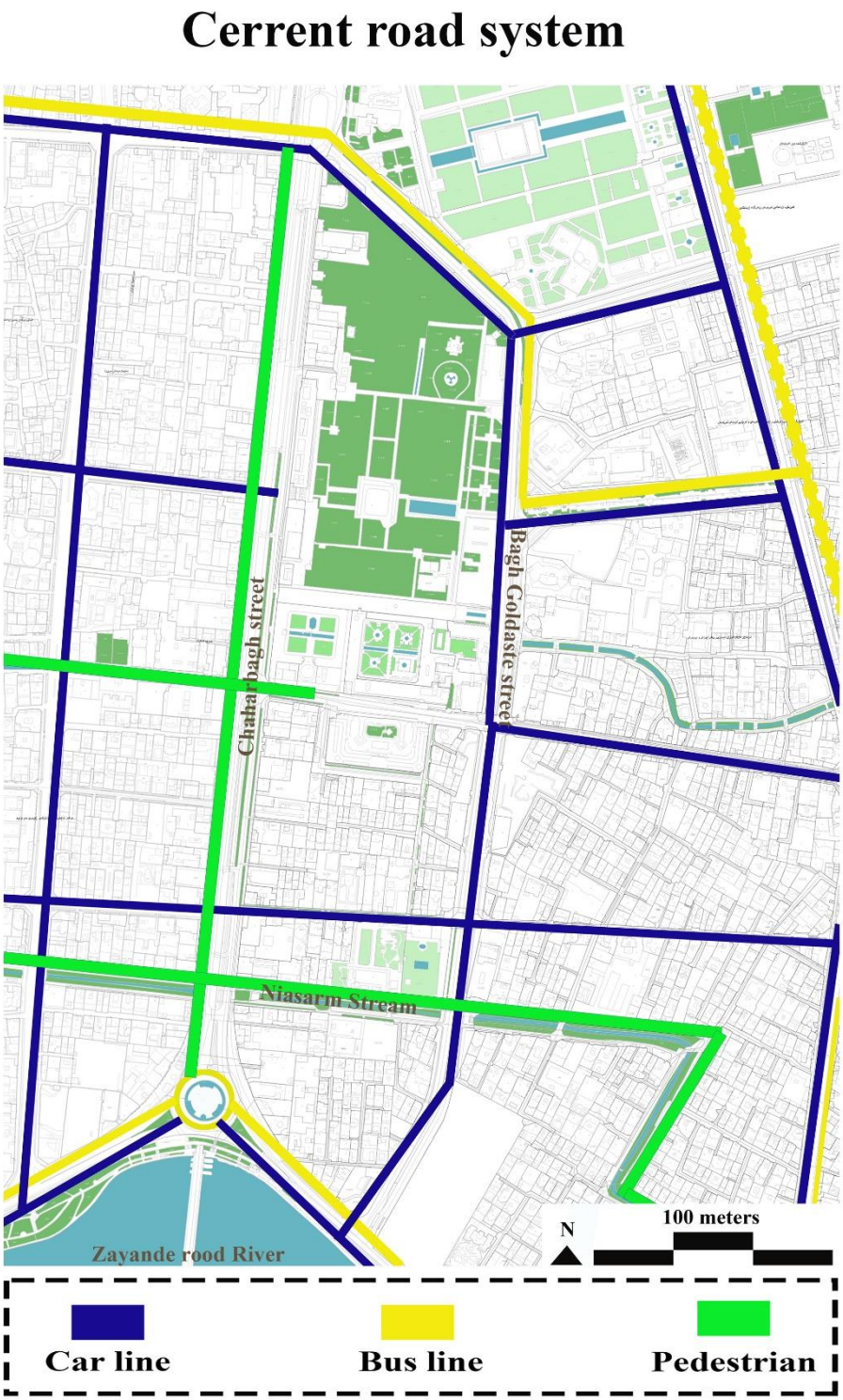
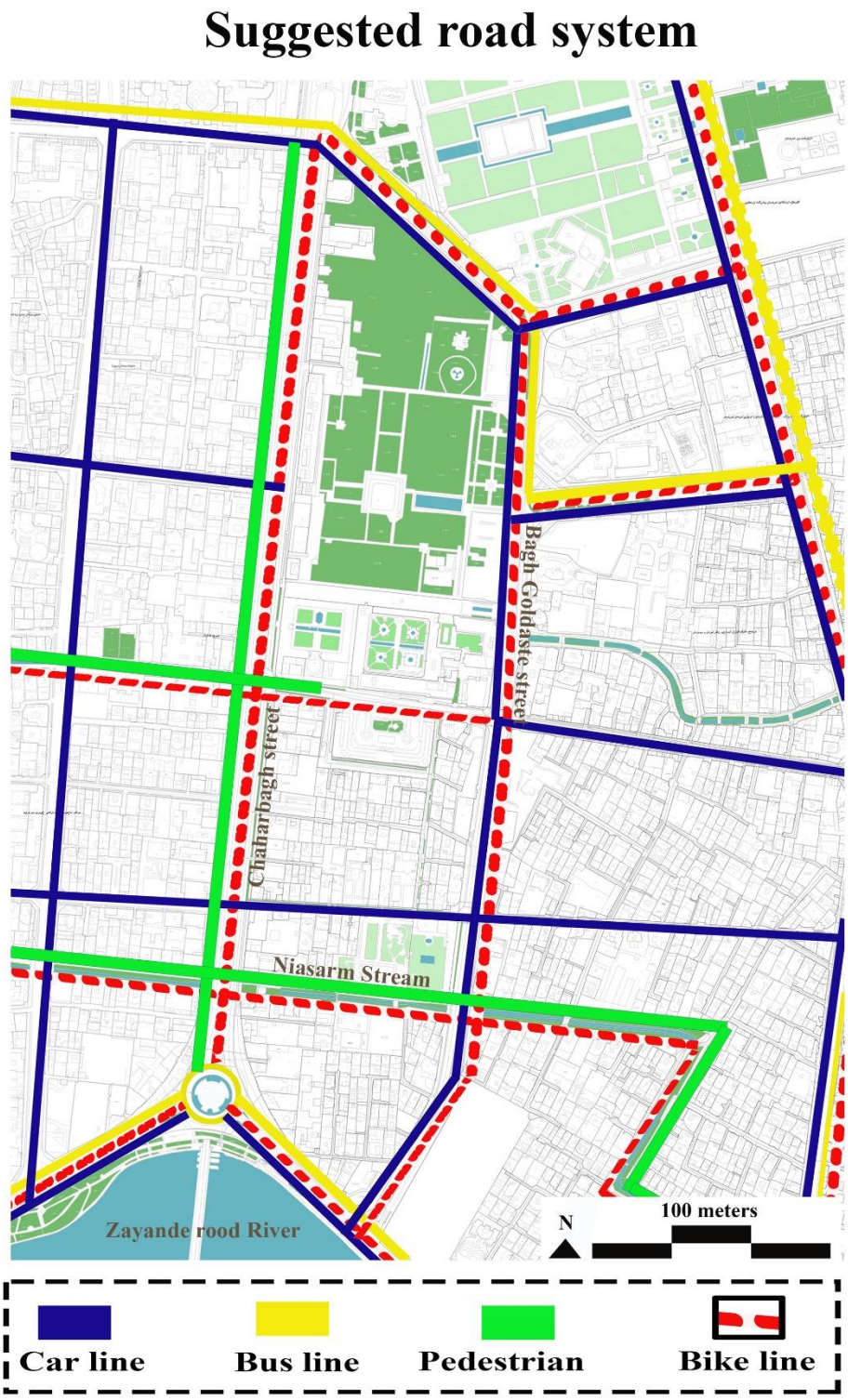


Figure 73.Current mobility map source: produced by the auther

According to the map, Chaharbagh street is a pedestrian path that is connected to Niasram pedestrian pathway. Public transportation ways are designed around Chaharbagh and cover the needs of residents. There is heavy traffic in the lines of cars in this district. There is no line for bicycles in this district.

3.5.4.Suggested mobility map



In the previous map, the lack of bicycle lines is illustrated,

These lines which connected the district were suggested as bike lines to decrease pollution by the author. These new lines can connect the district properly and make it easier to ride bicycles in this city. Today, there is not any bike lines in Isfahan.

Figure 74. Suggested mobility map source: produced by the author

The situation of the functions, green areas, and the mobility of the selected area in the third district of Isfahan municipality was surveyed. These analyses were necessary to explain the necessities for improving the selected district according to the Gaffron classification in the following.

4. proposal analysis for urban policies based on Gaffron classification of eco-cities for the selected part in the third district of Isfahan municipality

4.0. Introduction

As it was stated in the first part, Gaffron classified the goals of eco-cities according to the five issues. He also categorized the factors of achieving an eco-city as below, the arrangement was used for the analysis of the selected part by the author. Firstly, I visited the site several times and from what I perceived, I analysed the district and wrote some suggestions. Then I categorized them according to Gaffron classification. I selected this book for classification because, among all the books and articles that I have read about eco-city, this classification was the most comprehensive in which all the aspects of an eco-city were addressed in a clear way. All the eco-city teams of this book and the colleagues of Gaffron were mentioned in the main scientific reference. In the following, first, Gaffron classification is presented, and then the analysis of the district according to it.

- **The environment:**

Natural natural environment:

Efforts to protect the surrounding landscape and its natural elements

Appropriate use of the surrounding landscape as an economic and social resource

Planning based on climate, topography and geology

Artificial natural environment:

Trying for a multi-center, dense urban structure based on transportation

Consideration of concentration and revision for supply and consumption systems

Promotion, reuse and revival of cultural heritage

- **City structure:**

Demand for land:

Increasing the reuse of land and building structures to reduce the demand for land and new buildings, the demand for land, the development of structures with high density and suitable

Land use:

Organizing the distribution and balanced supply of employment and educational residential uses and recreational facilities

Efforts to create mixed use structures in buildings, blocks or at the level of neighborhood units

Public spaces:
Creating attractive and suitable public spaces for everyday life
Paying attention to the legality, appropriateness and relevance of public space patterns
Green spaces:
Integration of natural elements and cycles in the urban context
Creating vision patterns for superior social usability
Urban peace and comfort:
Striving for comfort and comfort outside the house on a daily, seasonal and annual basis
Minimizing noise and air pollution
The buildings:
Maximizing indoor comfort and conserving resources throughout the life of buildings
Designing flexible buildings, communication and availability

- **Calm situations / public transport**

Minimizing distances in time and space between activities to reduce travel demand
Prioritizing bicycle and pedestrian routes as the primary network for internal neighborhood traffic
Prioritizing public transportation as the most important factor in a sustainable personal transportation system
Creating management measures to support and change the situation to mentally adaptable situations
Travel by personal motor vehicle:
To reduce the volume and speed of travel by personal motor vehicles
Support the reduction of motor vehicle traffic through parking management
Transportation of goods:
Facilitating neighborhood measures and concept transfer to minimize the need to carry single loads by car
to the letter for efficient construction and implementation measures

- **Materials and energy:**

Energy:
Optimizing the energy efficiency of the energy structure
Minimizing the energy demand of buildings
Minimizing energy efficiency
Maximizing the share of renewable energy sources
Water:
Minimizing initial water consumption
Minimizing damage to the natural water cycle
waste materials:

Minimizing the amount of waste produced and the waste to be disposed of.
building materials:
Building Materials Minimizing the use of building materials and maximizing mod recycling
Maximizing the use of sanitary building materials and the environment

- **Social and economic issues:**

Social issues:
Promoting social diversity and inclusion
Provision of social infrastructure structures and other infrastructures with capabilities
Economic:
Maximizing job applications
Use of available work resources
Economy:
Efforts to structure the long-term economic infrastructure
Suggesting houses with workplaces and space for non-profit work that has a small cost. (Gaffron, Huismans, Skala, Messerschmidt, Verdaguer, & Koren. 2005).

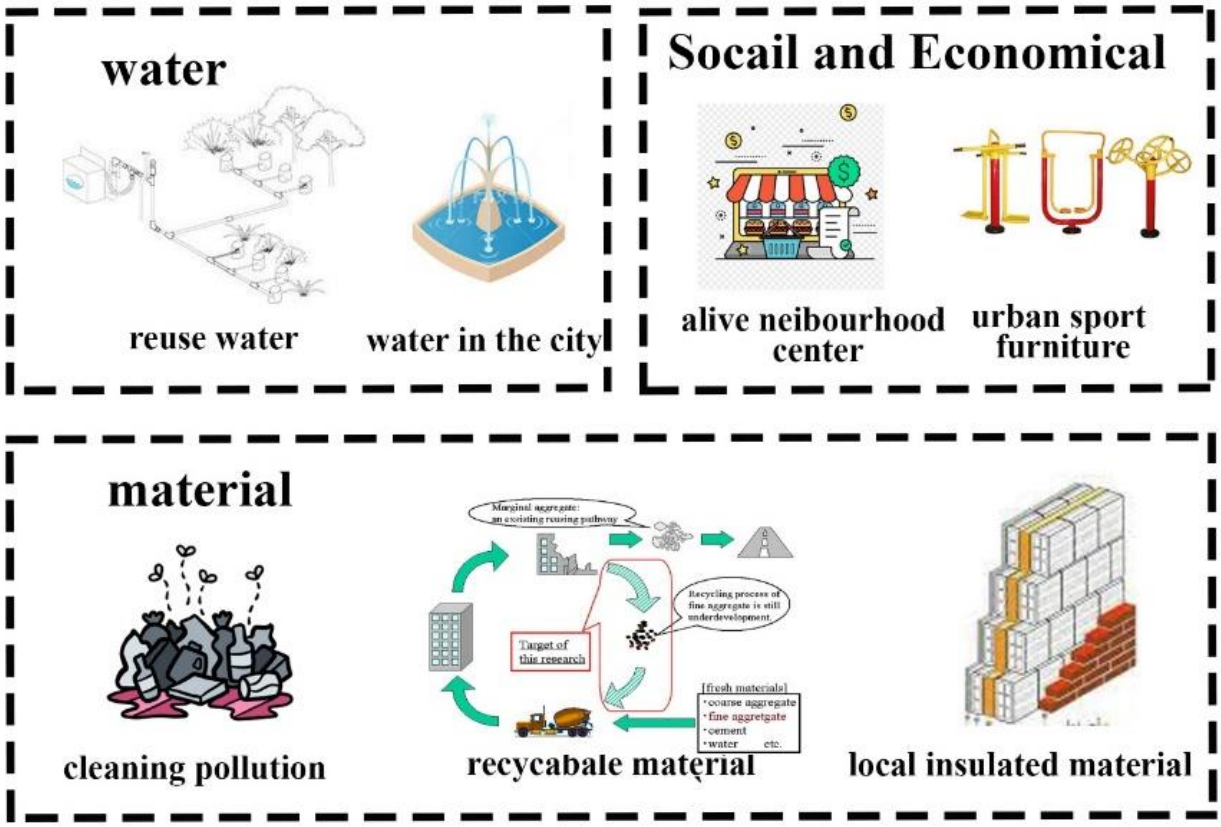


Figure 75 .Graphical analysis of the selected part according to Gaffron classification
source: produced by author

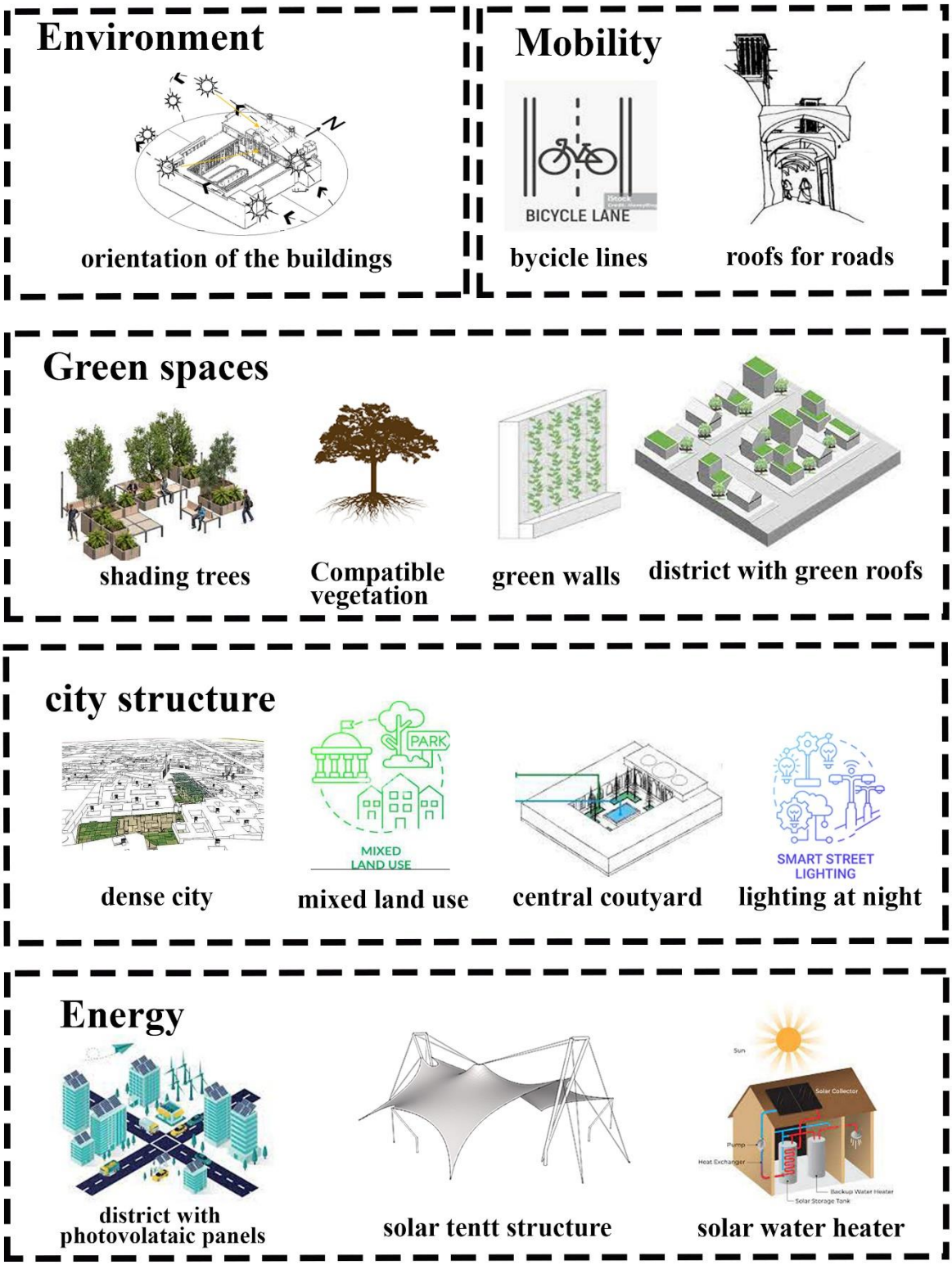


Figure 76. Graphical analysis of the selected part according to Gaffron classification
source: produced by author

In the following, an analysis of the district according to Gaffron classification for eco-cities theories will be explained:

4.1. Environment

Isfahan was formed according to the natural topography and due to the creation of the streams which were originated from Zayandeh rood river. Preserving these streams surrounding area and reviving them by creating social and cultural activities is recommended.

Moreover, the orientation of constructing the residential buildings from the past is north _south which is the best orientation of the houses in this city due to the sun and the winds which was investigated in the last chapter. making buildings with this orientation will decrease the energy usage of the residential areas.

4.2. City structure:

City structure analysis includes green spaces (horizontal and vertical), architecture of the houses Mixed-use buildings, and the compactness of the city.

4.2.1. Green spaces (horizontal and vertical)

As it was explained Isfahan is one of the most air polluted cities of Iran. By extension of the green spaces, the pollution can be reduced. The green spaces around Niasarm Stream and Rajayi Park and Chaharbagh Green Street can be connected to the green spaces near the district like riverside park by making proper lines and furniture for pedestrians and bicycles.

This district is a green district in which tall plants and trees make the district special. This is important that in the green spaces, plant some compatible vegetation to the dry and hot weather of Isfahan.

Figure 77. Niasarm stream(madi). Source: (https://www.imna.ir/news)

Furthermore, In this historical zone, many buildings have marvelous views of the historical buildings and natural landscapes. By creating green roofs in commercial and residential buildings it is possible to enjoy these landscapes. Moreover, the Existence of green roofs will help the cooling of the buildings consume less energy and we will benefit from the plants. Furthermore, in dense urban spaces, creating vertical farms and green shelves for agriculture is recommended.

4.2.2. Architecture of the houses

There is a central courtyard in the traditional houses of Isfahan. These central yards and gardens help the building be cool in the summer because of the blowing of the wind in them and the shading of the trees. And in winter, these introverted yards, protect the building from the cold weather and the wind. People live on the north side of the building in the summer and on the south side in the winter in the past.

4.2.3. Mixed land used buildings and the compactness of the city

In the hot and dry weather of Isfahan the buildings were constructed compact and connected to each other from the past. This characteristic and the existence of the extroverted yard, lead to consuming less energy. This compactness has many positive advantages according to the theory of the compact city. The existence of different functions in the neighborhood center, near the residential buildings, will lead people to reach the easily by walking. The advantages of mixed land use in the neighborhood center can be seen.

4.3. Mobility

Mobility analysis includes suitable paths for pedestrians and bicycles.

4.3.1. Suitable passages for pedestrians and bicycles

The passages of this district are 3 kinds, open spaces, semi-close (Sabat), and closed spaces. For example, the art market, in addition to functions as a market, is a road that connects Chaharbagh to Bagh Goldaste Street. This close space is cool in the summer because of the tall dome roofs and is warm in the winter. Moreover, some roads have a roof which makes the space semi-close and protects people from the hot sun rays and the wind. These kinds of elements lead people encourage to walk and reduce energy consumption amount.

Moreover, Chaharbagh Street is located in the dense part of the city which continues along the Si O Se Bridge. It is a pedestrian path and always there is heavy traffic in the district. Creating bike lines can connect different areas and reduce pollution.

4.4. Material and energy:

Material and energy included water and local and recyclable materials usage and energy and eco-technologies.

4.4.1. Water

In this district, there are two streams. These streams and their adjacent green spaces will decrease the pollution of the air, and the temperature, and because of the existence of the trees along them, they are proper spaces for walking and riding bicycles. Moreover, in this district, we can see water in the different forms of spraying, flowing, and….in the ponds and fountains which create freshness for the city spaces. Water is a principal element of urban design in this district and Isfahan.

It is advisable to collect the rainwater in the streams through the downpipes of the residential buildings around it. Moreover, the water from these buildings can be reused as

gray water for watering the plants. By this, the streams can be full of water during the whole year which is dried now.

4.4.2. Usage of local and recyclable Materials:

The material which has a high thermal capacity like brick, is compatible with the climate of Isfahan. The usage of stone on the facades and Roman facades caused the consumption of more energy and did not match the cultural background of the district. Using materials that are recyclable is recommended. Moreover, using material which is produced by recyclable materials such as some kinds of concrete is suggested. Using materials such as some kinds of adhesive layers that cannot be separated and recycled is not suggested.

4.4.3. Energy and Eco-technologies:

Isfahan was a sustainable city in the past which lost its sustainability during the time. In the past, every building was built in a way that needed the least amount of energy. Today, according to the need for electricity, it can produce electricity in historical zones. Because of these historical buildings, we should use eco strategies carefully. We must use these technologies in a way, that they don't damage the view of the historical buildings. And we should respect the historical tissue of the city.

Figure78. Green roof of a resturant beside Rajayi park, Source: (https://manoshahr.ir)

So, the usage of photovoltaic panels on the roof is recommended in a way that they are not visible to people in the streets. It can be used for some green roofs and walls and eco-technologies which are removable. In this way, they can be removed when it is necessary. Furthermore, to make sustainable the historical parts of the cities, it should pay attention to the past strategies. Moreover, the use of water heaters on the roofs is recommended. As they have been used on the roofs of public WCs in recent years in Isfahan. Furthermore, The usage of some tent light structures that work with solar energy in the plaza in front of the Hotel Abbasi is recommended to control the sunshine in the summer.

4.5. Economy and social

Economy and social issues will be explained as:

4.5.1. Social issues

Around Niasram Stream, there is a very good potential for creating some gathering places. In these public places, people can gather and communicate and the neighborhood will be more socially sustainable. On the side of streams, it can be constructed some cafes and restaurant to create a leisure place. By enhancing the sense of attachment to these places, people will be more willing to spend time in historical zones. When people use a place, they will feel a sense of attachment to it, and they will protect and clean it. The cultural events can aware and Educate people about some subjects such as planting, protecting the house environment, biodiversity, etc. Moreover, It can be added some recycling stations in different parts.

4.5.2. Economy issues

The existence of the mosque, Bazar school, etc Near each other in the neighborhood center, has many economic advantages for the district. by creating some places for festivals and seasonal exhibitions, to show the history and glory of traditional customs, the place can be more attractive for tourists and citizens it can have economic advantages and in this area cafes, restaurants and other commercial sectors can benefit from the attendance of people.

5. Isfahan district (selected part) proposal policies

5.1. Tabel for the district based on Gaffron theories about eco-cities

In the following, the table of analysis for the district according to the classification of Gaffron for eco cities theories is presented:

Gaffron clasification(Gaffron, Huismans, Skala, Messerschmidt, Verdaguer, & Koren. 2005):

Main Eco Topics	Details
Environmental issues	Natural Environment
	Built environment
City structure	Land demand
	Land use
	Public spaces
	Green spaces
	Tranquillity and comfort
	Buildings
Mobility	Transportation
Material and energy	Energy
	Water
	Waste management
Socio economic factor	Social
	Economy

Environmental issues: (produced by the author)

Natural Environment	• Preservation of the streams of the site and their limits and the improvement of the surrounding area to revive them, because the city was formed from the beginning according to the existence of these streams and the natural topography. • Construction according to the slope of the land and respect according to the natural characteristics of the land
Built environment	• Construction of residential buildings according to their orientation from the past to the present, which is north-south (the best orientation for this area according to the sun and wind is between 0 degrees and 15 degrees.) • Restoration of the historical buildings. For example, the walls of the Art market which is visible in the park need

City structure: (produced by the author)

Land demand	• Increase the density of the area as the buildings were constructed adjacent and introverted with a central courtyard according to the dry and hot climate from the past. • Demolish dilapidated buildings in the north of Rajayi Park and rebuild dense commercial buildings instead.
Land use	• Increase the multiple function buildings as there was a multiple neighborhood center from the past.
Public spaces	• Creating gathering spaces for all generations such as the old, children and designing friendly furniture
Green spaces	• Expansion of the green spaces in a continuous way. • Plant some kinds of plants and trees with a low need for water which are compatible with the dry and hot weather of Isfahan in Rajayi Park and other green spaces. • plant tall shading trees near the roads to create thermal comfort • create green roofs to take advantage of the unique view of the historical area and reduce less energy for cooling the houses. • Creating vertical green elements and usage of green vertical farms and green shelves in the dense areas of the city • Informing and encouraging people to plant in their houses and apartments.
Tranquillity and comfort	• Making safe around the Niasarm stream and Rajayi Park at night by creating various forms of lights in order to increase the eyes of local people to reduce the crime rate. • Preserving the diversity of the plants in the park and area to reduce air pollution. • Making safe by demolishing the ruined buildings in the north of Rajayi Park and making the area safer.
Buildings	• Creating a central courtyard (and garden) in the buildings according to the existence of it in the traditional architecture which makes them cool in the summer and warm in the winter.

Mobility: (produced by the author)

Transportation	• Use of the concepts of traditional architectural elements for improving sidewalks, for example making the roads semi-open and close areas by creating a roof for them like the Iranian element (Sabat), this will cause shading on the roads. • Due to the lack of a line road for bicycles, creating bicycle lines along the green areas (Around Niasarm stream and Chaharbagh Street) is recommended. • Calm down the roads of the district in order to encourage walking.

Material and energy: (produced by the author)

Energy	• Using photovoltaic panels on the roofs of the buildings which are not seen from the ground and putting them in the urban furniture hiddenly, to show respect to the historical buildings. • Creating portable green partitions and walls and light structures that are removable in order to respect the historical buildings. • The usage of tent light structure equipped with solar sensor (working with solar energy) for shading where it is needed(like in front of Hotel Abbassi) • The usage of solar water heaters on top of the public toilets and other services. • According to the existence of an under -ground courtyard as a public space, using the potential of underground construction is recommended to take advantage of the thermal capacity of the ground.

Material and energy: (produced by the author)

Water	• The flow of water in the various forms of spraying, flowing, and in the streams, ponds, and fountains to enjoy the thermal and social benefits of water in the area, creating aliveness and freshness • Reuse of wastewater from the residential buildings around the stream is recommended. In this way, the stream will be full of water during the whole year. • Collecting the rainwater in the stream through the downpipes of the buildings around it and also in the Rajayi park for watering the plants.
Waste management	• Cleaning the streams from the waste • Using local materials like bricks which have a high heat capacity is recommended. Constructing buildings with stone and Roman façade is not compatible with the site. (from the point of view of energy and culture) • Using recyclable material is suggested. material like adhesive layers that are not recyclable is improper. • Using materials that are produced by recycling such as recycling concrete is recommended. • Encouraging people to split the waste for recycling as there is a lack of separated containers in the residential and non-residential areas in the current situation

Socio economic factor: (produced by the author)

Social	• Creating cultural gathering spaces for performing street music and theater around Niasarm stream. and in Rajayi park • Promoting cafes and a leisurely cultural atmosphere around the Niasarm stream • Adding sport urban furniture to the park and the area enhance the health of people • Creating gathering places for the old (an area for the old near the children recommended in Rajayi Park. • Presenting the history and culture of the space for tourists and citizens by some concepts such
Economy	• Promotion of the neighborhood center by increasing the various functions as the center was built with different functions such as school mosque and bazaar. • By creating some exhibitions and festivals of local culture to attract tourists and people in Rajayi Park, it can be done some economical actions.

5.2. Suggested ideas for the plaza in front of Abbassi Hotel (inn)

In the selected area, there are some spaces which have the great potential to be redesigned and Make them socially, economically and environmentally more sustainable and eco-freindly. By visiting the site for many times, I cosider some planning ideas which will be presented in the following.

In front of Hotel Abbasi (inn) which is a five-star hotel, there is a very good space for attracting tourists who are always there, waiting for their bus. The Plaza in front of this hotel is a bookstore complex. The plaza's architectural design was made with the concept of the central courtyard and garden which is placed underground. The air and sun go through this courtyard to the underground level buildings. This is a traditional Persian concept. There are bookstores on both the first and the second level and also in the underground. There are trees and a pond in this garden which creates a living space for shopping. Furthermore, by constructing under the ground, it is used the thermal capacity of the ground like an insulating layer in summer and winter. Moreover, by being constructed underground, the complex respected the Hotel Abbasi, the historical building. But today, we can see in the summer there is a vast area without shading in front of the hotel, which is not used by any people Because of the intense sunshine. By creating some tent light structures that work with solar energy (they produce Their energy from the sun), this place can be usable for holding some Persian traditional man-made art and crafts or holding street music or theater to create social sustainability or can educate people about planting and preserving the environment. Usage of the tent structure was common in the past for protecting some places for presenting some religious customs. These light structures respect the historical hotel and can be removed whenever it is necessary. Moreover, creating a bike station can promote biking in this area.


Figure 79,80.The vast area in the plaza in front of Abbasi hotel(inn), source: photo by the author

Figure 81. The underground central courtyard and garden in the plaza in front of Hotel Abbasi, source: the photo by the author**.**

5.3. Suggested ideas for Shahid Rajayi Park (Bolbol Garden (nightingle garden) and Hasht Behesht (seven heavens) palace)

Shahid Rajayi Park remains of Bolbol Garden in the past which is located around Hasht behest palace. Bolbol Garden is a Persian garden with special characteristics which is changed into a park over time. This park is located between historical Chaharbagh Street and Bagh Goldaste Street. It is located in the center of Isfahan where many people cross this park in order to move to the other parts of the city. Other nearby green spaces are the big traditional square of the city (Naghshe Jahan) and the park on the riverside. This park is in the heart of Isfahan, which cleans the air and produces fresh air where always there is heavy traffic. By improving different aspects of this park, it can be more sustainable and ecologically preserved.

It was the place for gathering booksellers in the Friday market in the past which was changed to a parking function. The soul of this space is cultural and historical and there is much potential for presenting the culture and art of Isfahan to the tourists and citizens. Like creating a statue garden or holding traditional man-made industry exhibitions or Persian local clothes festivals. Unfortunately, now there is not any place for these kinds of activities in this park. Moreover, the parking of the park is detached from the park which can be improved by moving the parking to the underground and extension of the green space and the paths on top of it. In the past, the old gathered in this park but there is not a suitable place for them, so a place for the old gathering is recommended. Moreover, by creating a place for both children and the old, both groups can have the benefit of a live social area and make the area socially sustainable.

Figure 82.Rajayi park(Bolbol garden(Nightingle).Source: (https://wisgoon.com/pin)

Photovoltaic panels and other eco-technologies can be installed on the furniture and roofs in the park. For implementing this action, the important issue is the fact that these kinds of technologies should be used where is not visible, because of the respect for the historical tissue of the park. Setting sports facilities in the park can help people be healthy.

Moreover, some parts of the park in the north, need to be renovated or redesigned. In some parts of the park, there are some ruined buildings that should be renovated or demolished to make the district safe. Furthermore, the furniture needs to be redesigned as a friendly gathering space. The art market wall which is visible in the park, needs to be renovated. The entrances also must be designed. Moreover, the light of the park is not proper at night and it can be improved by using various kinds of lighting systems.

From the point of view of vegetation, there are various kinds of vegetation from the past in this park. Planting compatible vegetation with the climate is recommended. Moreover, proper drainage can collect rainwater for watering plants.

Figure 83.Rajayi park(Bolbol garden(Nightingle).

Source: (https://lastsecond.ir/attractions)

6. What urban policies are implemented today to enhance sustainability in Iranian cities and, in particular in Isfahan: a scientific analysis

Sustainability has many aspects such as economic, social, and environmental. According to the first chapter, the country's two environmental and economic components contain the most significant sustainability indicators. (Amoushahi.&. Salmanmahini. &. Others.2023). In this thesis, the focus is on environmental issues and as it was mentioned in the previous chapters, Iran began to take environmental issues seriously in 1971 when the revolutionary authority realized the importance of environmental issues and founded the Department of the Environment for environmental conservation. (Iran DoE 2009) It was claimed that Iran considered the discussion over sustainability by forming the Iranian National Committee on Sustainable Development (NCSD) in 1993, barely one year after the United Nations Conference.(Agenda 21). (Hakimi Nejad. &. Fu. &. others. 2021).

Isfahan as the third city of Iran in terms of population, always have been considered an important city, and in recent years, some efforts have been done to be more sustainable. Isfahan was a sustainable city in the past which flourished in Safavid period and nowadays due to the modern life, it has changed and lost its sustainability. This city has many potentials for being more sustainable.

One of the actions of the municipality of Isfahan is the signing of the contract with the head of the Energy Foundation (energy globe organization) on 17 May 2022. (https://www.imna.ir/news). In this meeting, it was stated that paying attention to the environment, and preserving and revitalizing it is one of the necessities of the city, which is why energy management is one of the main goals of the Isfahan Municipality's five-year plan (https://www.imna.ir/news).

Moreover, this city joined the smart sustainable cities network on the same date (17 May 2022). In a contract between Isfahan Municipality and the World Energy Foundation, this metropolis joins the network of sustainable cities of the world as the first city in the country in the field of "smart sustainable city"(.https://akharinkhabar.ir/local/).

In line with the development of multilateralism and taking advantage of the capacity of important international networks and organizations in the field of cities, the city of Isfahan became a member of the World Smart Sustainable Cities Organization known as WeGo after going through administrative processes. Currently, 34 urban planning services are provided electronically on this site, which will soon increase to 100 services. (http://tabnakesfahan.ir/fa/news/)

"Isfahan was the first city in the Middle East that featured a smart intersection by installing the intelligent traffic control system in 1990. The city also took advantage of the first computerized traffic signal systems functioning in an interconnected networked approach," Homayoun Yazdan-Panah, the Isfahan mayor's adviser and assistant for smart city projects,

said about the city's efforts to offer intelligent services to residents. (https://en.imna.ir/news/).

Lack of plan, lack of urban unit management, legal vacuum, information security, cultural barriers and lack of infrastructure, are among the obstacles to the realization of a smart city in the country. (https://www.irna.ir/news/)

Regarding sustainability, since 2016, Isfahan City has been working on a project named "Revitalizing sick buildings, Making the constructed environment of the city safe and sustainable," which was recognized with a Guangzhou Prize in China. This initiative is characterized as follows: The city of Isfahan has taken a novel approach to "sick" structures (buildings that are hazardous or inefficient in terms of energy). Trained "doctors," often urban studies graduates with uncertain employment prospects, examine the buildings and make a "diagnosis" of the building's situation and sustainability. After that, the building receives funding from the municipality to "cure" it, and after it recovers, it is given a health certificate. This initiative's long-term effects include: Nature of Outcomes: enhanced sustainable urban strategies; enhanced macro image of city status in case of crisis or disaster event; increased local level of life. (https://use.metropolis.org/case-studies/revitalizing-sick-buildings#casestudydetail)

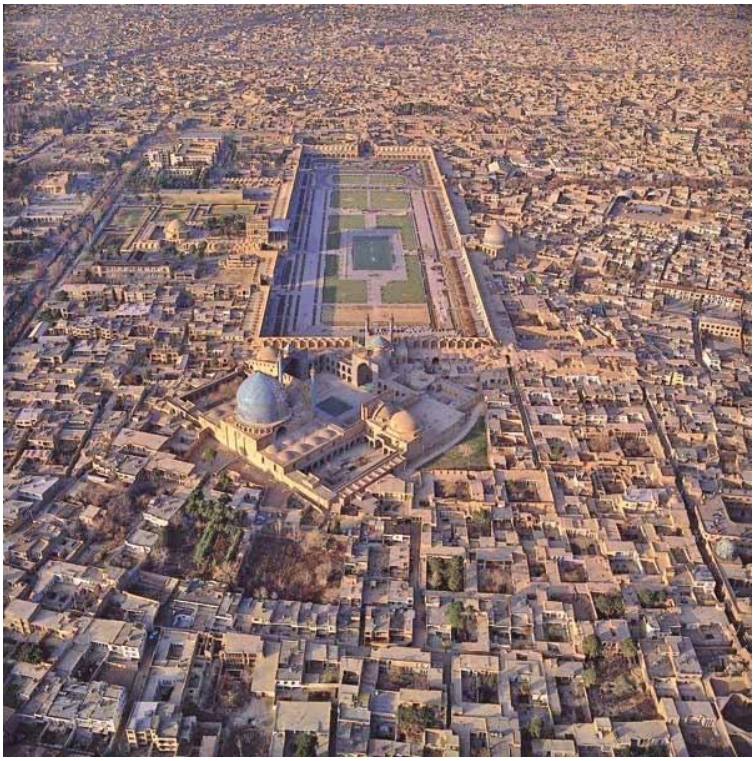


Figure84. Isfahan city (Naghsh Jahan square)

Source:(https://www.hamshahrionline.ir/news)

Despite these recent actions, making Isfahan a more sustainable city needs more efforts which should be planned by the policy makers. Masoud Taghvaei and his colleagues in their article "Physical Development and Sustainable Form of Isfahan City with approach of Smart Growth and compact city" present some suggestions for making Isfahan more sustainable. In the following they will be expressed:

- For the metropolis of Isfahan, it is necessary to compile an urban development strategy (by choosing a smart urban growth strategy and preparing an integrated urban development plan or the integration of the land use system and the transportation and traffic system, as well as the smartening of infrastructures and urban spaces). In this direction, improving and revitalizing the historical fabric of Isfahan City and recreating old and worn-out finds of the city is also one of the first strategic priorities.
- According to the theory of compact city, it is necessary that the area of Isfahan city does not increase and expand, and other cities do not join the Isfahan.
- To reduce environmental pollution as well as to preserve water resources and the Zayandeh Rohde River, it is necessary to prepare a comprehensive environmental plan for the metropolitan area of Isfahan, a plan for the gradual exit of polluting industrial centers, including Isfahan Refinery and other industrial centers.
- protection the existing natural and green areas of the city of Isfahan, especially the area of Najvan Gardens in the west of Isfahan, Soffe Mountain Park, East Natural Park and urban parks and green spaces, by creating and developing the green belt around the city of Isfahan. It should be prevented the expansion of the desert as the first priorities of Isfahan's urban management.
- Living in a compact city requires education and improvement of citizenship skills of the residents. Topics such as living in apartments, reducing energy consumption, using less private cars and using public transportation more, protecting the biological and natural resources of the city and the countryside are some strategic in citizenship education. (Taghvaei. &.Varesi.&. Narimani.2015)

Conclusion

Recently, the rate of urbanization in Iranian cities has increased a lot. The rapid growth of population, migration from villages to the cities, construction of factories, and the possibility of finding jobs in the cities are some reasons for urbanization enhancement the rate has risen from 31.76 % in 1955 to 71.37 % in 2011 in Iran. (Enayatrad, Yavari., Etemad., Khodakarim.& Mahdavi,. 2019).

This phenomenon led to an increase in the consumption of energy and materials. As The economy of Iran is based on gas and petroleum (fossil fuels) and the proportion of renewable energies for producing electricity was about 1 % in 2011(Mohammadnezhad. &. Ghazvini. &. others. 2011) The rising use of fossil fuels increased greenhouse gas emissions, Consequently, climate change occurred in Iran, becoming 2.6 degrees warmer and 35 less in rain precipitation in Iran. (Mansouri Daneshvar, Ebrahimi, & Nejadsoleymani, 2019).

Due to these occurrences, Iran attempted to control these destructive effects on the environment by creating an environmental committee in 1971, and in 1993, Just a year after the United Nations Meeting on Environment and Development (Agenda 21), it reacted to the debate on sustainability in the world and a national sustainability committee was established. (Hakimi Nejad. &. Fu. &. others. 2021). Following these efforts, it attended the United Nations Framework Convention on Climate Change (UNFCCC) 21st Conference of the Parties (COP21) in France in 2015 and signed the convention on 22 April 2016 in the United States of America (Mansouri Daneshvar, &. Ebrahimi, & Nejadsoleymani. 2019) to lessen the harmful effects of climate change and release of greenhouse gases. Moreover, some groups and activists started to work to compile the master plans of cities according to the sustainable issues.

In the nation's city master plans, sustainability challenges have not yet been adequately addressed. Because of construction according to these plans, (which mostly contain some suggestions about the road network, land use, and density), the physical body of the cities is changed outstandingly. (Golkar .2000). These master plans were planned to make the cities proper places for driving and widening the streets for cars. This led to the separation of different land uses in the cities. Therefore, people are not willing to walk or ride bicycles in these cities anymore. The low dense city and the excessive expansion of the cities have caused marginalization in the surrounding cities.

Regarding this, it is important to note that while Iranian cities were formerly constructed ecologically, they are no longer sustainable. By supposing these eco characteristics, some designs have been done to achieve sustainable goals on an urban scale. Among them, Young Town in Hashtgerd and the desert eco-park in Yazd can be surveyed. Yung Town planning follows: achieving sustainable water, energy, and mobility. The planning of this

town was done according to the topography and slope of the city. The alleys were designed sinusoidal (like the traditional alleys in Iran) and the blocks were created in different forms (not cubic) according to the topography and the direction of the wind and the sun. Energy and environmental factors played a key role in this project. The notion of a compact city was developed to make the city a suitable area for walking. The bus lines were developed to cover small distances within the area. Yung Town project was purposed for a dry and hot climate, Therefore, other urban planners can be inspired by this sustainable town to make other cities of Iran more sustainable with the same climate. In the other case study, Yazd desert is the closest desert to a city in Iran. By assuming this reality, the notion of designing a site to profit from the desert's potential was formed. In order to accomplish this purpose, the Yazd eco-park and the wastewater pond were built. The usage of the kinds of plants that need a low amount of water, using wastewater, constructing residences with traditional architecture, etc are the main policies of this project. Although there are some critics about finding the right place for making this lake, the main ideas of this experience can be carried out in ecological projects in other cities of Iran.

In the second part of this thesis, the city of Isfahan was examined as the third most populated city in Iran (with one million nine hundred and sixty thousand inhabitants) in terms of sustainable and ecological aspects. This city is located in the central plateau of Iran and has a hot and dry climate. Its form has experienced many changes during different historical periods, when it was chosen as the capital in Safavid era (it was the capital From 1591 to 1597 (Sultanzadeh. 1983)), started to flourish in every aspect. Many palaces, gardens, mosques, and Schools were built in this period and Chardin after visiting this city, compared it with London in this period. Zayande Rood River and Chaharbagh Street expanded as the city's main arteries throughout this period. These two features were identified as important once more in Isfahan's master plan. (1988). Unfortunately, due to the changes in the people's lifestyle, and appearance of cars in the streets, and the deficiency of Isfahan's master plans in some cases, the physical body of the city has altered a lot. Moreover, recently, the rate of urbanization was reported very high, equal to 85 % from 2006 to 2011[4]. These conditions, along with population growth and a high rate of migration, resulted in the city's overdevelopment and marginalization. Isfahan was a city with the function of agriculture which has been changed to an industrial city due to the construction of some industrial centers in it. This occurrence has intensified the city's drought, causing the river to dry up. As a result, climate change has happened. These are the variables that contribute to the city's unsustainable status. For more on this topic, four factors of sustainability, land use, mobility, energy, and water were investigated in more detail in this city.

[4] https://knoema.com/atlas/Iran/Isfahan/Urbanization-Rate

Land use: The expansion of the city and conversion of agricultural areas to residential structures has severely degraded the environment, resulting in structural and functional changes to neighboring spaces and land usage. Now, the urban limit has expanded 40 times more than the legal limit. (https://esfahan.agri-es.ir/)

Mobility: currently the ways of commuting in Isfahan are mentioned as walking, riding a bicycle, using private and public vehicles, bus services (and high-speed buses (BRT)), taxis, and subway. Generally, residents are satisfied with the public transportation in this city, but due to the affordable price of gas and petroleum, the rate of the usage of private cars is very high about 50 percent (Iran Metropolitan Agency News, https://www.imna.ir/news/681267) which is the cause of air pollution and high fossil fuel consumption which awareness of the people to use fewer cars, and improving bike lanes in the city can cause some positive effects in this sector. As, nowadays, there is not any bike line in the streets of Isfahan.

Energy: in Iran, a large amount of energy consumption (about 40 percent) is dedicated to the building sector which the share of oil and gas consumption in the building sector is about 98%,99%.(Mortazaei.&. Mohammadi.& others.2017). In the past, the specific characteristics of architecture of buildings and passages and the dense city theory, make the need for energy less. Today this demand has increased very much because of the shift in construction. The lifestyle is changed and due to the need for electricity, it can be supplied by using new technologies in every part of the city, even in historical parts. While the first zero-energy building was constructed on 30 May 2023 in Isfahan powerhouses have started to operate with limited capacity recently in Isfahan. (https://www.imna.ir/news)

Water: The city of Isfahan was formed around Zayande rood River. As previously noted, the river has dried up due to the transformation of the city into an industrial one, maintained droughts, the increased demand for water among people, and other issues One. option for reviving this river is to raise the public's knowledge about saving water, in addition to other activities such as moving water from neighboring provinces. Water flows in the city of Isfahan in other forms such as streams. These streams and their limits are threatened now, due to the dryness, loss of its surrounding greenery, creation of new streets, silent and unsafe atmosphere in the night, etc. Some actions should be implemented to revitalize them. Moreover, to supply the water demand, it should be implemented some new technologies such as using wastewater which now about 15 % of the demand for green areas in Isfahan is supplied by wastewater(https://www.khabaronline.ir/news/) other technologies like collecting rainwater were done limitedly in projects and can be developed more in the province.

The urban administration organization of Isfahan is a council-manager approach. The main player in the local projects is the municipality. (Rasoolimanesh, Jaafar, & Badarulzaman, 2013). In the last chapter of this thesis, it was investigated the urban policies in Isfahan. For more details on this topic, one part of the third district of Isfahan municipality was selected and for improving this part of the city in terms of eco-friendly, some suggestions were presented by the author according to her scientific studies and observation of the site. The suggestions were categorized according to Gaffron's classification of eco-cities and were presented in some tables in the last chapter. These actions were expressed about the city environment, structure (green spaces, architecture of houses, and mixed-use of the territory), mobility, energy, economic, and social issues for the selected part in the third district of Isfahan municipality. By implementing these strategies, the district can be more eco-friendly.

Main scientific reference

In the last part of this thesis (A detailed district analysis: The third Municipality of Isfahan)the main ideas was categorized according to the Gaffron(and his colleagues) classification about the co-cities in their book 'ecocity." in the following the Gaffron team is presented:

Gaffron P.,Huismans G.,Skala F., Messershmidt R., Verdaguer C.,Koren C., (2005), ***Ecocity Book I A better place to live,*** **Edited by Hamburgh University of Technology, Hamburgh and Wien.**

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