Sustainable Smart City Planning

A Case Study in city of Shiraz (Iran), District 1st (Ghodoosi)

Master's Degree Thesis

Architecture for Sustainable Design

by

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Abstract

In recent years, cities from various parts of the world have faced with uncontrolled physical expansion due to inappropriate policies. Together with different solutions against urban sprawl, the dominant sustainable cure is the so-called 'Urban Consolidation' (UC). The goal of sustainable development would be fulfilled at all levels of spatial organization, the urban level has attracted much attention because of a continuously growing focus on people and economic activities in urban centers, especially in the developing countries.
Transformations and quick changes have shown that the preparation and implementation of urban development projects, which led to the adoption of the process approach to sustainable urban planning, at the first need to identify requirements, opportunities, and objectives, and afterward, strategies, policies and the approach. Furthermore, during the time social relationships become more complex in this area, thus, knowledge and urbanization have led to the design of new topics. Among the subjects for getting people's opinions, urban management participation, understanding the main challenges and bottlenecks can be mentioned. In terms of sustainable urban development, energy consumption is another important problem in cities. Fortunately, recently reduction of energy demand is feasible through modern technologies and criteria in building construction. Therefore, this information and knowledge make it possible to achieve one integrated and sustainable urban planning. Nowadays, the smart city concept is viewed as a landscape, manifesto or promise the goal of forming a sustainable and ideal city in the twenty-first century.
Shiraz as a metropolitan is confronted with immense urban problems including environmental pollution, ecological degradation endangering carrying capacity, resource depletion, and administrative system and incapable urban management. Problems are well justified by the existence of UN sustainable ecologic.
The present research has sought to identify the features and capabilities of the sustainable smart city and their status "in a part of Shiraz that already mentioned", identifying the strengths and weaknesses of this city in comparison with the smart city. lack of a long-term plan for Shiraz is a huge problem. "Urban Planning is traditionally seen as an expert discipline with little room for 'soft' values and concerns based on feelings rather than fact". Furthermore, the final product of the planning process, the built environment, is a habitat for a wide variety of people with equally diverse wants and needs. The question is, how does planning incorporate the needs, wants and visions of existing and future inhabitants while at the same time raising awareness of the often-complex issues and wicked problems involved in urban development?
This research is mostly dealing with the needs and requirements for sustainable urban scale and sprawl green network of the city of Shiraz in district 1th (Ghodoosi) and offers a solutions for the energy-saving utilizing Architectural design/Architectural energy efficiency and implementing of solar power systems which can provides net-zero energy buildings, and also adequate urban services and a more active social life for residents and offering them comfortable modern life. Moreover, introducing opportunities and possibilities for energy saving and sustainable smart planning projects in the cities of Iran.

Keywords: Urban sprawl, Sustainable development, Urban consolidation policy, Smart city, Urban planning, Energy efficiency, Shiraz

Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners. I understand that my thesis may be made electronically available to the public.

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Chapter 1
Introduction

Since the mid-20th century, many global environmental, social and economic crises have occurred and have had a major impact on society. The concept of sustainability and sustainable urban development creates awareness about the production and use of resources needed for residential, industrial, transport, commercial or recreational processes (Yigitcanlar and Lee 2014).

The smart city is a new and evolving concept based on innovative information and communication technologies (ICT). It aims to turn the challenges associated with urbanization in the 21st century into opportunities for efficient, sustainable management and urban environmental planning (Caragliu et al., 2011). Through wise management of natural resources and participatory governance, investments in human and social capital, as well as traditional (transport) and modern (ICT) communications infrastructure, will contribute to sustainable economic growth and quality of life, when promoting, cities are smart. In this Research, the smart concept distinguishes three goals that must be sustainable, dynamic and participatory. Smart city development, called sustainable, addresses urbanization challenges by developing integrated, long-term, profitable, and environmentally friendly solutions and services that meet the needs of citizens today and in the future. Successful smart city initiatives require a comprehensive image of the urban environment affected by their application. From a dynamic perspective, this initiative needs to rebuild cities as sustainable and viable cities on a long-term smart ecosystem with spatial, economic, social and governance dimensions. Finally, smart cities must be participatory in the sense that they are built by and for citizens who must be a major concern of all urban development. (Branchi et al., 2014).

Can architecture provide this solution? Is the decay of the built environment at least partially responsible for social decay? Perhaps it is the other way around. I believe the former to have some significant level of cause on the latter. Today, the advent and embracement of modern sustainability allow for a new solution to the decline of traditional inner-city neighborhoods. Sustainability is a core issue for solving many problems. It is not that “sustainable” or “green” is just the catchphrase of the day. A home, a school, or any building that is low maintenance and has low energy costs will not deplete the resources of a family, the local school department, or that of a small business. Additionally, the reduction of energy and material demands is an important goal for our society. It is central to our ability to solve problems of global climate

change and political, economic, and financial turmoil resulting from dwindling fossil fuel reserves. It will help us better address the persistent problems of providing all people with clean air, clean water, food, shelter, education, and happiness.

1.1. Background

The rapid rate of urbanization after the industrial revolution has caused a tremendous amount of change in the world (UNHS, 2011). Human effort to achieve a higher quality of life harms the environment in local and global scales. Following the global environmental crisis (i.e. global warming, climate change, and widespread deforestation), the sustainability agenda has become one of the most controversial topics of the 20th and 21st centuries (UNHS, 2011). So far, there is a consensus that the conventional ways of resource consumption and waste production would not sustain for a long time; the state which originated from human-made changes over the natural landscape (Girardet and Mendonca, 2009). The variety of approaches in different scales towards sustainability makes new opportunities to learn from successful precedents taken towards sustainability achievement. Cities, as the most compact settlements of people, have a tremendous effect on environmental changes (Girardet and Schumacher, 1999). Although the industrial economy in contemporary cities has been replaced by the service sector, the rate of resource consumption is still growing up (Lehmann and Crocker, 2012). The predicted 70 percent rate of urbanization and 7 billion world population by 2050 (UNHS, 2011) reveals that the sustainability of urban space is a key factor in global resilience to forthcoming changes. Cities, like Curitiba (Brazil), Austin (USA), Copenhagen (Denmark), Melbourne (Australia) and Frankfort (Germany) are pioneers to represent some degree of sustainability in urban planning which can be studied in terms of applicability in other cities. The key point is that the proposals need to be contextualized based on local circumstances to become practically applicable.

The third millennium is the millennium of urbanization because for the first time the urban population of the world has crossed 50 %. The size and speed of recent rapid urbanization to the extent that it is known as the second wave of urbanization. Therefore, the growth of urbanization since the beginning of the third millennium, which is the era of governance of information technology in various areas of urban life, has grown more rapidly from the past, which may be called the third wave of urbanization. as projected, urbanization will increase to more than 70 % of world population by 2050 (UN, 2008). Therefore, the rapid urbanization process is aa inevitable reality. The 21st century is a century of cities; hence cities have a central role in the economy, and the driving force behind the global competition, information, development and innovation, and becoming globally integrated poles and more influential and responsible service communities. It is also a place to focus on physical and human capital. As 80% of the world's gross domestic product is in cities, it is anticipated that by the year 2050, 600 cities from the world's largest cities will produce 60% of world GDP1 (Mckinsey global institute, 2011). But urbanization, despite the great achievements for humankind, has brought with its problems and problems that, despite the huge scientific and technical advances, the solution to many of these problems have been accompanied by failure. At the moment cities consume 75% of global energy and produce large volumes of waste and 70% of greenhouse gas produced from cities. (Colldahi, Frey, & Kelemen, 2013), which has a major contribution to climate change, and air pollution. On the other hand, this rapid growth of cities is not proportional to the capacity to expand their infrastructure and imposes the increasing pressure on urban infrastructure. Hence, cities are naturally faced with complex and widespread challenges that are interrelated, which can only be solved through a systematic approach. In other words, the massive accumulation of residents has led to disturbances and disorderly conditions that have caused not only the collapse of the balance of cities but also the achievement of sustainability with the current methods of urban management and development. As a result, urban planners around the world strive to develop models for the development of the 21st-

century cities to meet the demands and expectations of today's world with a comprehensive look at all dimensions of urbanization. The enormous amount of data generated in the city space, coupled with the advances made in ICT, provides unprecedented opportunities to cope with the great challenges that cities face. One of the basic foundations of the smart city is access to real-time information on the actions and choices of citizens. Access to real-time information in the smart city makes it possible to identify and distinguish behavioral patterns (in the city as a whole and at the individual level), which is very valuable. This makes it possible to observe the invisibility (to understand what is going on), the behavior of a city over different periods, and allow them to influence them and model them. At the moment, many countries in the world have solved their problems and problems of the city, which cannot be solved by classical approaches, the approaches, and strategies of the virtual world to maximize the utilization of the capabilities of their urban life. Although the concept of the smart city has become a very popular subject of research in all fields of science, and despite the widespread use of this term and extensive efforts to explain it, there is not a clear understanding and consensus among professionals and academics. There is not a consensus in terms of concepts, meanings, features, elements, and components (for different perspectives from different domains of knowledge). Studies show that scholars from various scientific fields have proposed a variety of terms and used a range of conceptual types instead of the smart attribute. Some people have emphasized the dimensions of technology, and others believe that adopting technology in the smart city is not the end of the work and highlight the development of human and social capital and physical infrastructure.

This thesis will explore the possibilities of creating a sustainable smart city in one of Iran's cities. I will show how our current knowledge of the disciplines of architecture and sustainability can be applied to a solution that will yield a greater public good. Foremost will be the effort to show how good design can improve the lives of the people by creating urban areas, and neighborhoods that are comfortable, secure, and sustainable for all of the activities that make life enjoyable.

1.2. Research questions

This research will investigate in the context of a sustainable smart city in the urbanized environment. For holistic city planning, the project focuses on two key datasets which are essential for city managers: smart city planning and sustainable city planning. Therefore, this thesis research to achieve sustainable smart city seeks to answer the following questions:

- What are the key contributors to achieve sustainability?

It is generally accepted that the trilogy of economy, environment, and social equity are foremost components of the sustainability concept (Girardet and Mendonca, 2009 -21 Chan and Lee, 2008). World Commission on Environment and Development (WCED) established the definition of sustainable development as "a development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (1987). Sustainable principles of urban development are categorized into management, social-economic and ecological subdivisions. Management principles include local government responsibility with better environmental understanding, the flexibility of environmental policies and long-term strategic visions. The socio-economical category includes appropriate technology and design, creating adequate environmental indicators, standard regulations, market connectedness, supporting by social acceptability and public participation. Ecological principles contain prevention-led actions, integrated activities, using minimum resources (renewable and recyclable), producing minimum waste, respecting environmental diversity and expanding local environmental research (Haughton and Hunter, 1994). In this context, Moore (Moore, 2007) claims that there is a triangular conflict

among economy, ecology and equity as key sustainability contributors in terms of strategy achievement. A balance between development, property and resource discourses is required to achieve integrated sustainability in an urban context. Such a balance has more opportunity to make the city more profitable, fairer and greener for stakeholders, developers, and governors (Figure 1).

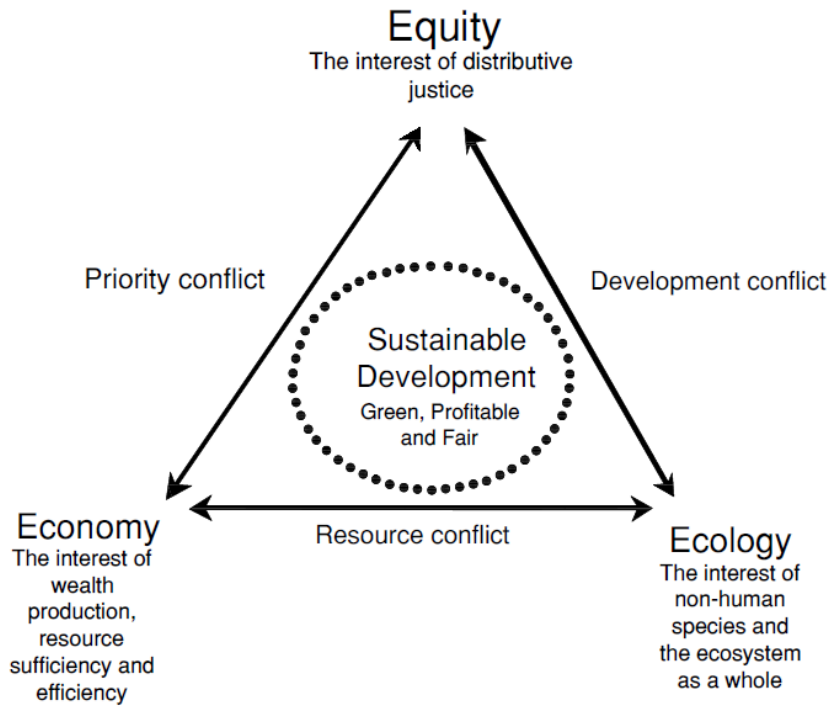


Figure 1. Triangular conflict among key contributors to achieve sustainability (Moore, 2007)

- What are the main challenges and dangers of creating sustainable cities?

- Urbanization is fragmented: Despite the demographic importance and potential role of such cities, urban planning efforts in developing countries have focused disproportionately on the problems of large metropolitan areas.
- Governance and finance: Decentralization is a key factor for cities, where city officials are elected rather than appointed. As cities separate from less-centralized governments, they are able to exert governance and democracy at the local level.
- The problem of slums: Slums and informal settlements aren't a new issue for cities. Because slums continue to be plague cities across the globe, the report deems them a "persistent" risk and "part of the unfinished business of the (Millennium Development Goals) or part of the 'old' urban agenda that must be addressed by the new urban agenda."
- Problem of providing urban services: When the provision of services breaks down, particularly for those in large informal settlements, "the basic productivity of all citizens will be compromised.
- Climate changes: Urban areas are centers for energy consumption and a key source of greenhouse gasses. Cities account for between 60 and 80 percent of the world's energy consumption and generate as much as 70 percent of all greenhouse gas emissions.
- Forced migration: The expanding involuntary migration issue is a global problem; Europe has been at the center of the migration issue in recent years, owing to conflict in the Middle East.

Increasing insecurity and urban risks: The effects of globalization have been complicated by a rise in crime and violence in the world's cities. These two issues continue to be of primary concern among urban dwellers, with one study showing that 60 to 70 percent of all urban residents have been victims of a crime. (UN World Cities Report, 2016)

- What kind of goals have smart cities got in the world?

City	Goals
Smart Amsterdam	Focus on reducing carbon efficiency, energy efficiency and behavior change.
Smart Malmo	Focus on improving climate, and reducing greenhouse gases by 20%.
Smart City of Malta (Malta)	Becoming an industrial city with advanced information technology, skills development and staff training in the field of technology.
Smart City of Masdar	Becoming Smart Green City, Sustainable Development, Affordable Economic Growth, Providing High Quality of Life and Innovative Business Environment.
Atlantic Planet (Plan IT)	With the goal of building the greenest city in the world from scratch and an operational pattern for the new generation of low carbon dioxide cities, saving on construction costs and higher quality.
Smart city of Singapore	Developing urban infrastructure, becoming an intelligent island with advanced intelligence infrastructure around the world, connecting computers in almost every home, office, school and factory, enhancing quality of life and economic growth.
Smart Curitiba	It seeks to achieve sustainable development and the integration of the Curitiba metropolitan area and addressing the rapidly growing demand for urban services due to population growth and economic growth.
Smart Sondgo	Achieving a clever, green and self-contained urban environment that is environmentally friendly and energy saving is a key feature of it.
Eco-friendly City of Tianjin	It aims to be a model for developing cities in China that is socially compatible and environmentally friendly, protects resources and serves as a reference (reusable and scalable) for other cities.
Smart City of Vokehama	Addressing urban issues including pollution, traffic congestion, flood and waste Management.

Table 1. smart city goals in different cities of the world (Pourahmad, Ziari, Hataminejad, pashabadi, 2018).

- What are the main challenges and dangers of creating smart cities?

- Competitiveness and the inability of cities to compete on a global scale, due to the global cohesion of cities (Cosgrave & Tryphon 2012).
- The lack of financial support for the implementation of a smart city project (Giffinger, et al., 2010).
- The complex texture and the need to accompany the political agenda (Hodgkinson, 2011, Nam & pardo, 2011).
- Innovative projects and small-scale developments do not necessarily guarantee effective realization at a wider level of the city. (Pike Research, 2011).
- Failure in investments and ignoring local needs and priorities (Caragliu & Del Bo, 2012, Giffinger et al., 2010, Walters, 2011).

- The slow progress of budget project issues and failures in attracting residents or capital (Vanloon, 2012; Brooker, 2008; Nordin, 2012).
- A unique focus on productivity can lead to a limited view of social values such as social cohesion and the quality of city life and sustainability dimensions (Bria and Lind, 2012).
- Repetition of technology solutions involve risk. The same solution may not be appropriate for all cities (Pike Research and Sassen, 2011, Townsend, Maguire, Liebhold & Crawford, 2010).
- The complex ecosystem of people, institutions, and shareholders requires much effort for organizing and disciplining (Ratti and Townsent, 2011).
-The infrastructure of existing smart cities can be obsolete and obstruct the realization of the smart city landscape (Pentikousis, Zhu and Wang, 2011).
- Existing cities have many problems that compete for a share of resources in cities. Therefore, addressing all aspects of a smart city is not possible.
Strategies should be based on prioritization.
- The danger of social disagreements (Social inequality) among the population groups, knowledge and unequal access to information and communication technology (digital divide, expansion of social divide, and strengthening of spatial polarization (Chourabi et al., 2012, Coe et al., 2001, Marciano, 2012., Walters, 2011).
- Technology advancements and the complexity of cyberspace continue to lead to inequality within parts of society (Neves, 2009, Townsend, et al., 2010).
- Issues and problems relating to privacy and the collection of personal information, security and oversight over the citizen (Bria and Haque, 2012).
- Lack of trained staff and the need for frequent updates (Alawadhi, et al., 2012; Chourabi, et al., 2012; Aldama-nalda, et al, 2012).

1.3. Research objectives

The purpose of this study is to achieve the practical potential of smart cities in the process of urban sustainable development through the application of Shiraz City and its role in the development of urban development policies in cities through the achievement of a series of sub-goals:
Identify the concepts and aspects of sustainable development.
Study some of the world's experiences in establishing and transforming smart cities

- Rapid urbanization

The world is on an unprecedented level of urbanization. This rapid urban population growth rate is not an interesting fact, but it calls for sustainable development and a better life. In the 18th century, less than 5% of the world's population lived in cities. According to a report released by the United Nations in 2008 on the prospect of urbanization, 2008 is the year in which more than 50% of the world's population lives in cities. This trend is growing rapidly and it is anticipated to reach more than 70% of the world's population by 2050. In Europe, now 75% of the population lives in urban areas. This is expected to reach 80% by 2020. Therefore, the early urbanization of the world is an inevitable reality that brings about many problems (UN, 2008). Therefore, rapid urbanization and efforts to reduce the problems that caused by urban population growth is one of the main causes of the emergence of a smart city (Chourabi et al., 2012).

- The effects of cities on the environment

Human development since the Industrial Revolution has had significant effects on the environment, and we live in an age that these changes in the planet are largely attributed to widespread and destructive human behaviors (Steffen, Jaques, Paul and John, 2011). Cities are the engine of economic growth and

80% of global GDP is devoted to cities (Habitat, 2015). But they have 2 percent of the world's drought and they consume about 75% of the world's energy (Ferraro, 2013). Today, most resources are consumed in cities all over the world that have high economic importance and poor environmental performance (Albino, Beradi and Dangelico, 2015). About 70 percent of greenhouse gas emissions originate from cities (Colldahi, Frey and Kelemen, 2013), which makes a major contribution to climate change. global carbon dioxide emissions increased by 45 percent between 1990 and 2010, largely due to the growth of cities (Habitat, 2015). Therefore, environmental problems and the need to develop sustainable cities are the focal points of many Smart City projects (Batagan, 2011); Smart cities in Europe focus on energy and sustainability issues. These issues have been considered as important issues for maintaining a high quality of life in cities (Meijer, 2013). This unprecedented rate of urban growth creates a necessity for finding innovative ways and solutions to manage the challenges ahead (Nam & pardo, 2011). Smart cities have a look forward to environmental issues and one of the centers of the smart city is to use technology to increase the sustainability and better management of natural resources (Chourabi, et al, 2012).

Urban population reaches 3.3 billion	Urban population reaches 50%	Rural population reaches its maximum	Urban population starts to grow rapidly	Urban population increases by 3.1 billion, totaling 6.4 billion
2007	2008	2018	2019	2050
	First time in history			Rural population decreases to 2.8 billion

Table2. Urbanization trend 2007 – 2050, (Ferraro, 2013).

- Economic crises (economic incentives)

The main motivation for moving cities towards intelligence lies in their desire for economic development. During the economic crisis of 2008 and 2009, the cities realized that they were competing with other cities, but in ways that had not experienced it before. They were not only competing with their neighbors in the state or nationally, but they were competing for generations (present and future) through global supply and demand networks and the Internet with their other counterparts around the world (Harrison & Donnelly 2012). Hence, the need for innovative and intelligent approaches to major economic crises was a global imperative. The requirements of the current economic crisis provide a good incentive to overcome resistance to change and transform problems into opportunities; in other words, the most significant stimulus for the development of smart cities was the economic crisis and the need to generate wealth. The global economy is now globally integrated which is based more on services, and cities are central to this trend. They also attract business activities and convert the city into global competition centers (Mosannenzadeh & Vettoratob, 2014). Cities are key actors in global competition and they need to use their resources to generate more wealth (Florida, 2002). It has been predicted that until 2050, 600 cities from the largest world's cities produce 60% of world GNP (Mckinsey global institute, 2011). Cities compete together to attract more and younger workforce (something Richard Florida calls the "creative class") to produce more wealth (Florida, 2003). High-value jobs that make the city attractive will be concentrated in a small number of cities and regions (Florida, 2008). Glycer and Barry (2006) showed that the highest rates of urbanization growth gained in the cities that there is a high share of the well-trained workforce (Albino, 2015).

- Demographic changes

The fourth huge process that destroys the capabilities of cities in the series of demographic changes. It is expected that over the next ten years, the older generation over 65 will grow almost twice as much across the world, from 7% to 13%. It means that many infrastructures need to be adapted. Hence, it is expected that there are major changes in health care and the elderly. Therefore, smart solutions are needed for cities whose goal is to increase (or at least maintain) the overall life quality of their inhabitants. The rapid growth in the number and size of their population to cities has, more than ever, played a pivotal role with technological, political and economic power (Ferraro, 2013). Perhaps one of the most useful functions of the smart city is to help the elderly and the poor to do their daily routine. One of the examples of this assistance is the lack of need to attend a visit for treatment and administration (Hataminejad et al, 2014).

- ICT advancements

The urban model of the 21st century is understandable by utilizing the potential of information and communication technology (Habitat, 2015). Taffler pointed out that the advances made in ICT have created a third wave in the evolution of cities (as cited in Castells, 2001). Communication systems connect citizens, companies, and organizations to a nervous system. With the help of technology and Internet connectivity, citizens receive services without time and space constraints. Without investment in broadband infrastructure, the flow of information between different parts of a city and between cities is cut off. This will slow down economic activity and affect financial services (Karadag, 2013). Therefore, connecting is an important aspect of city life, which is possible in the light of technological advances.

1.4 Thesis outline

Current research focuses on the capacity of investigating sustainable smart city in the developed part of Shiraz that has the highest potential of becoming sustainable smart area in near future because of easily connection to green areas and “Qasr-dasht” gardens, energy saving, water resources, capacity of developing to the north part of the city which is recently constructing very fast. Moreover, the built environment, transport system, health, education, and more are shopping for the city for the future.
This thesis is divided into 9 chapters which:

- First chapter

briefly explained the sustainable city and in advance, smart city. Summaries the structure of the thesis and how tolls can be provided to implement on the case study area.

- Second chapter

represents the structure of the sustainable city and assessment methodology required to be embodied within a conceptual framework and vision of the sustainable city, recognize which features of urban sustainability are generally acknowledged as objective fundamental requirements, indicators need to be formulated in terms of rates of change and finally, the measurement system should focus on the essence of sustainable development and be kept as simple as possible.

- Third chapter

simply shows that in the present world technology is playing a significant role in the transformation of life while having both positive and negative effects. Stability has been a core element of design strategies. The product developed to have strong research behind its stability and durable nature. The measures are behind the materials cycle, toxicity, and energy consumption. The infrastructure of smart cities (energy, mobility, public services, water, and buildings. This factures towards smart city systems in cities open the

door to new services, new forms of economies of scale, a reduction in inefficiencies and waste and ultimately new business opportunities.

- Chapter 4

provided an extensive investigation of social, structure, architectural methods for addressing sustainable smart city strategies. The analysis of this research is divided from both theoretical and actual precedents and establish the basis for the development of this research proposal and explained the case study city (Shiraz), history of the city, the capacity of contemporary city to become a sustainable city. This chapter compared the case study city (Shiraz) with a similar city in Brazil (Curitiba) and Iran (Isfahan) in case of sustainability concerning mutual method and technics that has been used in the city of shiraz and these two cities and try to study about implementing their sustainable technics and parameters to shiraz with considered ancient (Isfahan) and modern (Curitiba) approaches toward sustainability.

- Chapter 5

represented the problem and challenges that a sustainable city will face, in Iran and specially in Shiraz. Climate change, shortage of natural resources, environmental crises are some issues that governments need to scope and solve it. Strategies and measurements and capacity of contemporary city to become a sustainable city, represented natural disaster can cause the problem for city and potential of energy saving in the city.

- Chapter 6

focuses on the case study area (Ghodoosi) and study about the problems of the selected area and finding solutions, analyzing the case study area and planning the sustainable smart city and puts into design the methodological tools presented in the last chapters.

- Chapter 7

dedicated to provide the conclusion of the research and explain how to reach to outcome with considered the facilities, tools, technics, and methods to apply sustainable smart cities in the existing part of the Shiraz.

Chapter 2
Sustainable city

A city is not just a physical entity, but a place where people live and work. As many researchers have stated, cities are works of imagination and symbolism, cities are like documents of cultural and historical value, changing times and different political flavors which consist of different elements.

However, the globalization process has resulted in the fundamental social, cultural, and economic changes that have been experienced in cities. In particular, historic cities where the past and present interpenetrate and testify to the past, and where people are participating throughout the space and places of the city that have been greatly affected by these transformation processes. They are affected by population growth and rapid urbanization. The growing demand for more homes and the emergence of new residential areas, officially or informally, will change the characteristics of cities, especially the traditional residential environment. At this point, the importance of sustainable urban development must be understood as an action that balances not only the present and the future but also the past. But sustainable cities are not a new phenomenon. Historical towns and cities around the world have been able to develop and maintain a continually balanced relationship between internal, social and economic activities and the external and natural and agricultural landscapes, Exists.

The most empirical literature on ecological or sustainable cities highlights principles and parameters for achieving a balance of ecological, economic and social objectives in urban environments. Sustainable cities, on the other hand, cannot see only these three networks of relationships. The built environment and spatial relationships are very closely related to this well-known triangular network and are obviously equally important.

2.1. What is sustainable city?

In my point of view, a "sustainable city" is a city that combines history, natural environment, and climate, buildings, and structures, arts and culture, business and industry, works efficiently and develops continuously. This means the city is sustainable. It leads to a strong sense of place and creates a sense of

belonging. In fact, this is a dream that cares for people and this may be given the appeal of creating a sustainable city.

The first thing we need to know is how to create a more sustainable world for people. Knowing the answer to this question is undoubtedly the goal of sustainable development that provides people with advanced environmental sustainability, decent housing, clean water, and health care, along with other global needs. "The 2009 Human Settlement Global Report assesses the effectiveness of urban planning as a tool to address the unprecedented challenges facing cities in the 21st century and enhance sustainable urbanization. Today, in many parts of the world, urban planning systems have changed little and often contribute to urban issues, rather than functioning as tools for improving people and the environment. There is recognition against this background, the central discussion of the Global Report must change the current approach to planning in most parts of the world and find a new role for urban planning in sustainable urban development. It must be. The Global Report argues that it is necessary to understand the factors that make up the 21st-century city and implement future city planning.

• Environmental challenges of climate change and cities, too much dependence on fossil fuel vehicles;

• Demographic challenges of rapid urbanization, the rapid growth of small and medium cities, the growing youth population in developing countries, and shrinking city challenges, aging and increasing multicultural composition of cities in developed countries.

• The economic challenges of uncertain future growth, the fundamental doubts about the market-driven approach brought the current global financial crisis and the increasing informality in urban activities;

• increasing socio-spatial challenges, especially social and spatial inequalities, urban sprawl and unplanned peri urbanization; and

• The challenges and opportunities to promote the democratization of decision-making, as well as to raise public awareness of social and economic rights. According to global reports, urban planning has not changed in almost every country for almost 100 years. In the past few decades, many countries have adopted some innovative measures. These include strategic spatial planning, the use of spatial planning to integrate public sector functions, new land regularization, management approaches, participation processes and partnerships at the neighborhood level, more sustainable, such as compact cities and new Urbanism includes planning for a spatial form. " However, in many developed countries, old-style master plans remain. Here, "The most obvious problem with this approach is that it grows rapidly, is largely poor, cannot cope with the lifestyles of the majority of informal urban populations, and often contributes directly to social and spatial exclusion. That's what we do. " As a result of the global economic crisis and key messages to find a new role for urban planning in sustainable cities, governments are leading key initiatives in developing initiatives and ensuring that key urban needs are met. This "has revealed the limitations of the private sector in terms of its resilience and future growth, and the ability of the" market "to solve most urban problems." City planning is an important role in helping governments to meet the challenges of 21st-century cities:

The global report identifies many promising trends to bridge green and brown challenges including:

• the development of sustainable energy in order to reduce cities' dependence on non-renewable energy sources;

• the improvement of eco-efficiency in order to enable the use of waste products to satisfy urban energy and material needs;

• the development of sustainable transport in order to reduce the adverse environmental impacts of dependence on fossil fuel-driven cars; and

• the development of 'cities without slums' so as to address the pressing challenges of poor access to safe drinking water and sanitation as well as vulnerability to natural hazards.

Three-step process for effectively responding to urban informality are. “first, recognizing the positive role played by urban informal development; second, adopting revisions to policies, laws and regulations to facilitate informal-sector operations; and, third, strengthening the legitimacy of planning and regulatory systems”. To promote more compact forms of urban expansion there is a link between strategic spatial plans and infrastructure development focused around public transport. “In this context, linking major infrastructure investment projects and mega-projects to strategic planning is crucial and infrastructure plan is a key element of such strategic spatial plans”. Another important message is that land use links should take precedence, while other forms of infrastructure, including water and sanitation trunk infrastructure, can follow. The problem is that, many urban planning systems do not have monitoring and evaluation as an integral part of their operations. In this case, urban planning systems should integrate monitoring and evaluation as permanent features, along with clear indicators that are aligned with plan goals, objectives and policies and also Urban plans should explicitly put in plain words their monitoring and evaluation philosophies, strategies and processes. “The outcomes and impacts of many large-scale plans are difficult to evaluate because of the many influences and factors that are at play in cities over time. For this reason, it makes more sense to focus on site plans, subdivision plans and neighborhood plans, all of which are smaller in scale and more conducive to monitoring and evaluation”. A final message of the Global Report is that curricula in many urban planning schools need to be updated. This is particularly the case in many developing and transitional countries where curricula have not been revised to keep up with current challenges and issues.

Planning schools should embrace innovative planning ideas, including the ability to engage in participatory planning, negotiation and communication, understanding the implications of rapid urbanization and urban informality, and the ability to bring climate change considerations into planning concerns. In addition, it should be recognized that planning is not ‘value-neutral’ – for this reason, urban planning education should include tuition in ethics, the promotion of social equity and the social and economic rights of citizens, as well as of sustainability[1].

- Urban challenges and the need to revisit urban planning

Over the last century, urban planning1 has become a discipline and profession in its own right, has become institutionalized as a practice of government, as well as an activity of ordinary citizens and businesses, and has evolved as a complex set of ideas which guides both planning decision making processes and urban outcomes. At certain times, planning has been seen as the activity which can solve many of the major problems of urban areas, while at other times it has been viewed as unnecessary government interference in market forces. More recently, it has been argued that systems of urban planning in developing countries are also the cause of many urban problems, and that by setting unrealistic standards, planning is promoting urban poverty and exclusion.

This Report views urban planning as a significant management tool for dealing with the sustainable urbanization challenges facing 21st century cities. While the forces impacting on the growth of cities have changed dramatically in many parts of the world, planning systems have changed very little and contribute to urban problems. This does not need to be the case: planning systems can be changed so that they are able to function as effective instruments of sustainable urban change, that is, capable of making cities more environmentally sound and safe, more economically productive and more socially inclusive (see Box 1). Given the enormity of the issues facing urban areas, there is no longer time for complacency: planning systems need to be evaluated and if necessary revised.

[1] Planning Sustainable Cities: Policy directions global report on human settlements 2009, Abridged Edition

Figure 2. urban planning is a significant management tool for dealing with the challenges facing 21st century cities, (@ Bill Grove / iStock).[2]

- Urban challenges of the 21st century

Future urban planning needs to take place within an understanding of the factors which are shaping the socio spatial aspects of cities and the institutional structures which attempt to manage them. It also needs to recognize the significant demographic and environmental challenges which lie ahead.[3]

- Main forces affecting urban change

Over the last several decades, global changes in the physical environment, in the economy, in institutional structures and in civil society have had significant impacts on urban areas.

- Environmental challenges

The most important environmental concern now is climate change. Climate change will affect the basic elements of life for people around the world, including access to water, food production, health and the environment. Hundreds of millions of people are likely to suffer hunger, water shortages and coastal flooding as global warming increases. The poorest countries and people are most vulnerable to this threat. The global use of oil as an energy source has both promoted urbanization, and its easy availability has allowed the emergence of low density and sprawling urban forms –suburbia – dependent on private cars. An oil-based economy and climate change are linked: vehicle and aircraft emissions contribute significantly to greenhouse gas emissions. Responding to a post-oil era, in the form of public-transport and pedestrian-based movement systems, more compact cities, present new imperatives for planning. Urbanization modifies the environment and generates new hazards, including deforestation and slope instability, thus resulting in landslides and flash flooding. The world's one billion urban slum dwellers are more vulnerable, as they are usually unprotected by planning regulations. Economic change Processes of globalization and economic restructuring in recent decades have affected urban areas in both developed and developing countries. Particularly significant has been the impact on urban labor markets, which show a growing polarization of occupational and income structures. In developed countries, firms have sought lower production costs by relocating to developing countries, to less developed regions within the developed world, or even from inner city areas to suburbs. Urban residents are disproportionately affected by global

[2] iStock is an online royalty free, international micro stock photography provider based in Calgary, Alberta, Canada.

[3] Planning Sustainable Cities: Policy directions global report on human settlements 2009, Abridged Edition, p-1

economic crises. The current global recession that began in 2008 has accelerated economic restructuring and rapid growth of unemployment in all parts of the world. One important effect of these economic processes has been the rapid growth in the informal economy in all urban centers, but particularly in developing countries.

Future urban planning in both developed and developing countries will thus be taking place in a context of inequality and poverty and with high levels of informal activity. Institutional change Within the last three decades, there have been significant transformations in local government in many parts of the world, making them very different settings from those within which planning was originally conceived. The most commonly recognized change has been the expansion of the urban political system from 'government' to 'governance', which in developed countries represents a response to the growing complexity of governing in a globalizing and multi-level context. In developing countries, the concept of governance has been promoted along with decentralization and democratization. These shifts have had profound implications for urban planning, which has often been cast as a relic of the old welfare state model and as an obstacle to economic development and market freedom. Generally, urban planning is highly reliant on the existence of stable, effective and accountable local government, as well as a strong civil society. Many developing countries simply do not have these. Under such conditions, urban planning will continue to be ineffective. Changes in civil society Since the 1960s, there has been a growing unwillingness on the part of communities to passively accept the planning decisions of politicians and technocrats. Planners have come to recognize that planning implementation is more likely to be effective if it can secure 'community support'. Successful participatory planning is largely conditioned by broader state civil society relations, and the extent to which democracy is accepted and upheld. There has been a tendency in planning to assume a one-dimensional view of civil society and the role it might play in planning initiatives. The ideal of strong community based organizations, willing to debate planning ideas, may be achievable in certain parts of the world, but civil society does not always lend itself to this kind of activity. While organized civil society has been a characteristic of Latin America, it takes very different forms in Africa, the Middle East and much of Asia, where social networks which extend beyond kinship and ethnicity remain, to a large extent, casual, unstructured and paternalistic.[4]

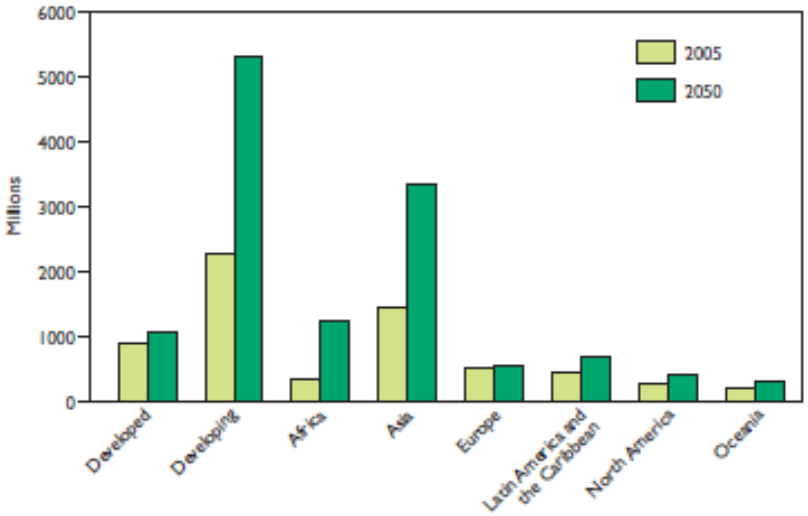


Figure 3. Urban population by region, 2005-2050, (@ Bill Grove / iStock). [5]
Note: Asia does not include Japan,

[4] Planning Sustainable Cities: Policy directions global report on human settlements 2009, Abridged Edition, p-3

[5] iStock is an online royalty free, international micro stock photography provider based in Calgary, Alberta, Canada.

- Urban change

Changes in economic and governmental systems, in the nature of civil society, and in the nature and scale of environmental challenges, have all had major impacts on processes of urbanization and urban growth, and socio-spatial dynamics in urban settlements. Urbanization and urban growth the global urban transition witnessed over the last three decades has been phenomenal. While the period 1950–1975 saw population, growth divided between the urban and rural areas of the world, the period since has seen the balance tipped dramatically in favor of urban growth. In 2008, for the first time in history, over half of the world's population lived in urban areas and by 2050 this will have risen to 70 per cent. Figure 1 shows urban population growth projections by region.[6]

Figure 4. Urban poverty and the growth of slums have refocused attention on planning, (@ Steven Allan / iStock). [7]

- Urban socio-spatial change

Planners and urban managers have to increasingly contend with new spatial forms and processes. Socio-spatial change has taken place primarily in the direction of the fragmentation, separation and specialization of functions and uses in cities. In many poorer cities, spatial forms are largely driven by the efforts of low-income households to secure land that is affordable and in a reasonable location, often in peri-urban areas. This process is leading to new urban forms as the countryside begins to urbanize. In fact, the bulk of rapid urban growth in developing countries is taking place in the peri-urban areas. Large cities are spreading out, engulfing nearby towns, leading to continuous belts of settlement. In Latin America, the coastal corridor in Venezuela now includes the cities of Maracaibo, Barquisimeto, Valencia, Caracas, Barcelona-Puerto La Cruz, and Cumana.

2.2. approaches to sustainable city planning

Over the past few decades, new approaches, which seek to address the problems in traditional master planning systems have emerged. Most of these initiatives have elements in common. These elements are:

- Strategic rather than comprehensive;
- Flexible rather than end-state oriented;

[6] Planning Sustainable Cities: Policy directions global report on human settlements 2009, Abridged Edition, p-4

[7] iStock is an online royalty free, international micro stock photography provider based in Calgary, Alberta, Canada.

- Action and implementation oriented;
- Stakeholder or community driven;
- Reflect emerging urban concerns;
- Play an integrative role;
- Focus on the planning process.

The new approaches are grouped under seven broad categories:
Strategic spatial planning, which does not address every part of a city but focuses on only those aspects or areas that are strategic or important to overall plan objectives;
• Spatial planning to integrate government or public sector functions, including injection of a spatial or territorial dimension into sectoral strategies;
• New approaches to land regularization and management, which offer alternatives to the forced removal of informal settlements, ways of using planning tools to strategically influence development actors, ways of working with development actors to manage public space and provide services, and new ideas as to how planning laws can be used to capture rising urban land values;
• Participatory and partnership processes, which include 'participatory urban appraisal', 'participatory learning and action' and 'community action planning', including 'participatory budgeting';
• Approaches promoted by international agencies, which have placed emphasis on urban management and specific sectors such as the environment, crime and disasters, as well as on partnerships and participation;
• New forms of master planning, which are bottom-up and participatory, oriented towards social justice and aiming to counter the effects of land speculation; and
• Planning aimed at producing new spatial forms, such as compact cities and new urbanism, both of which are a response to challenges of urban sprawl and sustainable urbanization.[8]

2.2.1. The monitoring and evaluation of urban plans

Urban planners and decision-makers need to know how best to use limited resources to address the complex urban challenges (and opportunities) that are presented. Urban planning seeks to be efficient (make optimal use of resources), effective (create desired and meaningful impacts and outcomes), and also seeks to enhance equity (of opportunity, rights and power, especially with regard to gender). To achieve this, decision-makers need a solid foundation of information and direction that can be provided by urban planning, specifically the monitoring and evaluation of urban plans. Urban plan monitoring and evaluation generates many benefits. Continuous monitoring and evaluation of plan relevance, integrity, and coherence helps decision-makers to make informed decisions about resource allocations. Monitoring and evaluation can demonstrate whether urban planning has made a difference, whether it has improved (or undermined) the quality of life and wellbeing of the city's residents, enhanced sustainability, or achieved related goals and objectives.

- Types of monitoring and evaluation

Given the rapid pace and extent of change in local government decision-making environments, there is a need for constant assessment of trends, activities and performance. This has led to increased interest in program monitoring and evaluation. Box 10 provides a brief overview of the key components of this process. The monitoring and evaluation process have been described in many ways. It is, however, possible to identify several core and common stages in monitoring and evaluation design:

- Formulate goals and outcomes;
- Select outcome indicators to monitor;

[8] Planning Sustainable Cities: Policy directions global report on human settlements 2009, Abridged Edition, p-6-7

- Gather baseline information on the current condition;
- Set specific targets to reach and dates;
- Regularly collect data to determine progress; and
- Analyze and report the results.

Organizational culture—Staff attitudes and demonstrable support from senior management and politicians are very important determinants of the success or failure of the monitoring and evaluation process. Therefore, the monitoring and evaluation approach must reflect the reality of the organization.[9]

In developed countries, there is considerable experience in monitoring and comprehensive evaluation of urban programs, especially in transportation, regional economic development, and environmental interventions. Central governments and more progressive sub-states or local governments typically require an assessment of program performance. The intent is to ensure that plans are relevant, strategic, and action oriented. There is also an expectation that regular evaluations will lead to outcomes and impacts that reflect good planning, and ensure compliance with relevant rules and policies. These evaluation processes are supported by an active monitoring process in which key indicators are tracked and information is assessed. There is less evidence of community/official plan-level monitoring and evaluation in developing countries. There are few resources for planning generally, and especially for plan enforcement or monitoring. In countries with reasonable planning capacity, the emphasis is typically on the production of comprehensive land-use plans, master plans, and urban design plans. The emphasis is on problem solving and implementation to meet short-term needs for housing, potable water, waste management, economic development, and infrastructure. Urban planning in this context is often adversely affected by governance problems caused by political instability, and a sheer lack of social and fiscal capital, technical capacity, and institutional instability.

There is, however, considerable evidence indicating the usefulness of participatory monitoring and evaluation approaches. community participation has proved to be an important element in all parts of the urban planning process, including monitoring and evaluation. Participatory urban appraisal and participatory budgeting in particular have proved very useful to achieve the '3Es' of good planning practice — efficiency, effectiveness, and equity. Increased transparency, increased sense of ownership of the development process itself, and increased flexibility to adapt by learning from experiences during plan implementation, are among the main positive outcomes of participatory monitoring and evaluation. The experience with the use of citizen report cards in Bangalore, India, shows the effectiveness of involving the users themselves directly in monitoring and evaluation. Although there has been very little progress in embracing monitoring and evaluation as integral parts of the urban planning process in the formerly communist countries of Central and Eastern Europe, there are some indications that this may change in the future. The participation of such transitional countries and city governments in internationally funded programs and projects has made public institutions in participating countries aware of the need to enforce transparency and accountability in all their actions related to the use of public resources.

In most cases, numerous potential indicators can be identified for each key issue. As a considerable effort (and cost) may be involved in the collection and maintenance of data for indicators, it is essential to be highly strategic in the choice of a limited number of indicators that specifically support urban plan monitoring and evaluation efforts.

In many developed countries more gendered statistics are being produced at the level of central government. However, such statistics tend to be based on existing data sources which historically may not have taken full account of specific gender issues. Gender statistics need to relate to policy goals and indicators of success. Gendered indicators are important in that they can help drive and focus

[9] Planning Sustainable Cities: Policy directions global report on human settlements 2009, Abridged Edition, p-61

implementation. Unfortunately, gender is often not considered relevant to high-level indicators. The result is that there are no criteria to assess whether policies and projects promote gender equality. Performance measurement in urban service delivery is a key policy issue for international development agencies, and for progressive developing countries. Users of public services can tell governments a lot about the quality and value of the public services provided. The city of Bangalore, India, uses the 'report card system' to demonstrate whether and to what extent its services have been delivered.[10]

It is important to note that most urban plan-based monitoring and evaluation has occurred in the cities of developed countries. These are places that have a reasonable base of finances and technical planning expertise, political stability, sophisticated governance structures, and comparatively manageable rates of urbanization. The scale and type of challenges is significantly different from their counterparts in developing countries. Furthermore, there has been little critical analysis of these urban plan monitoring and evaluation experiences. This means that there is not yet a good sense of the range of experiences, positive and negative, with urban plan monitoring and evaluation. However, it is possible to learn from the existing body of knowledge and limited experience to identify some key, common lessons for practice. A key challenge, and a common argument against introducing plan monitoring and evaluation, is the lack of adequate resources – money, technical services, and trained professional staff. This is a real issue in most developing countries, and in some developed countries as well. Many local governments struggle to deliver basic services. In that context, a comprehensive urban planning function is not possible, let alone a sophisticated system of plan monitoring, evaluation and indicators.[11]

Figure 5. Successful implementation of mega-projects requires monitoring and evaluation before, during and after implementation (www.burjkhalifa.ae).

The purpose of this concluding chapter is to suggest a new role for urban planning. In many parts of the world, a paradigm shift in urban planning is required to ensure tolerable urban living through the next

[10] Planning Sustainable Cities: Policy directions global report on human settlements 2009, Abridged Edition, p-63

[11] Planning Sustainable Cities: Policy directions global report on human settlements 2009, Abridged Edition, p-65

century. This chapter firstly identifies the main urban issues in various parts of the world to which planning will have to respond. The third section following from the second section draws out the main elements of more positive urban planning. What is identified here are the main principles of innovative planning, although the actual form they would take will be influenced by context.
The fourth section identifies the changes which would need to be in place, or the initiatives which might be supportive in promoting new approaches to planning. The last section provides the conclusion.

2.2.2. Infrastructure and technology in urban planning

Urban planning and design with natural disasters and social pressures provide energy, telecommunications, water, electricity, and transport with the help of new knowledge and advanced technology. Firzli and Bazi define "infrastructure is the basic physical and organizational structure required to operate a society or business, or the services and facilities required for the functioning of the economy" (69 Firzli and Bazi, 2013). Urban infrastructure is known in two groups: soft and hard (70 Portugal-Perez and Wilson, 2012). Hard infrastructure refers to the large physical networks required for the functioning of modern industrial cities. Soft infrastructure refers to all organizations required to support and manage infrastructure and standards. Whereas "soft" infrastructure refers to all the institutions which are required to maintain the economic, health, and cultural and social standards of a country, such as the financial system, the education system, the health care, the system of government, and law enforcement, as well as emergency services. The hard infrastructure consists of physical water supply and distribution systems, sewage networks, transport networks, energy and power networks, and telecommunications networks that provide access to the functional and livelihood infrastructure of cities (Hosono, 2013). Water is a major concern in Iran, and city planners and designers must plan the supply of water resources to all cities. As proposed by Elizabeth Shaw, water supply, distribution, and management include:

- Water supply coming from underground reserves, surface resources, and precipitation
- Distribution networks for handing out the water between drinking, agricultural, and industrial consumers.
- Necessary infrastructures and installations to supply, depot, distribute, consume, and manage the waters.
- Financial, logistic, and human recourses for example the needed professional software and knowledge" (Shaw, 1988).

The hydro-social change balance as Merret defined is a soft infrastructure to manage the water supply and distribution network. "A set of accounts for hydro social water flows in an area in the balance between two periods" (Merret, 2002). Merret's definition of a hydro-social change balance describes the volume of water supply and uses in a given city at a certain time. The balance purposes to manage the water resources optimally. Transportation and traffic infrastructure are vital in every city and region. Some parts of a traffic network are included in hardware infrastructure and others are software. In this discussion as Fulmer suggests we propose three significant parts of a generic traffic and transportation network.

i. "Networks: They are basic necessary installations for movements. They would be streets, roads, freeways, railroads, airlines, water lines, canals, pipelines, terminals, airports, train stations, bus stations, cargo storage, truck terminals, fuel stations, and harbors.
ii. Transport instruments: They are machines, automobiles, cars, trucks, airplane, helicopters, trains, ships, bicycles, humans, and other tools that travel on the infrastructures.
iii. Operations refer to the actions, which cause functioning of machines and services: It refers to methods which offer precise and continuous functions of infrastructures and machines as well like financing, regulations and police "(Fulmer, 2009).

To plan and design traffic infrastructure of the cities we need to supply the three parts that Fulmer suggested. Planning must include urban traffic engineering as well. As Homburger and Perkins outlined the fundamentals of traffic engineering are: "The method of traffic engineering uses engineering techniques to meet the safe and efficient movement of people and goods on roadways. It focuses on studying and construction of the infrastructure necessary for safe and efficient traffic flow. These are road geometry, pedestrian lines, cycling lines and facilities, streets, highways, traffic signs and terminals", (75 Homburger, 1992). New technologies and advanced digital devices are needed to solve the urban traffic and transportation problems in the cities. Electronic and digital communications infrastructure is a part of urban planning and design. Planning and building of electronic town are functional economically and with less pollution and traffic, suggesting that the electronic new towns are better places for living and working. Cohen and Elimicke define an electronic new town as:

"An electronic city is a place there, every inhabitant access to municipal services, banking services, educational services, medical and other services every day round clock securely, safely and secretly", (Cohen and Eimicke, 2001)

The urban planners shall supply required infrastructure to build an electronic city. Jalali listed the communication facilities to plan an electronic new town as:

"Communications services are bases to project a new electronic town. The following Actions shall be made to give foundations to an electronic new town:

- Postal services including sorting and distribution facilities
- Telephone and mobile phone networks
- Television and radio transmission stations and cable television physical networks
- The internet including the internet backbone, core routers, servers and undersea cables
- Communication systems including satellites and transmitter stations.
- Major private/ government/ dedicated telecommunications networks such as those used for internal communication and monitoring by major infrastructure companies, by governments, by the military or by emergency services. (Jalali, 2003).

And renewable natural energies. In Iran energy infrastructure like transportation and water shall be made of three main components as follows:

I. Resources that give needed energy for the functions and services of the city.
II. Abstracting energy from the resources and distributing them to different nodes of the urban life and activities.
III. Planning, designing, building, controlling, managing, and monitoring of the energy infrastructure.

Peter Droege in his newly published book focuses on the urban energy transition. He discusses the novel trend in Australia for using new technologies in renewable clean natural energies instead of traditional fuel energy. When Scandinavian countries like Sweden and Denmark take benefit of a diversity of resources to supply urban energy infrastructures Iran's cities have more possible sun and other natural resources to supply energies. However, Iran counts almost totally on underground fossil/oil resources. Denmark has well managed institutions in research and design, and produce new technological machines to produce energy from earth, seawater, wind, and sun. Sweden outlined its present energy policy in the late 1990s. The government wanted to promote efficient and sustainable energy use and a cost-effective energy supply.

The Swedish energy policy rests on the following cornerstones:

- Large amount of renewable energy
- High power consumption and low emissions
- Biofuel provides heat and power

- Renewable electricity
- Fast growing energy source
- Alternative fuels
- Cleaner transportation
- Using rechargeable cars
- Conserving energy in industry
- End to energy-wasting products

Sweden has built new plants to generate and combine heat and power for a further 12% of the electricity output mainly by bio-fuels. Urban planners and designers in Iran need to learn the new programs and technologies on different urban and regional infrastructures and must use them for better urban planning and design outcomes.

2.3. Assessing and communicating urban sustainability (Case study: Chur-Switzerland)

Sustainability assessment (SA) in urban areas requires the measurement of economic, ecological and social parameters in order to engage stakeholders and to develop policy implementations. A number of approaches have been developed and implemented to assess sustainability. These are measuring either a larger number of independent multi-criteria indicators, attempting to assess detailed economic, social and ecological data; or they calculate composite indicators, attempting to measure the systemic effects in the interplay of economic, social and ecological data aggregated into one figure. However, any urban sustainability assessment tool needs to provide both detailed and relevant information for policy makers, and understandable and motivating information for inhabitants, businesses, visitors and other stakeholders, who are needed to support sustainable development with their taxes, votes and actions. A joint currency' is missing that is capable of reducing the complexity of SA and that allows for better stakeholder communication, though still provides sufficiently detailed information for policy makers.

- How to measure something that is complex, dynamic, and highly subjective?

The integration of an individual 'understanding' or 'mental model' of sustainability (Luthe and Wyss, 2015). Is of high importance for an integrative assessment approach, because the transition towards a sustainable society is based on behavioral change of the relevant stakeholders. Although authors in sustainability assessment increasingly recognize the importance of stakeholder values and perspectives for the success of integrated sustainability assessment processes, the unravelling of how an individual understanding or mental model can inform the selection and development of appropriate sustainability assessment tools remains a research challenge (Gasparatos and Scolobig, 2012).

At the end, it is a human decision what balance between ecological, social and economic aspects is supported. We thus need to engage stakeholders and provide them with the necessary baseline of quantification for their opinion building process.

- The CERCLE multicriteria assessment tool

The CERCLE sustainability indicators have been developed for Swiss cantons and communities in the years 2003-2005. Currently there are twenty cantons and eighteen municipalities participating in their assessment. The CERCLE consist of 30 indicators measuring economic, social and ecological aspects. The results are visualized and communicated online, but not targeting the public (figure 6); it rather is a tool to inform policy. Single (multi-criteria) indicator approaches have been most commonly applied in assessing

sustainability in urban areas, and a major lack of such tools is that the resulting list of rather independent parameters cannot reflect their interaction in a system understanding (figure 6).

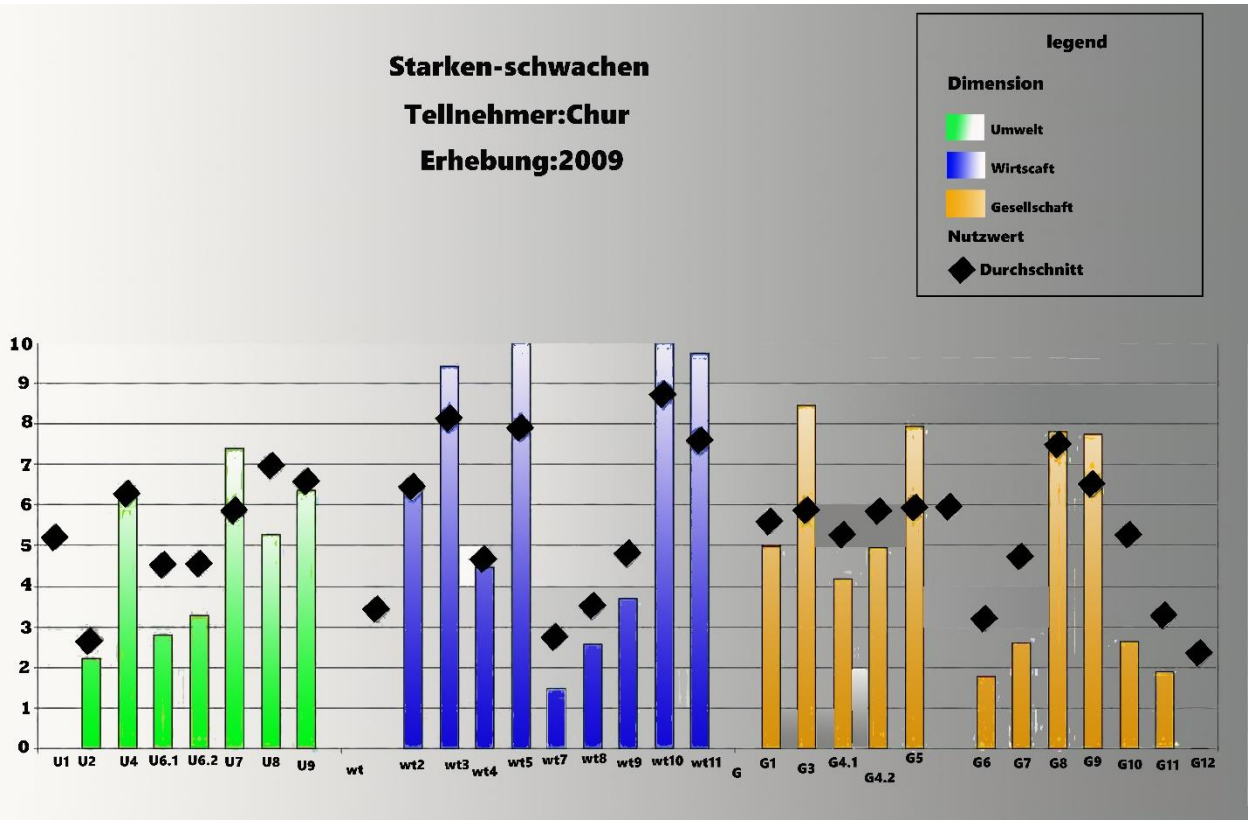


Figure 6. The circle indicator set for Chur (https://www.researchgate.net)

- The Ecological Footprint for cities

The Ecological Footprint (EF) as another quantitative approach is a composite indicator that sets the needed and locally available, biocapacity-based resources into relation to the ecosystem capacity to assimilate the residuals of human consumption and re-introduce them into the biosphere. The EF calculation is partly based on economic consumption data and results in one single parameter of global hectares (Gha), an internationally used and comparable single unit in SA. The footprint may have advantages in accessibility and applicability, as well as in reducing complexity of SA, but may loose on accuracy because of many implied simplifications – social aspects are e.g. completely ignored. Data needed for calculation of the EF is based on country and regional data in the areas of household expenditure, price differentials, energy mix and its production, CO2 emission of industry and household, land use, and yields out of land use.

- The experiment – applying measurement approaches to the City of Chur

Chur is an Alpine town in Switzerland of about 40'000 inhabitants. We calculated the EF for its status quo (2012) as well as for two development scenarios (this is the first time that the EF has been measured for such a small city and present the results together with the CERCLE multicriteria indicator set for 2009 as well as for the calculated scenarios in participative stakeholder workshops. Both approaches are compared given their technical applicability and feasibility, their accuracy, and their capability to communicate and translate results into policy strategies in an underlying reflexive process. As part of this comparison, both

quantitative results were visualized and presented via flipchart and video beamer in order to test individual and collective understandings of the different approaches.

Figure 7. The city of Chur in the canton of Grison, Switzerland (https://www.researchgate.net).

- Technical feasibility and applicability

In calculating the indicators, we experienced some barriers for measuring sustainability in communities. It was difficult to find a city as a partner in developing sustainability assessment tools. Officials found it delicate to engage in public discussions on sustainability. Municipalities were internally not willing to dedicate resources to assessing such data, and often were neither ready to integrate sustainability assessment tools in the administration, nor to involve the public and communicate sustainability at all. Most municipalities we spoke to were not satisfied with internal (costs/efforts) and external applicability (complexity), which is the main reason why Chur did not participate anymore in the CERCLE indicators after their last assessment in 2009. Astonishing enough, there was no evaluation process from the Swiss authorities nor the cities in place to monitor the success and the application of the CERCLE in practice. The EF (Ecological Footprint) of Chur is with 4.31 gha/person lower than the one for Switzerland with 5.01 gha/person (figure 8). The main differences origin from the carbon intensity of the energy production (about 50% nuclear, 50% hydro in Chur in comparison to roughly 25% petroleum based, 25% nuclear, 10% gas, 10% hydro, and 30% other in Switzerland). The energy consumption data is mostly expressed in the household sector. The results translate in the number of 2.82 planets needed if everyone on earth lived like the Swiss average, while 2.4 planets were needed if everyone lived like Chur's inhabitants. Overall, the EF proved to be tricky to calculate. For Switzerland, the Swiss Federal Statistical Office (FSO) is a source where most of the required data for the whole country is available. Required EF data for a smaller entity (such as a small town) needs significant detail and is therefore not available at FSO (so that the amount of

working hours needed by one person were about 100 h, including internet research, telephone calls and mail shots). Many assumptions needed to be done due to a lack of regional or local data. However, the difference to the national EF of Switzerland is relevant and explainable (figure 8).

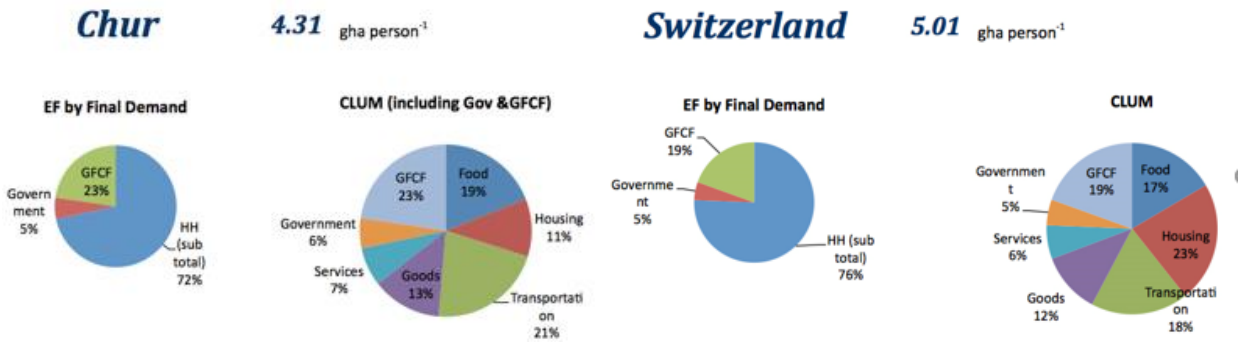


Figure 8. The EF for Chur (2012), compared to the EF for Switzerland, and the respective Consumption Land Use Matrices (https://www.researchgate.net).

- Findings from the workshops

Statements like “if you want to look at economic or social aspects”, “we have to consider a variety of aspects” and “sustainability is a rather multifaceted concept, which we should not reduce to consumption of resources” indicate that the focus group debaters see the EF as a SA system, which equals sustainability with consumption of resources and therefore as not sufficient to address the concept of sustainability as a whole. In this respect debaters often use CERCLE indicators to contrast and to clarify the one-dimensional character of ecological footprint.

Furthermore, comments such as “compares apples and oranges”, “weighting these indicators, that’s highly subjective”, “displaying all those indicators in the same way is simply wrong” and “CERCLE doesn’t show any interconnections” point to the fact that focus group debaters view CERCLE indicators as suitable to stimulate discussion about sustainability but as insufficient when it comes to mapping sustainability. This insufficiency, according to focus group debaters, arises from the fact that CERCLE treats all its indicators as isolated, independent components not considering whether a certain component has no relations to other components or whether it is closely related to others.

Figure 9. Workshop setup (https://www.researchgate.net)

Regarding the transmissibility of the results, focus group debaters have suggested that visualization of the EF using the earth (see figure 10) is rather “attractive,” “fully functional from an advertising perspective,” or “all education class people. “This is not surprising, as the founders of EF emphasize that the system is fascinated by its “intuitive intelligibility.” However, other comments “black box” and “concealment”, especially “potential dangers in the use of these earth visualizations” and “possible to share a very imperfect perspective on sustainability” “Are” indicates that this “advertising attraction” is considered important among certain focus group participants. While the CERCLE indicator raises the perception that sustainability should not be reduced to resource consumption, some statements point out that the visualization of ecological footprints may do the opposite. Visualization of ecological footprints is usually said to create a sustainability perspective, as well as ads that provide a fairly narrow perspective for each product, and are usually referred to as “social” (e.g., “health”, “equal opportunities”, “working conditions”).
Interestingly, one workshop participant argued that the visualizations” we used as stimulus material are to be considered mere illustrations, that is, visual representations of terminated considerations and not findings of a query run by means of the SA systems and – consequently – asked for an instrument, which may show and assess consequences regarding different urban design scenarios. Another comment addressed one of the main problems of urban planning tools: where to set the system boundaries? Some debaters argued that using the EF (as well as CERCLE indicators) in urban planning may lead to inadequate solutions. Several participants underlined the importance of being aware of the specifics of certain places and taking these into consideration. As an example, one participant put forward that the factors used by the ecological footprint, i.e. the consumption of drinking water, should be adapted to the location, which is assessed – as for instance Chur ‘drowns in drinking water’.

Figure 10. The EF results as planets as communicated in the workshops (https://www.researchgate.net)

Chapter 3
Smart city

By integrating the different characteristics of development (economy, environment, mobility, etc.) into self-sufficient or connected cities, smart cities, as advanced cities in terms of technology and sustainability in general, Improve the overall quality using life and performance. In addition, this can reduce operating costs and improve communication and engagement with citizens. Key sectors or areas that can be improved through technology include transportation, energy, healthcare, water, and waste. The idea is to create a sustainable and self-sufficient city using modern and useful technologies. This will allow us to do a lot of things such as direct traffic, inform residents about available parking and reduce gas emissions.

3.1. What is smart city?

Before checking out the details of a smart city, as an innovation, we need to understand the main conceptual elements. In fact, the first step to create a smart city is to understand its concept. A brief overview of the related literature in this area suggests that the concept of smart city is very controversial. In fact, the emergence of similar terms such as intelligent cities, the virtual city, the city of knowledge, the digital city, etc. has added to the conceptual confusion of this term (Schaffers et al., 2011). Smart Cities and the Future Internet: Towards Cooperation Frameworks for Open Innovation. The concept of smart city has developed in three main areas: 1. University, 2. Industry, 3. Government (Mosannenzadeh, Vettoratob. 2014). Academic literature holistic and comprehensive approach and according to the interest in the development of knowledge and information means smart covering of the whole range of features such as intelligent self-configuration, self-healing, self-optimizing and self-protecting (83 Nam & Pardo 2011). In industrial literature, with a tendency towards business and industrial tools, the concept of smart refers to smart services and products, artificial intelligence and thoughtful devices (Ibid). Finally, in government documents aimed at managing urban development, the word smart was interpreted in conjunction with the smart growth urban planning theory, which emerged in the early 1990s to avoid dispersed overlook. Despite this diversity, it seems that the use of technology and social innovation is the key issue in this concept. One of the most influential definitions in academic literature was given by the University of Technology in Vienna in 2007.
•The smart city is a city that is well versed in forward-looking ways in the six-personality (smart people,

intelligent mobility, smart governance smart life, smart economy and intelligent environments), which is built into a smart mix of fateful, independent, and informed citizens assets and activities (Mosannenzadeh and Vettoratob. 2014). While in the industrial literature, including the idea of IBM about the smart city, cities are considered as a system of systems. This company defines the smart city as a city that uses technology to modify its main systems and optimize the return of entirely limited resources (Habitat, 2015). But government literature focuses on the administrative and financial aspects of the smart city and on environmental goals such as greenhouse gas emissions. Generally academic literature has a comprehensive approach and covers a wide range of topics, mainly focused on improvement in three areas of governance, social development and the environment. From an industrial point of view, smart cities have emerged mainly due to the interaction between competition and sustainable urban development. In addition, sustainability and social development are the main goals of smart cities. Finally, government literature focuses more on international challenges such as life quality, economic growth, the environment, energy, sustainability, safety, health and mobility. (Mosannenzadeh and Vettoratob. 2014) defined the smart city as •Smart City is a sustainable and efficient city with high quality of life that its aim is confronting urban challenges (improving mobility, optimizing use of resources, improving health and safety , improving social development, support for economic growth and participatory governance) through the use of information and communication technologies in services and infrastructures, cooperation between stakeholders and key stakeholders (citizens, universities, government and industry) and capital investment in social capital (Mosannenzadeh and Vettoratob. 2014). Ku, et al defined the smart city as a community that teaches learning, innovation, and adaptability (Sinkiene et al, 2014). In the meantime, a number of similar terms with the smart city (wireless communities, broadband communities, digital communities, network communities, informatics communities and intelligent communities, etc.) emerged, which in some cases were used by different scholars instead of each other. These terms refer to the less inclusive and specific parts of a city, and the notions of the smart city often include them (Caragliu, 2009). On the other hand, an element that does not exist in these terms is people. People are the main actors in the smart city that form it through continuous engagement. For this reason, other terms are often associated with the concept of smart city. But all this suggests that communities have begun a conscious effort to understand and engage in a highly interconnected world (Albert, et al., 2009). Dawes and Pardo discussed that the components of the concept of a smart city are divided into three categories: technology, people and organization.

A city can be smart when investment in these three areas leads to suited that the concept of smart cities is not limited to technological advancements but seeks to reinforce socio-economic development (85 Nam & Pardo, 2011). Social inclusion is one of the key features of smart city (Allwinkle and Cruickshank. 2011), and any opportunity for economic development must be accompanied by investment in social capital (Scott, 2000). Orihi (2009) argued that, while there are different perspectives on smart cities, the idea that ICT is central to the future performance of the city is the central focus of all perspectives. Kommunnos (2003), Hollande (2008), Caraglio (2011) agreed that ICT is the main feature of a smart city, but this does not mean ignoring social issues, and technology does not automatically trigger intelligence. And people have a key role to play. An overview of various definitions shows the meaning of a multifaceted smart city. Each writer has emphasized on different aspects of a city. Thus, measuring a smart city is complex. Since each city has administrative, economic and social status and its specific geographic location, as well as different priorities; therefore, it is difficult to define a global steady system, due to the diverse character of cities around the world. On the other hand, the definitions raised by certain cities that call themselves smart are not universal. Therefore, it is better to maintain the original structures (smart city model) as the basis of conceptualization, and the city's specific definitions of smart based on their perspectives, preferences and content. Hence, a profound analysis of literature shows that in the definitions of authors, special emphasis has been placed on some concepts in the definition of smart city As the use of information and

communication technology in urban services and infrastructure, the integration of different systems in planning and implementation, the co-operation of different stakeholders at all stages of urban development, investment in social capital, independence in decision making, participatory governance, interconnection and integration , Creativity, learning and managing various local sources is the initial alphabet of smart city concept.

In fact, smart city “Identify the transportation challenges and needs of the citizen and business community and demonstrate how advanced technologies can be used to address issues in safety, mobility, and climate change, now and into the future and Determine which technologies, strategies, applications, and institutional arrangements demonstrate the most potential to address and mitigate, if not solve, transportation challenges identified within a city”. Smart city “support and encourage cities to take the evolutionary and revolutionary steps to integrate advanced technologies – including connected and automated vehicle technologies – into the management and operations of the city, consistent with the USDOT vision elements. Furthermore, smart city “examine the technical, policy, and institutional mechanisms needed for realizing the potential of these strategies and applications – including identifying technical and policy gaps and issues – and work with partners to address them”.

A smart city is often defined through its goals, and intelligent is defined as more efficient, sustainable, fair and livable (Alawdhi, 2012). The concept of smart city focuses on smart government, smart grids (smart energy), education, smart home, smart agriculture, internet of things, open data, smart retail, smart mobility, smart health. It also focuses on the city as a system with multiple subsystems (Chourabi, et al., 2012). This subsystem function as a whole ultimately allows the system to behave in an intelligent and consistent manner (Colldahi, et al, 2013). In other words, the city is a complex system of diverse and unpredictable interactions between its sub-systems. The goal of the smart city model is to find suitable solutions to manage this complexity, in particular by solving the negative consequences of global urbanization and the higher quality of life for urban populations. (Nam, and Pardo, 2011).

The ultimate goal of the smart city is to provide intelligent services in all of the city’s vital functions.

A look at the Smart City project in the world represents different goals, differences and similarities as follows:

1- Carbon reduction

2- Achieving energy efficiency.

3- Influence of ICT in the development of specific industries (in the field of multimedia or knowledge-based industries).

4- Achieving the highest quality of living environment for residents.

5- Developing green spaces within the city.

6- Developing advanced intelligence infrastructures.

7- Achieving economic growth and quality of life simultaneously.

8- Development of sustainable societies.

9- Ensuring social compatibility among different groups of residents.

10- The evolution of the city as a living lab for continuous improvement (Ojo et al., 2014); (Table 3).

City	Goals
Smart Amsterdam	“Focus on reducing carbon efficiency, energy efficiency and behavior change”.
Smart Malmo	“Focus on improving climate, and reducing greenhouse gases by 20%”.
Smart City of Malta (Malta)	“Becoming an industrial city with advanced information technology, skills development and staff training in the field of technology”.
Smart City of Masdar	“Becoming Smart Green City, Sustainable Development, Affordable Economic Growth, Providing High Quality of Life and Innovative Business Environment”.
Atlantic Planet (Plan IT)	“With the goal of building the greenest city in the world from scratch and an operational pattern for the new generation of low carbon dioxide cities, saving on construction costs and higher quality”.
Smart city of Singapore	“Developing urban infrastructure, becoming an intelligent island with advanced intelligence infrastructure around the world, connecting computers in almost every home, office, school and factory, enhancing quality of life and economic growth”.
Smart Curitiba	“It seeks to achieve sustainable development and the integration of the Curitiba metropolitan area and addressing the rapidly growing demand for urban services due to population growth and economic growth”.
Smart Sondgo	“Achieving a clever, green and self-contained urban environment that is environmentally friendly and energy saving is a key feature of it”.
Eco-friendly City of Tianjin	“It aims to be a model for developing cities in China that is socially compatible and environmentally friendly, protects resources and serves as a reference (reusable and scalable) for other cities”.
Smart City of Vokehama	“Addressing urban issues including pollution, traffic congestion, flood and waste Management”.

Table 3. Smart city goals in different cities, (Sinkiene, et al., 2014 and Albino, et al., 2015).

- Key Dimensions of Smart City

- The first dimension is: the use of a range of digital and electronic technologies for a cyber city, digital, information, or knowledge-based.
- The second dimension is the use of information technology to transform life and work.
- The third dimension is the introduction of information and communication technology in urban infrastructure.
-The fourth dimension, deals with: directing information and communication technology and people together to enhance innovation, learning and knowledge.

Gifinger et al. identified four components for the smart city: industry, education, partnership and infrastructure (Albino et al, 2015) Then they referred to the center for regional studies at the Vienna University of Technology for the six main components (diagram below) for the smart city, which has been emphasized by many authors in this area. The EU has ranked 70 medium cities on this basis. (Giffinger et al., 2008)

1. Smart economy is the main base of smart development and refers to the competitiveness of a city based on its innovative approach to business, research and development, entrepreneurship opportunities, productivity, flexibility of labor markets and the city’s economic role in the national and international markets.
2. Smart people, pertains to providing a high level of consistent education to citizens, as well as describing the quality of social interactions, cultural awareness, open thinking and the level of citizen participation in social life.
3. Smart governance, specifically addresses citizens’ participation at the municipal level. The governing system is transparent and allows citizens to participate in decision-making. ICT facilitates the participation of citizens and access to information and data related to the management of their city.

4. Smart mobility supports more efficient transport systems (for example non-motorized options) and drives new social attitudes towards vehicle use that guarantees citizens' access to public transportation. ICT boosts integrated productivity. Smart cities are seeking to promote the movement of people, goods and vehicles in a city environment.
5. Smart environment emphasizes the need for responsible resource management and the planning of sustainable cities. Natural beauty of the city can be enhanced by reducing greenhouse gas emissions and efforts to protect the environment. Smart cities promote energy efficiency, and the integration of technological innovation leads to productivity gains.
6. Smart living, seeks to improve the life quality of citizens through the provision of safe and healthy living conditions. Citizens in smart cities have easy access to healthcare services and care, electronic health management and social services.
Albino and Berardi (2015) have been reviewing key dimensions and smart city indicators since 2008 by various authors (Albino, et al., 2015), which are presented in the following. Many of the dimensions and elements that have been proposed by researchers in literature are often overlapping.

3.2. Theoretical foundations and research background

The term "smart city" and its root must be followed by the smart growth movement that emerged in the late 1980s and early 1990s and supported new urban planning policies (Harrison & Donnelly, 2012). Based on the smart growth approach, developmental decisions affect everything from personal life to communities and nations. In order to overcome the side-effects of development, intelligent growth strategies can help to maintain and develop health, safety, and more comfortable and attractive urban environments (Karadag, 2013). The smart city term was first used in Brisbane Australia and Blacksburg in the United States, where ICT supports social participation, reducing digital gap and access to services and information (9Alvarez, et al, 2009). Smart cities appeared as a tool for urban texture visualization. They developed slowly after the 1990s, but quickly evolved since early 2000 (Habitat, 2015). These infrastructure and services include buildings, transportation routes, electricity, water and sanitation infrastructure, and health and safety. In fact, since 2000, the Smart Growth Approach has given its place to the smart city, based on the advances in information and communication technology in planning, development, sustainability and urban services (94 (Harrison & Donnelly, 2011) And has since evolved from any kind of technological innovation in the planning and development of urban functions. (Alvarez, et al, 2009). Then many governments have found that they have access to sources of free information that has been obtained through a number of trading goals such as water billing, energy billing, tolls, and so on. This general perception has led to widespread use of technology and attention to smart infrastructure around the world (Harrison & Donnelly, 2012). The California Institute for Smart Communities was one of the first institutions to focus on how smart communities and cities are designed based on information and communication technology (Alawadhi, et al., 2012). Many major cities in the world, such as Seoul, New York, Tokyo, Chicago, Amsterdam, Cairo, Dubai, and Tokyo started the Smart City project. In addition, many international and industrial organizations have developed the smart city agenda. Survey of the existing study resources shows that the domestic study background in relation to the smart city is very limited, and the smart city in Iran is a completely new issue and has recently been raised and is in the early stages. In this part of the study some attention is paid to part of the existing literature and theoretical literature that is external.
In a paper titled "Smart Cities in Europe," focused on six major categories in a smart city "using network infrastructure, emphasis on business, social inclusion of urban residents in public services, creative industries, and with high technology, deep attention to the role of social and social capital in urban development and ultimately social and environmental sustainability" (Caragliu, et al., 2009) emphasizes that there is a positive relationship between urban wealth and the presence of creative professional forces

in a smart city. (Nam et al 2011) developed another framework for the conceptualization of smart cities. In their view, key factors are: technology, people and institutions. They again recognized that the dimensions of smart cities are: technology (as a tool used for innovation), organization (for innovation management), policy (for creating an enabling environment) and peripheral conditions (Nam & Pardo, 2011). Anastasiya (2012), in an exploratory work entitled “The Concept of Smart Cities; Towards the Development of Societies”, expanded the concept of smart city by exploring its different meanings, its potential and its key dimensions for the development of societies and pointed out that Broadband network development (telecommunication, satellite, cable, etc.) greatly enhances the potential of different actors (individuals, small businesses, institutions, and local government) that affects through providing access to information and knowledge resources throughout the city as well as a range of tools for connecting locally and globally. Part of this article is based on the experience of the city of Trikala, the city’s first smart city in Greece, and received by the ECF for three consecutive years (2009, 2010 and 2011) the top smart city award in 21 cities. In a research entitled “Understanding Smart Cities: An Integrated Framework”, (Chourabi, et al., 2012), while referring to different definitions in the literature of smart cities, cited eight key factors in an integrated framework for Smart Cities Initiative : (1.Management and Organization, 2.Technology, 3.Governance, 4.Politics, 5.People, and communities, 6. Economics, 7.Infrastructures,and 8.Natural environment). They considered technology as an intermediary that affects seven other factors (Chourabi, et al., 2012). The International Telecommunication Center focuses on the technological, human and institutional dimensions of smart cities in a feasibility study in February 2013 entitled “Smart Cities: Seoul’s Case Study” and deals with Smart city framework and concludes that urbanization imposes a growing strain on traditional urban infrastructure, and ICT provides a completely practical means of updating Due to the interdisciplinary nature of the search, it includes urban studies, public administration, information science and computer science.

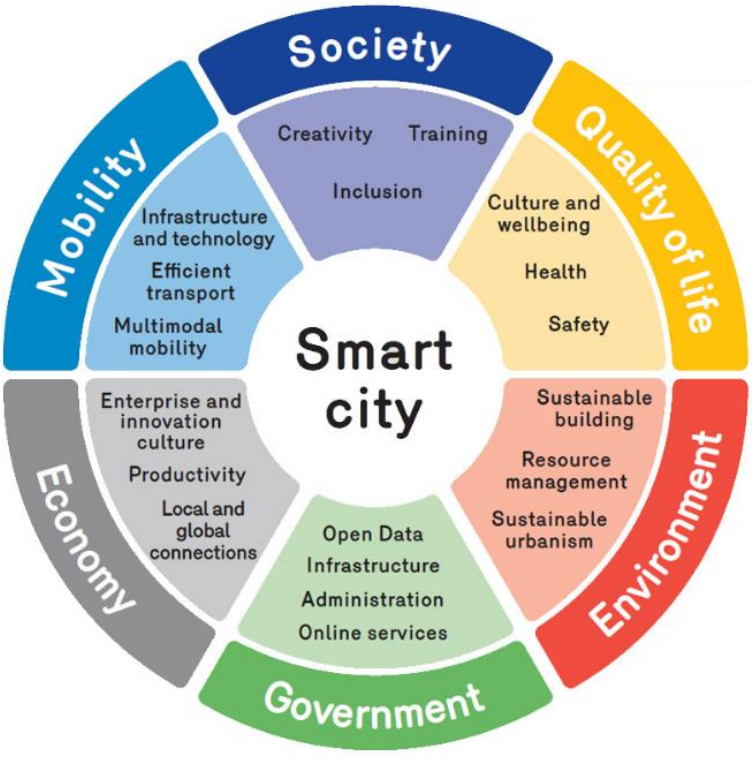


Figure 11. Smart city definitions (UN Department of Economic and Social Affairs, World Urbanization Prospects, 2011)

3.3. Smart City Indicators

For these six main factors (smart economy, smart people, smart governance, smart mobility, smart environment and smart mobility) researchers have cited 33 sub-sections for measuring them in the city (Table 4) Albino and Berardi (2015) have been studying the smart city indexes since 2008 mentioned by various authors.

Indicators of a smart city	Number of indicators
smart economy: "Public expenditure on R&D, Public expenditure on education, Per capita GDP of the city's population, Unemployment rate, . . ." smart people: "Percentage of population with secondary-level education, Foreign language skills, Participation in life-long learning, Individual level of computer skills, Patent a plications per inhabitant, . . ." smart governance: "Number of universities and research centers in the city, e-Government on-line availability, Percentage of households with Internet access at home, e-Government use by individuals, . . ." smart environment: "ambitiousness of CO2 emission reduction strategy, Efficient use of electricity, Efficient use of water, Area in green space, Greenhouse gas emission intensity of energy consumption, Policies to contain urban sprawl, Proportion of recycled waste, . . ."	60
smart living: "Proportion of the area for recreational sports and leisure time, Number of public libraries, Total book loans and other media, Museum visits, Theater and cinema attendance ,Pollution, Innovative spirits, CO2, Transparent governance, Sustainable resource management, Education facilities, Health, conditions, Sustainable, innovative and safe public transportation, Pedestrian areas, Cycle lanes, Green areas, Production of solid municipal waste, GWh household, Fuels, Political strategies and perspectives, Availability of ICT, infrastructure, Flexibility of labor market".	18

Table 4. List of indicators for smart cities assessment in some rating systems. (Ahmad Pourahmad et al.; 2018).

3.4. Approaches to smart city

Talking about smart cities, at the first needed to manage some technologies and solutions in the city:

- To set international standards in risk management
- To stablish data management methodologies
- To provide digital development for asset operators
- To have world class engineering with focus on smart city technologies and solutions
- To have an experience in providing software solutions to the energy and utilities sectors, highly relevant for developing smart city infrastructure.

3.4.1. The present framework conditions for cities

Evidence shows that the world is undergoing rapid urbanization. The speed has been unprecedented; the progress in the last 40 years is equivalent to the urbanization achieved in the preceding 4 000 years. Every day, urban areas grow by almost 150 000 new people, either due to migration or births. Between 2011 and 2050, the world urban population is projected to rise by 72 % from 3.6 billion to 6.3 billion. This means that the urban infrastructure needed to cope with this growth over the next 35 years will surpass the one built over the last 4 000 years. This pace of urbanization, coupled with a small decline in rural populations,1 is

expected to lead to an increase in the level of the population share in urban areas from 52 % in 2011 to 67 % in 2050 (UN Department of Economic and Social Affairs, World Urbanization Prospects, 2011) According to the United Nations (UN) urban and rural population datasets, the year 2009 marked the first time in history that the number of people living in urban regions exceeded that of people living in rural regions, while the UN-Habitat (UN-Habitat, 2012) projects that if the trends continue, 7 out every 10 people in the world will be living in an urban environment by 2050. Notably, migration from rural to urban regions is seemingly no longer the major cause, since today the greatest part of this growth occurs from natural urban population growth (UN-Habitat, 2012 and World Energy Council, 2010). The developed and emerging worlds are expected to experience significantly different urbanization patterns. In particular, the developed regions and countries (i.e. North America, Australia, New Zealand, Japan and Europe) have already attained very high levels of urbanization, often exceeding the value of 80 % and thus, have relatively small room for further increases in their urban populations. In contrast, the emerging regions of Africa and Asia are projected to experience a large growth in urban population over the course of the next four decades. By 2050, approximately 53 % of global urban population is projected to live in Asia and around 23 % in Africa (UN Department of Economic and Social Affairs, World Urbanization Prospects, 2011). The aforementioned regional trends illustrate that there are divergent urban growth patterns among major regions with different levels of economic development. Still, significant disparities in the level of urbanization can also be observed across different countries within the same region. For example, in Africa research has shown that countries experience different levels of urbanization, depending on, among other factors, their degree of economic development. This further highlight that urbanization is by no means a homogenous phenomenon and that the stage of national economic development can be critical in determining the pace of urban growth (UN-Habitat, 2012)

3.4.2. The key pillars for cities

All cities have something in common, in-as-much as they all strive to achieve three objectives, presented here as city sustainability pillars. The first is economic sustainability, i.e. a dynamic, productive city with numerous business opportunities generating wealth. This requires from the one hand high productivity and wealthy cities and healthy and well-financed public services. The second is social sustainability, guaranteeing access by all citizens to basic services and avoiding social exclusion. The third is environmental sustainability, guaranteeing environmental services and a healthy living environment. We also note an additional challenge which is financial sustainability, which simply means achieving the objectives of the city based on a financially sound plan, ensuring that the costs are fully covered and the city is not at risk of insolvency.

- Economic sustainability

By economic sustainability, this paper refers to the business environment and wealth generation capacity of the city. It is a proxy for gross domestic product (GDP) growth, but encompasses wider criteria than just GDP. Population growth, the quality of private undertakings, the attractiveness as in investment location as well as the ability of city authorities to tax the citizens for public services, all depend of the city's ability to attract business and capital. The development of smart cities, the financing of change and the fullest adoption of innovations by city inhabitants, require an understanding of the economic fabric of the city and the market for smart solutions. Understanding the market allows for the development of new approaches to infrastructure financing, as well as influencing citizen's behavior through those approaches. For cities requiring public private partnerships (PPPs) and systems of cost recovery using user charges, this knowledge is of paramount importance. Smart city services contribute to the economic sustainability and the resilience of cities to economic shocks, as those generate a new level of economic diversification.

Economic sustainability is also closely linked to financial sustainability, particularly in the wake of the financial crisis. Many cities have seen their access to capital curtailed and their credit rating deteriorate, while financial institutions have restricted the access to credit. Thus, even though well-designed investments in improved efficiency can make cities more sustainable financially, short term investment capital may be unavailable at the required scale. Nevertheless, investing in the city structures of the future can be done using novel financial models, which monetize savings and use them to finance the reimbursement of capital expenditures. In addition, the cities of the future are expected to have much more decentralized energy services and supply provision systems, creating new economic activities and allowing PPPs. The right models should be able to combine financial sustainability with higher investment rates. Depending on the circumstances of each city, the need for special support by donors, governments and international financial institutions may arise. Cities in richer countries with limited credit access may need state guarantees or guarantees by public financial institutions to help reduce the risk rating, and thus interest rate costs. Poorer countries may in addition need financial aid by donors and international financial institutions. Financial models need to be well designed, aiming ultimately at developing cost effective and sustainable solutions, and also at attracting foreign investment. Importantly, financing models must be based on solid cost benefit analysis, including wider socio-economic benefits where necessary.

- Social sustainability

When large numbers of people live in agglomerations, actual or perceived social inequalities and social exclusion of sections of the population can lead to social unrest. City authorities have a key interest to ensure social inclusion, which starts with a basic level of services for all citizens. In a smart city, it is important to take into account the risks of alienating important groups of citizens. This may happen because smart services are limited to richer areas of the town, or because user charges make many important services unaffordable for certain parts of the population. All models of development of cities have to ensure that public transport, water, sanitation, electricity, and telecommunications are affordable and accessible to all population groups. Citizens are also the ultimate beneficiaries and users of “smart” changes. Inclusiveness can be achieved by involving all relevant stakeholders from the start, and ensuring that new changes are understood and accepted, and thus inclusive. Smart city infrastructures or services need to respond to the following questions:

- Are the expected objectives of the planned changes taking into account real behavior of the city stakeholders?
- How can it be guaranteed that basic city services are affordable?
- Who is paying for the services? Are the users that can afford them the right target group?
- Can the new services and infrastructures be understood and used by all citizens targeted?
- Are the social and cultural values of the citizens taken into account? Smart city approaches strongly focus on technology and often rely on sophisticated applications. Badly understood or poorly implemented, they may be pursued for their own sake and divert cities from real issues (employment, education, crime, etc.). Ideally, smart city projects should be carried out only if they help cities to meet their needs, with a quantifiable added value facilitated by technology integration, usability or cost reductions.

- Environmental sustainability

Environmental concerns are growing in cities. Three pressures arise. The first is on resource limitations, such as water scarcity and quality, or fuel requirements. The second is on QoL and health. Not only are citizens and authorities more environmentally aware, but the economic implications of pollution can be serious, due to the impact on health and the attractiveness for businesses to operate from the city. The third is risk management and resilience to environmental shocks (such as heat waves and flooding caused

by climate change). One of the first stages to address sustainability is to increase resource efficiency in all domains, such as energy efficiency in buildings and networks, fuel efficiency in transport, water efficiency and new methods to transform waste to energy. Technology is not the only aspect required for sustainability, but is an important and necessary step forward. Efficiency gains can need significant investments, and the integration of different technologies can be complex. Resilience and risk management need to be integrated in city planning, based on estimated future risks. The smart city is essential and possibly our best bet to move towards sustainability. The integration of different technologies in the areas of ICT, transport, energy, water etc., which form the infrastructure backbone of cities, currently offers the best prospect for sustainability.

4.4.3. Same objective but different challenges, trends and needs

The future challenges of urban areas will depend on many factors, which will affect the kind of investments needed. Some factors will be linked to the geographical position and the exposure of the city to climatic events, e.g. exposure to impacts from a rise of sea level, flooding from changes in river flows, increased risks of heat islands, etc. Location may also create considerable constraints for the city. Many cities in developed as well as in emerging and developing countries are considering their hinterland in the planning phase, but some cities like Singapore or Honk Kong are highly constrained in their land resources. Finally, the level of migration to cities and the kind of existing infrastructure or building stock will determine if investments are mainly greenfield or brownfield. A green field approach is often related to emerging and/or developing countries, i.e. regions where new cities or economic regions are built from scratch. However, this approach can also occur in industrialized and developed countries where new districts and towns are planned in an integrated fashion. Examples are Songdo in Korea and Seestadt Aspern in Vienna, Austria. In the latter case, an entire new quarter of an existing city has been planned and built, leaving traditional frameworks behind. The brown field approach defines the process and the related actions to turn an existing urban infrastructure into a smart city/city of the future. In this case, key for success is the transformation/ replacement of existing infrastructures, taking into account the needs of citizens and the character of the city. In industrialized and developed countries this approach is the usual one. Due to the need to integrate or amortize existing infrastructures, the whole process could stretch beyond a decade. In terms of the final result, there are in principle no major differences between brownfield and greenfield approaches for smart cities as the definition and parameters of the final product do not change. However, the path and time to achieve the objectives can be very different.

- Demographic change and the implications for cities

Many challenges will come from within the city itself, and one of the key challenges will be demographic change and the impact of ageing. According to a recent study by the Global Cities Indicators Facility (Global City Indicators Facility, 2013), the number of people over 65 years of age will increase by 183 % globally in 2050 compared to 2010, with astonishing spikes expected in certain regions. In West-Asia and North Africa the increase is expected to be of 366 %. In 2045, the projections show that elderly people will outnumber children under 15 for the first time in history. The countries with the largest shares of elderly population will still be Europe and North America, but in Asia-Pacific and Latin America the shares are expected to be similar in 2050, which means a stronger increase in percentage terms.
The report highlights how vast the implications for cities are in terms of physical planning and design, and in terms of economic repercussions. Cities are responsible for 70 % of the world GDP, and the impacts of ageing on productivity, labor supply, income security and housing security bring important political and economic policy challenges to cities.

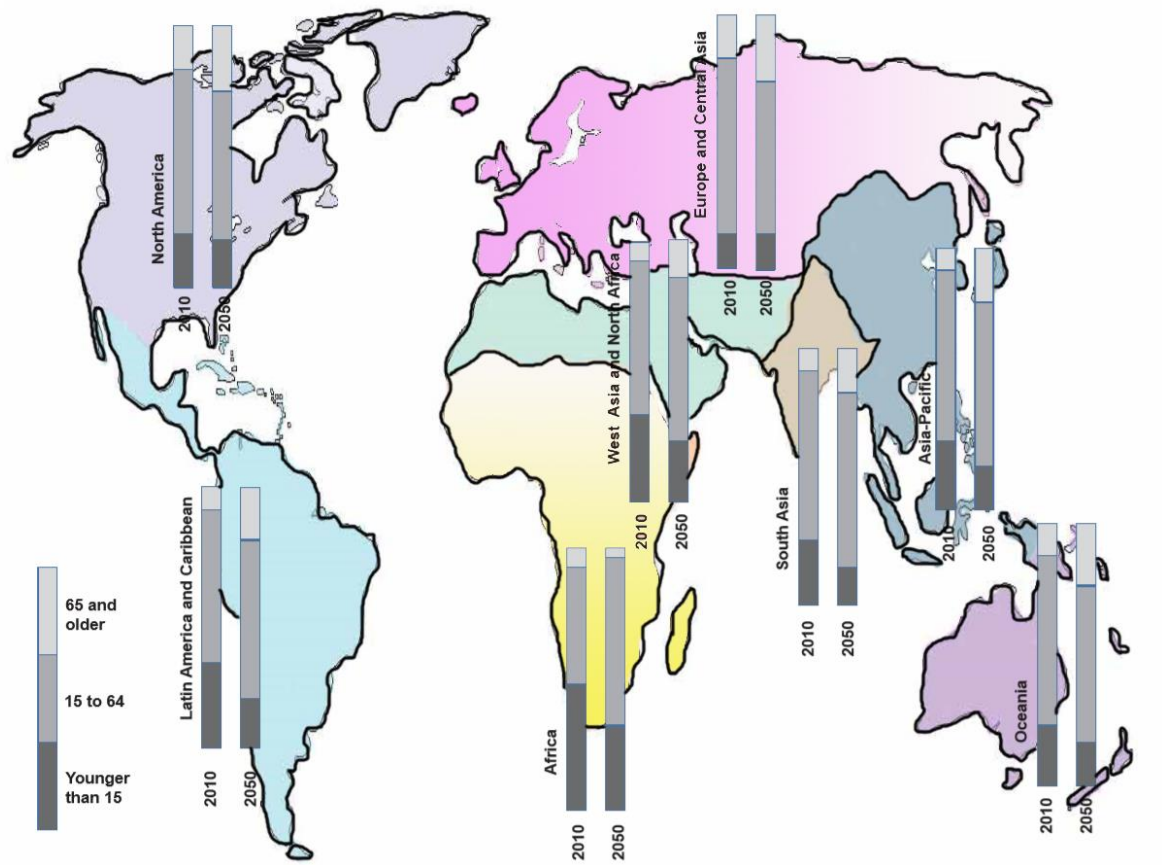


Figure 12. Population distribution by age cohort and world region [2010-2050], (Global City Indicators Facility, 2013).

- Economic development and the financial change

Urban productivity is considered to be of key importance in determining the prosperity of any city, as it reflects the efficiency with which a city uses its resources to produce outputs that can generate additional income and thereby improve living standards. This is the reason that GDP per capita is generally used as a leading indicator of urban productivity. The use of GDP as a leading indicator of urban productivity and prosperity has been criticized for not addressing other notions of urban well-being such as QoL, social cohesiveness, environmental sustainability and availability of opportunities for business and residents (Moffat, et al., 2012 and UN-Habitat, 2012). However, the limited availability of data is considered to be one of the principal reasons for not adopting a broader concept of productivity, which would incorporate other factors of production, beyond land, capital and labor, such as human, intellectual and social capital (100 UN-Habitat, 2012). Urbanization has generally been accompanied during the past 50 years by an increase in national productivity, as measured by GDP per capita. This increase in productivity is important to facilitate the necessary investments in smart solutions. As was mentioned above, smart solutions can generate new opportunities and reduce costs through economies of scale. Appropriately tailored solutions for cities using new innovative financial systems can produce economic results that outweigh investments. However, this positive link between urbanization and national productivity has not been confirmed in all cases, as some low-income countries underwent rapid urbanization although their GDP per capita remained rather stable or even decreased (UN-Habitat, 2012). This is a worrying trend, as the likely repercussion is the appearance of considerable urban poverty and the incapacity for authorities to invest

in basic infrastructures ensuring the access of basic services, such as water, sanitation, health, food and education, thus fueling poverty. Responses to such situations are needed with tailor made interventions in line with the economic circumstances and the needs of the towns.

3.4.4. Examples illustrating a different mix of challenges

This section illustrates how complex and different the challenges are that cities face in different parts of the world. The speed of urbanization, levels of social inequality, infrastructure needs are highly different and complex. Four examples in four continents are presented below for comparison.

- Beijing

Beijing is a city example that illustrates the sheer scale of China's urbanization. From 2000 to 2010, the city's population increased by 42 %, reaching the population number of around 20 million residents, while China saw its population increasing by only 6 % during the same period. This rapid urbanization trend together with the huge investments in infrastructure has increased the city's global influence and economic competitiveness (Brookings, 2013).

Still, a number of challenges have emerged for Beijing in response to this massive urbanization process. Low air quality affects the quality of its residents (UNDP et al., 2013) and the city has been ranked by the World Health Organization (WHO) in 2014 among the most polluted places across the globe. Despite the city's investments in subway systems, an increase in private car ownership, fueled by the increased living standards among others, has led to significant congestion problems (McKinsey, 2009). The city has furthermore faced shortfalls in the supply of energy resources (McKinsey, 2009) as well as difficulties in managing the supply and demand for water (UNDP et al., 2013). Added to this, the huge population expansion of the city has been accompanied by rising income and wealth inequalities (106 Brookings, 2013).

- Nairobi

Nairobi's population increased from around 1.3 million in 1989 to about 3.2 million in 2009 (Kenya, 1989 and 2010) reflecting Kenya's high levels of urbanization. However, as the city expands, it faces difficulties in supporting its citizens with adequate education and healthcare services. Due to the high levels of poverty and absence of appropriate urban planning strategy, people are often forced to live in slums where they lack access to basic services such as clean water supply, sanitation and waste collection (UNEP, 2009). A combination of factors such as lack of appropriate infrastructure, insufficient use of technology and weak enforcement of traffic regulations is responsible for a huge congestion problem which in turn creates a loss of productivity, air pollution and has an impact on citizen QoL (UNEP et al., 2007 and IBM East Africa, 2012). The unreliability of energy supply also poses a threat on the city's businesses, often having an effect on their capacity to compete with companies located in other African countries. Improving safety across the city presents an additional challenge that requires the successful integration of multiple public and private information systems to improve the flow of information in case of fi re, medical and security emergencies (IBM East Africa, 2012).

- Boston

The city of Boston has put forward the ambitious climate change targets of reducing greenhouse gas (GHG) emissions by 25 % by 2020 and by 80 % by 2050 (City of Boston, 2007 and 2011). Transportation is one of

the sectors that holds significant emission reduction potential as it is responsible for about 25 % of the city's GHG emissions, of which the majority comes from automobile traffic (City of Boston, 2007 and 2011). To accelerate progress towards reducing its emissions from the transport sector, the city needs to make the best use of the various collected transportation data which are available in a range of different formats and are often scattered over several departments. In particular, the city faces the challenge of improving the alignment and aggregation of data from several sources in order to enable easy access to key information by various possible users such as transport and urban planners, researchers and policy-makers. This will also help citizens avoid traffic congestion as well as make more intelligent travel choices (IBM, 2013).

- Glasgow

Glasgow, with more than half a million residents, is the largest city of Scotland and the third largest city in the UK (National Records of Scotland, 2014 and IBM, 2011). The city hosts about one quarter of Scotland's largest businesses (Reed in Partnership, 2009) and is among the top European financial centers (IBM, 2011). However, although the city offers many economic opportunities, it also has many income and health inequalities (Glasgow City Council, 2008) as well as some of the most deprived areas across Scotland (IBM, 2011). Aside from the economic disparities, the city faces the major challenge of alleviating fuel poverty which has a major impact on social sustainability. The rising energy fuel prices, the low quality of houses, the difficulties in accessing the energy meters in many houses and the lack of understanding among citizens of energy-saving techniques have been cited as among the causes of this problem (IBM, 2011).

3.4.5. Worldwide standards as facilitators to develop tailor-made solutions

Smart cities are a necessity, and improving the framework conditions of cities to accelerate change is needed. As shown above, different cities will thus require different approaches to their smart development. Smart development requires solutions to be adapted to the specific needs of the city and its citizens. Technologies can be adapted and combined in different ways to address multiple situations. Worldwide standards would considerably facilitate the development of tailor-made solutions adapted to different circumstances. There are unfortunately still many gaps today, thereby creating a barrier to technology integration, technology transfer and thus the replication of good practices. The next section will make the case for the need to integrate infrastructures further to generate value for the cities and citizens, followed by an analysis of the essential role of standards and also the need to reform how these are created and communicated.

3.4.6. Value creation for citizens through smart cities

The primary function of cities is not only to house citizens, but to offer them better opportunities to develop their personal and entrepreneurial potential. Cities have to provide the right environment, backed by efficient and affordable services and infrastructures. Smart cities have to be inclusive and benefit citizens, or will otherwise fail to be smart. Smart solutions are not to be seen as a cost to the city, but as an investment, and need to be planned and implemented as such. Developing smart cities is not only a process whereby technology providers offer technical solutions and city authorities procure them. Building up smart cities also requires the development of the right environment for smart solutions to be effectively adopted and used. One of the particularities of smart cities is the need to incentivize citizens to adopt smarter ways of living and interacting within and with the city. Citizens should also no longer be the users

of city services, but also the providers and developers of smart city solutions. The need to integrate citizens into the process of shaping the city means that smart cities cannot be built by decree, but need to naturally grow into the urban fabric. Many of the solutions do in fact need the active participation of city dwellers as users, consumers, service providers and de facto voters. This may not be through ballot boxes, but can also take place through their own actions, by adopting new forms of living and working. The need to factor in citizen behavior, places city authorities in front of a daunting challenge. First and foremost, the authorities need to develop a strategy, which takes into account the needs, objectives and the long-term development scenarios of the city. Second, they have to factor in that much of the developments will be out of their direct control. A smart city is expected to partially self-organize with private operators supplying services, data and even energy as prosumers (i.e. consumers and producers). Services are increasingly developed under public-private partnerships and integrated in complex systems. Thus, city authorities at all levels will have an important role to play that goes far beyond merely procuring technologies. Within the limit of their competences, they have to develop the right planning and incentive structures. They also have to launch intelligent procurement processes that take into account the wider objectives of the city in an integrated fashion. Through their capacity to act, city authorities can encourage – or hinder – social innovation, creativity and human interaction, employment and business opportunities. The regulatory framework is crucial, and the way city authorities organize their activities and procurement systems is a key element for the development of a smart city. As such, they need to act as a partner with industry, service providers, financiers and end users to build the smart city. In short, smart cities are complex and will ultimately be self-organizing and be run by city dwellers and private sector operators. Essentially, this means that the right markets need to be set up with the right enablers. Standards are essential enablers when developing a smart city by guaranteeing an expected performance level and compatibility between technologies. They open the door to a larger choice of products, increased competition and thus foster the innovation drive, benefitting both cities and their citizens. They facilitate the replication of solutions and propose common metrics permitting the comparative analysis and benchmarking of solutions.

- Smart infrastructure integration is essential to create value

The availability of smart solutions for cities has risen rapidly over the last decade. As a result, technical solutions exist for every city to become smarter. The challenge today is primarily to implement appropriate solutions efficiently, rather than only focusing on new technology development. Smart cities cannot be developed through a patchwork approach, but by the step-by-step adoption of incremental improvements. Smart cities are developed by introducing smart systems, working for the benefit of both residents and the environment. Urban infrastructures will need to better meet the challenges of city environments: energy and water scarcity, pollution and emissions, traffic congestion, crime prevention, waste disposal, and safety risks from ageing infrastructures. The increased mobility of our societies has created intense competition between cities for investment, talent, and jobs. To attract skilled residents, companies, organizations, as well as promoting a thriving culture, cities must achieve the sustainability objectives. This is only possible by becoming more efficient and integrating interoperable infrastructures and services. The efficient integration of electrical grids, gas distribution systems, water distribution systems, public and private transportation systems, commercial buildings, hospitals and homes is essential. These form the backbone of a city's livability and sustainability. The step-by-step improvement and integration of these critical city systems is the road to make a smart city a reality. This process has to be driven bottom-up combined with a top-down, data- and systems-centric approach. A smart city can thus be defined as an efficient,

sustainable and loveable system of systems, designed for and shaped by citizens, businesses, organizations and technology developers with the aim of creating added value. The movement towards smart city systems in cities opens the door to new services, new forms of economies of scale, a reduction in inefficiencies and waste and ultimately new business opportunities. There is a large potential to create economic value, but also to improve the living standards of citizens and create considerable social value. This is particularly important in the present economical context in which cities need to reduce operating costs and promote economic growth by identifying areas to invest in (Leterrier et al., 2013).

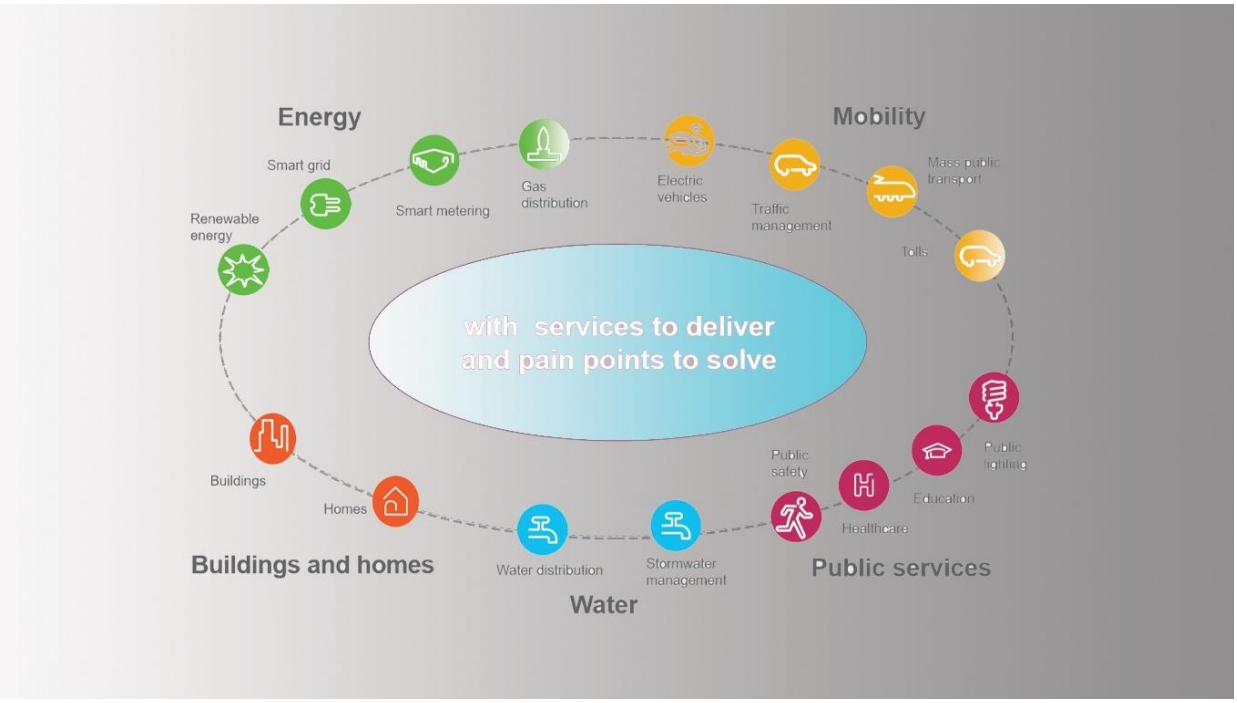


Figure 13. The operating systems making a city's infrastructure (Leterrier et al., 2013).

- Reducing inefficiencies

Huge inefficiencies are present in the cities that involve complex interactions from resource use, to consumption and waste. This is due to a historical, piecemeal development without cross integration. Systems and services enabling urban efficiency and sustainable management are already commercially available and continuously improving. For example, efficient and cost-effective urban energy infrastructure combines heat storage, electricity demand-side management and active network management. This system provides electricity generating capacity when required to support the electricity distribution network. Integration of smart technologies is already being achieved at all levels of the energy network, from power stations through distribution of heat and power to individual smart appliances and micro-renewables (Aecom, 2012). By the end of the current decade, many technologies critical to a smart city, including monitoring and sensor technologies, intelligent traffic systems and energy management systems for buildings, will have been deployed on every continent. A critical challenge is to ensure the pieces are combined and laid out correctly. This is why in addition to technology development and integration efforts; cities need to change their approach to planning and management.

- Generating new economic opportunities

The rate of technological progress has been very fast in recent years; new technological breakthroughs such as cloud computing, hyper connectivity and modern analytics are providing opportunities at affordable cost that could not have been foreseen just a few years ago. Technology can ignite new applications and services, and in turn, create better living and working conditions; citizens have now access at any time to powerful smart devices (The Climate Group, 2011). The challenge is to enhance living standards, improve social equity, and ideally enable more efficient responses from authorities to the city challenges at potentially lower cost. This creates opportunities for planners and administrations that go beyond managing construction, automation and use of infrastructure in cities. They can develop a cycle of innovation and economic activity generating business opportunities to provide new products and services to citizens.

- Planning the building blocks of a smart city

The most appropriate path to a smart city is for the community to define a sustainability vision and develop a practical, step-by-step roadmap and implementation plan. A thorough review of your vision, roadmap, and implementation plan is one of the most important tasks in the process and requires expert support. Identifying the most serious bottlenecks, deploying integrated, scalable solutions and leveraging these results for other smart city initiatives requires experience and strong technical and process expertise. This vision usually focuses on mid-term city goals, i.e. if a city wants to be 5-10 years in terms of efficiency, sustainability, and competitiveness, and even in line with long-term goals, For example, decarbonization by 2050. Once the vision has been formulated, city authorities need to start by improving existing basic operational systems such as electricity, water, transportation, and gas. Using a combination of connected hardware and software for measurement and monitoring provides a vast amount of information that can be analyzed by intelligent software systems. This data analysis allows cities to develop actionable information that promotes more effective and efficient services.

- Integrated city planning

Selecting and turning a suggested objective into something tangible requires a clearly defined master plan developed by city managers with the active consultation of stakeholders. Cities need to prepare an integrated impact assessment or similar based upon a clear process which takes into account multiple considerations in order to ensure most elements are covered, such as:

1-Fundamental analysis of the city: geographic, geodesic, population, living standards, etc.

2-Fundamental framework: objectives of the investments.

3-Spatial planning: usage of land (or district).

4-Construction planning: prepared by developers and generally selected through procurement processes.

5-Renovation: upgrade of existing buildings and infrastructures, combining modernization with preservation.

6-Impact assessment: economic impact, environmental monitoring, and various assessments.

7-Operation: operational requirements, human capacity requirements which the city services managers need to estimate.

One of the most important components of an effective and achievable plan for a smart city is to make it a comprehensive and cooperative process. No company or organization can build a smart city on its own. Also, it is not possible to create a smart city by law. In smart cities, services are formed by the actions of all city actors that change the role of citizens and city managers, such as the emergence of energy

consumers and the ability of individuals to use and provide data through smart applications. Developing the right kind of city requires a proper balance of interests between all stakeholders:

- Political leaders, managers and operators of the local government (city).

-The service operators – public or private: water, electricity, gas, communication, transport, waste, education, etc.

- End users and prosumers: inhabitants and local business representatives.

- Investors: private banks, venture capitalists, pension funds, international banks.

- Solution providers: technology providers, financiers and investors. Giving each of these groups a real stake in community development is critical to achieving the necessary acceptance of the change. Their concerns need to be carefully considered and approved, and ultimately the plans must be collectively approved. Without proper consultation, authorities will sooner or later face significant additional obstacles to realizing their vision. Unique smart city plans require collaboration with global technology providers and local organizations that are best suited for the specific system improvements required. The most powerful emerging smart cities are ones where solution providers work together, rather than compete, putting the political differences aside and bringing together the most comprehensive and best solutions. This means sharing information between city departments, destroying silos, involving global leaders with world-class capabilities, and local providers and stakeholders who know the city best. You. Incorporating citizens' ideas and ideas is important to identify potential problems. It can also help to gain public support and participation in smart initiatives. Involving the local college community, when needed, can provide additional impetus, innovative ideas, and support. Examples of citizens as prosumers (The Climate Group, 2011):

1- A resident that participates in a microgrid serving a smart city can draw and consume electrical power from the microgrid during high usage periods and can provide in return, electrical power from alternative energy sources, such as solar, wind or fuel cell during low usage periods.

2- Individuals providing information platforms, such as applications for smart phones, which citizens can then use to exchange information.

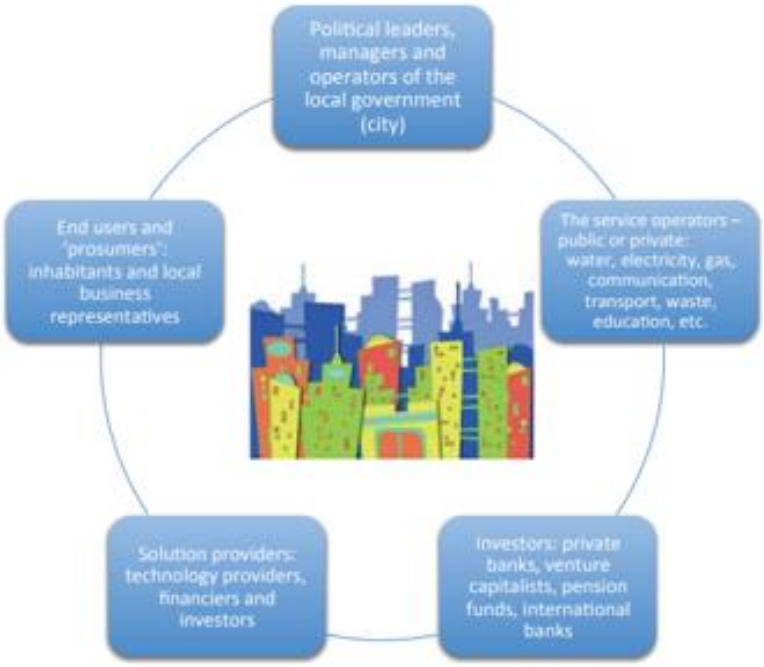


Figure 14. Stakeholders involved in shaping the city (The Climate Group, 2011)

- Strategic long-term vision vs short term objectives

In many cities long term success is built upon a variety of overlapping short term achievements which requires a delicate balance. City decision makers need to have a dynamic, constantly refreshed strategic vision for what the city will look like in the long term, and make sure that the various short-term projects and initiatives have a direct line of sight to the long-term strategic vision. Cities need to prepare a value case justifying why the smart city initiative is a good idea. The value case needs to investigate through an impact assessment the costs and benefits of the project areas identified as well as the economic, social and environmental impacts. City planners will require ways to assess new technologies and integrated solutions for their city. This may often require complex modelling tools that simulate the impact of potential solutions, as there is often a lack of relevant experience on the impact of a technology for a given city; one of those being visualization tools modelling the complex interdependency of systems in city simulations.

What is a visualization tool? An interactive digital model of the existing structure and dynamics of a city which can provide a set of "before and after" views, relative to the proposed infrastructure changes using a particular configuration and operation of technical solutions. A series of "what if" scenarios can be generated and used as inputs in making the choices of the technical solutions to be deployed.

The impact assessment can be subject to a scoring system to enable selection from competing options. The scoring criteria can include:

1- Applicability (e.g. integration into existing urban infrastructure, flexibility and regulation required).

2- Factors describing the likely impact of the initiative (e.g. CO2 emission reduction, affordability, potential for scale up).

3- Innovative nature (e.g. progress behind the state of the art and multidisciplinary approach). Annex A presents a possible scoring system based on a document released by the European Smart Cities Stakeholder Platform in 2013 (EU Smart Cities Stakeholder Platform, 2013).

- Linking short term value and long-term goals by metrics

Individual projects to improve urban efficiency and develop new services are usually developed at the sectorial or local level and can bring value by themselves while contributing to higher level objectives. Here are some examples:

- The monitoring of emissions and their impact on the city can lead to smart approaches to reduce them, potentially producing quick cost savings as well as delivering a number of associated long-term benefits.

- Smart traffic management together with smarter buildings, transport and waste management reduces air pollution. However, while the value of each project can be readily assessed on the sectorial level, it is less easy to understand the contribution of the project to the city's overarching objectives such as city-wide aims of economic development, livability, and environmental sustainability. Impact assessments should be used to quantify the short term and long-term value creation. Figure 3-3 illustrates that realizing the full value of a smart city requires an assessment of the value of positive externalities, economies of scope and scale, and the value of individual smart projects. This is a complex task as the outcomes of the former two arise from a combination of factors, are distributed across various different stakeholders and can often only be realized in the long term (The Climate Group, 2011).

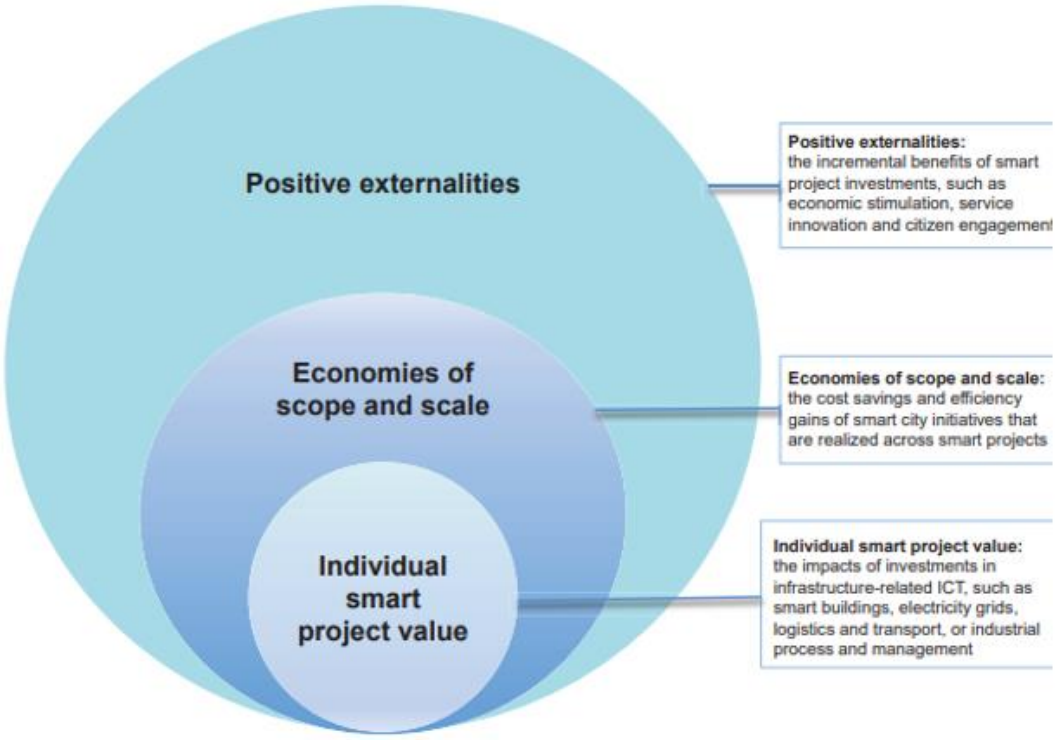


Figure 15. Layers of smart city value (The Climate Group, 2011)

To measure the wider contribution of projects to higher level objectives, a common and consistent suite of metrics can be developed to weigh up the contribution of individual initiatives, such as a smart buildings scheme or new smart technologies, to the city's long-term strategic objectives. These metrics should include not only the overarching criteria, but also the individual projects' indicators; this will help cities to monitor their performance (The Climate Group, 2011).

- Reaping the financial opportunities of smart cities

The major challenge to the adoption of new technologies is financial, as many cities today have been constrained to reducing their budgets. The revenue they have must first be allocated to essential operations and staff, and there is often little left over for upgrades, retrofits, and other improvement measures. The added need to often change existing incumbent infrastructure to introduce new approaches to energy, transport, water and waste management makes upfront capital expenditure (CAPEX) a serious concern for municipal budgets which are often higher than for traditional investments. This is because even if the operational expenditure (OPEX) costs are lower, many city administrations work on the basis of annual budgets which are ill-fitted to handle technologies with large CAPEX.

However, a large upfront investment is not a prerequisite for a smarter city. The most progressive smart city players are tapping innovative financial and business models to make efficient infrastructure a reality. There are a variety of models available to cities, such as fully funding, joint ventures to PPPs, and other similar models, which relieve the city from the upfront costs. It is also important that the development choices take into account the economic rate of return (ERR) which includes the socio-economic returns of investment. This means that user fees may neither be the only nor the best cost recovery method, as those fees cannot fully reflect the public benefits some of the technologies can provide. Public support may be needed to ensure that the solutions with the best returns for society are implemented; these may be in the

form of grants or publicly supported financial instruments, or in the case of developing countries, aid by international financial institutions or donors. New business models combining technology and a paradigm change are today under development and demonstration which might be supported by standards, for example:

- The increasing numbers of energy service or energy savings companies (ESCOs) which are commercial or non-profit businesses offering a broad range of energy solutions (e.g. energy saving project design and implementation, retrofitting, efficient and green energy supply solutions, energy storage, energy infrastructure development or risk management).
- Demand-response services: dynamic pricing, interruptible load- or dynamic-load capping contracts for industry, commercial businesses and households, participation in balancing markets, services aggregating and optimizing demand for households. These increase system flexibility and reduce the need for generation capacity. They can reward consumers by enabling them to shift part of consumption to cheaper periods.
- Asset sharing: for example, electric cars or bicycles – they can be associated with other transportation means (railways, tramways, etc.).
- Software as a service (SaaS) covering any cloud service where consumers are able to access software applications over the internet is another interesting model. These applications are hosted in the cloud and can be used for a wide range of tasks for both individuals and organizations.

- Risks of limited connectivity and collaboration

Lack of integrated infrastructures and city entities can create significant inefficiencies, risks, and will affect a city's economy. Developing integrated infrastructures with the support of integrated technologies can lead to a better service for citizens, but can also enhance the city's resilience to safety and security risks. Urban safety and resilience are becoming a central issue in debates about the future of cities. The observed increase in extreme weather events has revealed a number of vulnerabilities of present cities. An accident in one infrastructure, such as the rupture of water pipes can affect other networks. Future infrastructure has to be designed to be resilient to such events. This resilience requires a better integration of the infrastructures and more access to open data. Presently water, electricity and telecommunications infrastructure are managed separately by different operators. These operators do not communicate and are generally ignorant on the infrastructure of operators of other services. Under the city however, electric cables, water networks, gas pipes, telecommunication cables are sharing the same space.

In fact, the American Society of Civil Engineers (ASCE) calls for the better integration of infrastructures as crucial in a recent report (122 ASCE, American Society of Civil Engineers, 2009), highlighting the substantial unnecessary vulnerabilities the present state generates. Their analysis even implies that integration is not merely a technical problem; organizations responsible for critical infrastructures may inhibit a focus on safety due to their reluctance to coordinate. The ASCE lists four guiding principles for critical infrastructure:

1) Quantify, communicate and manage risks.
2) Employ an integrated systems approach.
3) Exercise sound leadership, management, and stewardship in decision-making processes.
4) Adapt critical infrastructure in response to dynamic conditions and practice.

The four principles above have important repercussions for city management as well as the need to design the appropriate standards. To qualify, communicate and manage risks, clear data collaboration practices need to be supported by standards on the data contents, quality and format. Employing an integrated systems approach requires the necessary technical and procedural standards that will allow integrated

systems to be deployed and managed. Standards need also to be designed to support the management and decision-making process. This means that standards should be well designed to support city planners, civil engineers, managers of services and ultimately those with the power to take decisions. Finally, standards have to ensure that infrastructures become responsive to dynamic conditions and practice. This means that long term infrastructure needs to be monitored and be adaptable to change. Here, the role of standards on monitoring, data processing and sensors and surveillance systems is essential to support the responsible authorities.

One risk of not having the appropriate type and level of integration of city infrastructures and services would be the simultaneous loss of electrical power, water supply, gas supply and telecommunication networks. When the different sub-systems do not have integrated backup power or control and operational systems, but are wholly dependent on a common power grid or communication network, they can become single points of failure.

3.4.7. Collaboration, integration, and interoperability enabled by standards

In the last decade we have experienced an explosion in technical solutions in the area of smart technologies, supported by a rapid increase in data. This means that while technological innovations are important, it is not the main driver for the development of smart cities. What is missing today is the appropriate framework conditions enabling the large-scale deployment of smart city technologies. This requires standards facilitating the communication between actors, technologies and systems.

- Management standards create a common communication tool; thus, different actors have the same definition for each part of a process. This is important in benchmarking, knowledge transfer, quality assurances, project assessments and collaboration between different operators and service providers.
- Data standards will be necessary to ensure that data formats are adapted to the different needs and include the necessary security levels. This is, for example, needed to ensure the correct level of anonymity of personal data.
- Technical standards that provide the necessary connectivity, expanding markets and opportunities. Without those standards, cities will remain a patchwork and the replication of good solutions limited. This can have serious repercussions for the economic and social development of the cities.

There is a clear demand for integrated collaborative approaches that are leading to a number of ideas coming from many SDOs and other organizations. The patchwork approach to smart cities development is reaching its limits. While the technology responses are accumulating, the transformation of cities is not following in the necessary speed and manner. Much of this is due to a lack of collaboration and clarity.

Many of standard organization initiatives have been launched. Among those is the IEC Systems Evaluation Group on smart cities (SEG 1). The purpose of SEG 1 is to summarize and evaluate the status of standardization in the field of smart cities (inside and outside the IEC and ISO), and to work out plans for new standardization work to be taken in IEC.

In 2012, ISO formed TC 268/SC 1 on smart community infrastructures. This SC published ISO/TR 37150:2014, Smart community infrastructures – Review of existing activities relevant to metrics. This Technical Report provides a review of existing activities relevant to metrics for smart community infrastructures. Additionally, ISO TC 268 published ISO 37120:2014 which defines and establishes methodologies for a set of indicators to steer and measure the performance of city services and QoL.

ITU-T formed a focus group on smart sustainable cities, SG 5, whose scope is to exchange knowledge in the interests of identifying the standardized frameworks needed to support the integration of ICT services

in smart cities; and ISO/IEC Joint Technical Committee 1 (JTC 1) also formed a study group on smart cities, SG 1, which among other items will study and document the technological, market and societal requirements for the ICT standardization aspects of smart cities (BSI PAS, 2014).

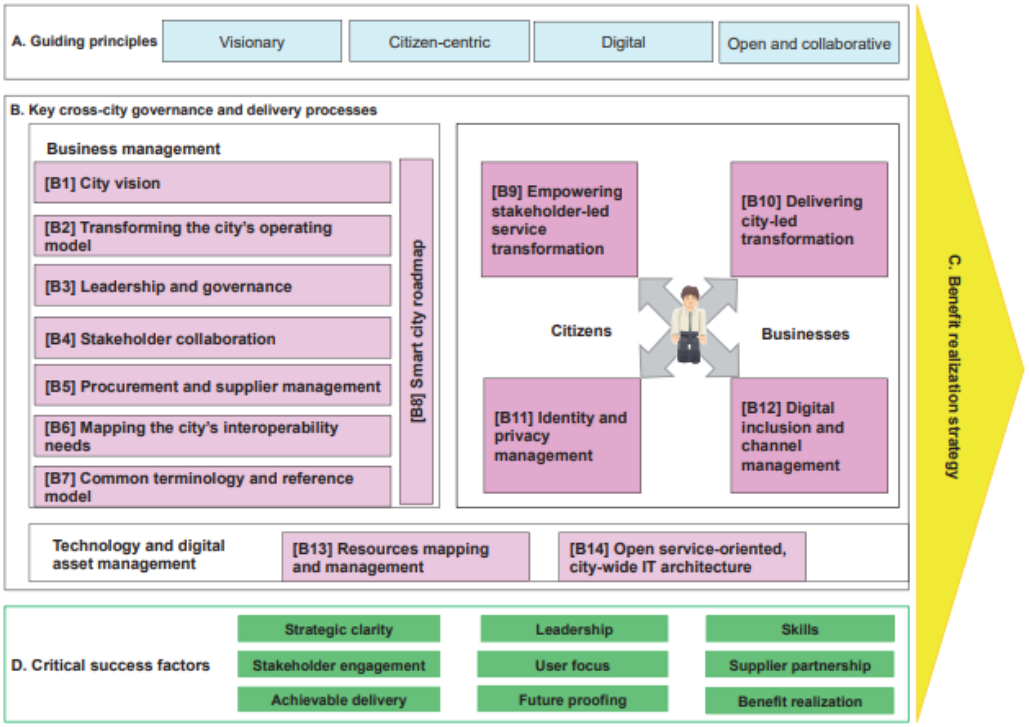


Figure 16. The smart city framework (BSI PAS, 2014).

Regionally, CEN-CENELEC-ETSI Smart and Sustainable Cities and Communities Coordination Group (SSCC-CG) is in place to advice on European interests and needs, relating to standardization on smart and sustainable cities and communities.

In the UK, BSI in collaboration with the Department for Business, Innovation and Skills has released in February 2014 the document Smart city framework – Guide to establishing strategies for smart cities and communities (BSI PAS, 2014), a proposal on regulation and standardization of smart cities, see Figure 25; In Germany, VDE, responsible for the daily operations of DKE German Commission for Electrical, Electronic and Information Technologies of DIN and VDE, published the German Standardization Roadmap Smart City in April 2014. In the United States, ANSI launched the ANSI Network on Smart and Sustainable Cities one stop shop, where city authorities and others can network in researching their standardization needs.

A number of other organizations are drafting specifications for smart cities. One of the most ambitious examples is the City Protocol program (City Protocol Society). This initiative, City Protocol Society, aims to provide guidance on the procedures (required standards) and legal frameworks necessary to achieve such partnerships. The City Protocol provides “The Anatomy of City Habitat” which aims to present in a common language the key features affecting city life. These are represented by three systems (structure, society and data) and eight sub-systems or thematic areas (environment, infrastructures, built domain, public space, functions, people, information flows and performance).

One of the keys aims of the City Protocol is to provide the first certification system for smart cities, developed with the guidance of over 30 organizations. The objective being to provide a framework for designing sustainable systems of systems integrating the numerous elements that creates the urban space. One message is increasingly emerging from many stakeholders, namely, that the time for experimentation is over. It is time for a coordinated approach and critical issues to tackle are integration, including interoperability, and collaboration.

- Opportunities in an integrated system of systems

Becoming a smart city starts with smart systems which work for the benefit of citizens and the environment. Electric grids, gas/heat/ water distribution systems, public and private transportation systems, and commercial buildings/ hospitals/homes are the backbone of a city's efficiency, livability and sustainability. It is the improvement and the integration of these critical city systems that will make smart city become a reality. Successful development of a smart city will require the combining of a bottom-up systems approach with a top-down service development and a datacentric approach. Technology integration includes vertical integration from sensors, to low cost communication, real time analysis and control, and horizontal integration of historically isolated systems up to citizen-based services. Combined, this creates a system of systems.

Figure 17 describes the path of integration starting from monitoring to increase the data availability up to the full development of a system of systems where formerly isolated domains are coordinated.

- Vertical integration from sensors to management tools

The key ingredient to develop smart solutions for cities is data. Thus, the key initial step in the process is the deployment of sensors throughout city infrastructures to collect raw data, which is then transmitted through communications networks, either wired or wireless. Data is not only necessary to plan the changes in the city, but also to gather real-time information to manage services and infrastructure use better. Real-time systems can be used to automate management of city infrastructure, which can result in significant performance and cost advantages.

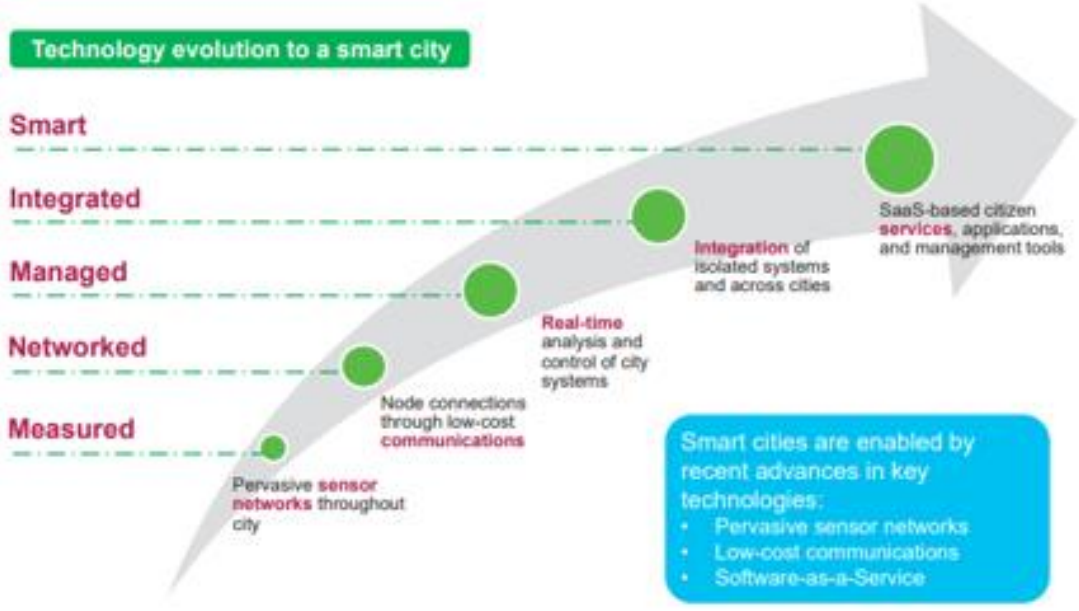


Figure 17. Step-by-step approach to becoming smarter (Leterrier et al., 2013)

We are presently undergoing a data gathering revolution, and recent advances allow the collection of unprecedented amounts of data about city infrastructures, for example through the following (Charbel, 2013):
1- Pervasive sensors enable cities to collect measurement data about energy, water, transportation, and buildings systems in real time.
2- Low-cost communications and new communications protocols greatly simplify information flows and reduce the cost of gathering data collected by sensors. Protocols such as Zigbee® and Bluetooth®4, growth in machine-to-machine (M2M) networks, as well as continued improvement in wireless and wired line communications technologies, enable cities to affordably collect data from widely distributed networks of sensors.
3- Real-time management systems automate the control of infrastructure systems, improving the efficiency by optimizing performance.
4- Advanced analytics make use of the large amount of raw data that is collected and translates it into actionable intelligence, which a city can use to improve the performance of its infrastructure. Once all of these factors are in place, cities can further leverage them to create value by applying advanced analytics tools to support optimization, as well as provide data back to city residents through public services which improve their daily lives in the city.
By measuring performance of city infrastructure systems, the city authorities can identify problem areas and track the effectiveness of solutions in achieving the city's long-term goals.
- Horizontal integration of domains
Optimization and integration in historical verticals are the core of today smart cities projects and very few have started to address horizontal integration Examples of horizontal integration are emerging, however. Some projects cover mutualization of geographical information systems, and weather forecast or customer information systems.
Greater information about a city's operations and infrastructure can facilitate the identification and management of risks to the city. For example, real time information about the flow of citizens around the city from combined smart transport and mobile data can help cities to deploy security services during emergencies.
Integration of isolated systems and sharing of data yields further performance benefits through coordinated actions and holistic management of the city as a system of systems. Operational intelligence can be the base of integration supported by analytics (algorithms using data to produce information of high user value), which need to be developed in three directions:
a) Data analysis and modelling.
b) Simulation for prediction.
c) Optimization for problem solving.
Examples include:
1- When monitored at the right precision, energy consumption can accurately reflect the performance of a machine, of a process, or of an organization.
2- Traffic pattern identification and contextual observations (weather, type of day, events, etc.) enable traffic forecasts on different time scales.
3- Real-time comfort set points calculation using predictive control models save on operational costs, while taking into account energy price variations, changing weather and occupancy conditions. Today, smart integration addresses security, mobility, weather intelligence, and energy or environment monitoring and

citizen information. City management platforms have started to be deployed, even if the services are still largely independently operated.

- Interoperability

Interoperability is a key to manage systems of systems and to open markets to competitive solutions. The existence of standards guarantees that components of different suppliers and technologies can interact seamlessly.

We are today experiencing the IoT revolution, which is driven by the appearance of smart devices, such as wireless sensors, RFID tags and IP-enabled devices. IoT allows creation and management of ad hoc networks of autonomous devices generating and sharing data across systems.

But still, different producers are generating technologies using their own communication specifications and data protocols.

Furthermore, strict technical interoperability is not enough; there are also organizational issues at stake. Interoperability can have significant legal and organizational impacts such as issues of intellectual property (do people want to share their data?), or labor relations (are people prepared to undergo training?) and usability (can users operate the instruments?). In fact, complex system integration requires interoperability on three levels: 1) Technical and syntax level: this concerns physical and logical basic connectivity, message exchanges and data structure of messages.

4) Informational and semantics level: this concerns the business context and the concepts contained in messages exchanged.

5) Organizational level: this concerns operational processes and business procedures as well as strategic and tactical objectives shared between the businesses and can include economics and regulatory context elements. To ensure it, internationally recognized standards are the best way to do so.

- Architecture integrating existing systems – Progressive and open deployment

Standardized architectures will be necessary to foster integration of existing and new systems and devices, ensuring scalability through the use of open technologies such as IP and web services.

A portal server will allow for the creation of unified, even if personalized, user interfaces, taking into account individual settings such as language, (see Figure 18). In the cloud, virtualized machines avoid investing in oversized servers remaining idle for a large proportion of time.

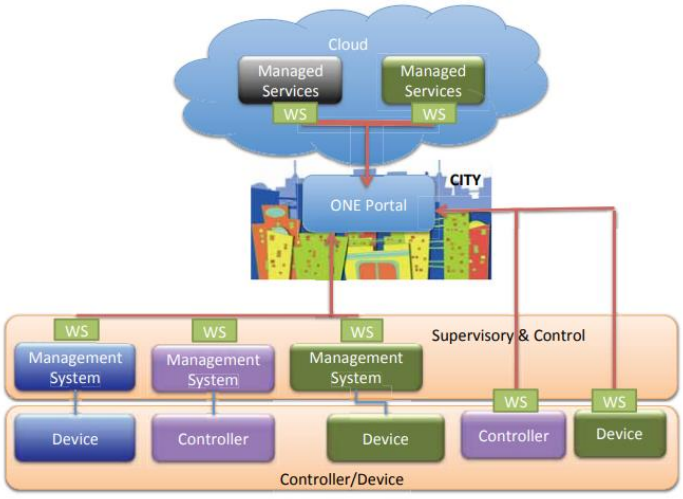


Figure 18. One portal server structure, integrating systems using standards from IEC, ISO, JTC 1, ITU-T, etc. (Leterrier et al., 2013).

Figure 19. Integrated city management platform (Leterrier et al., 2013).

Performances (to be technically improved) \ Community infrastructures		Energy	Water	Mobility	Waste	ICT	Others
		- Power grid - Gas - Fuels	- Water process - for industry - treated water - sewage	- roads - railway - airport - port, river	- waste recovery - recycling	- Information - Internet - Carrier - Broadcast	
Residents perspective	(1) Reliability						
	(2) Availability						
	(3) Service quality						
	(4) Others						
Community Manager perspective	(5) Operational efficiency						
	(6) Maintainability						
	(7) Resilience						
	(8) Value for money						
	(9) Expandability						
	(10) Others						
Environmental perspective	(11) GHG emissions						
	(12) Pollutant emissions						
	(13) Resource efficiency						
	(14) Others						

Table 5. Infrastructure performance assessment matrix (ISO/TR, 2014)

Optimization of infrastructure efficiency and communication network(s) mutualization will be the basis for an integrated city management platform (Figure 19) and shall progressively integrate the different city smart sub-systems (energy, mobility, water, buildings, public services, etc.). Collaborative and customized applications and solutions shall on top answer to city and city resident needs through information and services. The challenge will be to develop this integrated city management platforms that balancing top-down governance with bottom-up innovation.

- Measuring the smartness of city infrastructures

Key to efficiency in an integrated city management platform is the ability to meet the expectations of stakeholders with the optimal and effective use of available resources. By combining the various city infrastructures and performances into a matrix, we can create a table to assess the performance of infrastructures, see Table 5.

- Open and big data as an enabler for value creation

It is important to stress the key role of data (see Annex B) in the development of smart cities. Digital data is the inexhaustible, precious, raw material of the 21st century.

Accessible and digitized data will be an essential part of cities' infrastructure and backbone of their success. It is the glue for smart cities, enabling collaboration and integration across departments, domains and systems, and will allow better decision quality and speed driven by new insights. By managing and presenting the right data at the right time to the right stakeholders, data management technology can act as catalyst for cities to move beyond pure administrative processes to deliver transformative efficiency gains and sustainable innovation that will benefit city stakeholders. It is an enabler towards a more transparent and accountable government by improving efficiency in day to day operations, as well as create the opportunity to deliver new innovations, services, and business models. Without open data, there can be no integration, no interoperability, and no smartness.

Technology continues to evolve to enable handling of large, growing, and disparate data sets, in a cost-effective manner. Best practice sharing and development of standards are needed to ensure that data can flow freely between systems while protecting confidentiality and individual privacy.

There are a number of readily apparent technical challenges usually summarized as the 3Vs: volume, velocity and variety. How and where data is gathered, how gaps in data are extrapolated, as well as data validity, quality, and aging are additional important considerations. Beyond these technical challenges, however, one of the most important opportunities is deciding what data is relevant and to whom. This is further compounded by the fact that the more insight and transparency we have as a result of this data, the more we will want to leverage yet unstructured sets of data and newly available technologies to support finding the next sweet spot for smartness in the context of our cities.

New technologies are being developed that transform large and random data into information and knowledge enabling better and smarter stakeholder decisions.

Collecting, storing, analyzing, and working with data bring many challenges related to data privacy, cyber security, and protection of intellectual property. These challenges need to be well managed as it takes a lot of effort to build trust but only one misstep to break it. Standards, technologies, and working practices will need to be refined to protect private data as well as sensitive government or business data. New and advanced privacy and cryptography technologies will help mitigating these concerns.

Opening US weather data led to gross receipts by the commercial weather industry of 400-700 million USD per year and created jobs at 400 fi rms for as much as 4 000 people. By comparison, Europe has a similar-sized economy, but with largely closed weather data, and had only 30 fi rms with 300 employees and receipts of 30-50 million USD a year (Parfeno, 2012). According to McKinsey (Manyika, 2013) open data can enable trillions of dollars in value in education, transportation, consumer products, electricity, oil and gas, healthcare, and finance sections (e.g. commuter time saving, emission reduction, etc). The European Commission Communication on Open Data (129 China National Human Development Report, 2013) predicts that overall economic gains from opening up public data could amount to 40 billion EUR per year in the EU.

It is important to note, however, that big and open data does not mean that "Big Brother is watching you". It is rather a means to optimize outcomes, to share best practices between peers and to offer opportunities for individuals to improve their lives (e.g. comparing my energy consumption to comparable households in my neighborhood or city with similar characteristics).

- Enhancing collaboration between SDOs to get the full benefit of standards:

While standards are a central part of our daily lives and a necessity in many markets and procedures to operate efficiently, they are not well understood and often misinterpreted. Standards are voluntary and adoption tends to occur due to their usefulness. Being voluntary by nature, some companies or

organizations may decide either not to follow a given standard or to create their own technical specification. Many different standards may thus exist in parallel. Ultimately, market forces and policy decisions will tend to adopt some standards in preference to others. The adoption of standards by legislation is most likely the primary reason for the present existence of confusion between regulation and standardization, where many citizens believe that standards are legal acts. This may bring resentment and resistance against some of the standards. The adoption of standards into legislation may be a matter of concern, because specific standards adopted may benefit specific operators.

Standards by themselves are essential and positive, but the way standards are set and published needs to change. Technical standards which may profoundly affect the kind of solutions that are adopted in the case of infrastructures are written by specialists in the field. In the case of the IEC, International Standards are drafted by electrotechnical engineers for other electrotechnical engineers. However, due to the need to integrate infrastructures and services, standards should also have city managers in mind. Standards need to be understandable by non-specialists.

Integrating infrastructures and services depends strongly on interoperability (i.e. devices and systems working together), which in turn is facilitated by technical standards. The voluntary international standards agreed between technology providers have been shaping the development of our modern technology and ensure the interoperability and cross-border compatibility of technologies. Citizens' daily lives are affected by the standards that shape our built environment, such as electrotechnical and ICT devices. Much of the interoperability and compatibility that is taken for granted today has not become so by default. It is the result of complex agreements in international standard bodies and market competition between technologies, which ultimately determines what will be adopted by technology providers and users. SDOs are the main sources of the national and international standards, assessment schemes and certification programs that provide the bases for interoperability guidelines, frameworks, and practices. When managing the various types of physical flows within a smart city, a set of common concepts of interoperability is needed.

Presently, however, the development of standards is not overly coordinated. This can be addressed by increasing the collaboration between standardization bodies, the rise of systems-level technical standards committees and involving city planners more closely. This would improve the quality of standards and cross-operability of technologies which form the basis of functioning cities. It would also help develop a wider market of integrated solutions for cities. A wider market with solid standards and interoperability will support the expansion of replicable and more affordable technologies globally. New approaches in developing system-oriented standards, where several technical committees in different organizations are involved, will be necessary in developing standards that are intended to enable the implementations of smart city solutions.

The interoperability of sub-systems will require new forms of collaboration among related efforts of the IEC, ISO, JTC1, ITU-T and other technical committees of other SDOs. These standardization efforts will involve the development, promotion, and deployment of standards series and conformity assessment schemes that enable it within systems and sub-systems as well as between a city and its associated supply chains.

- Within the ISO

Numerous projects with the aim of developing smart cities are in process, but there is no clear consensus of what defines a smart city or what sort of solutions can be considered smart. In 2012, ISO TC 268

(sustainable development of communities) was set up, and subcommittee SC 1 (smart community infrastructures) was approved, aiming to clarity on the standards on smart infrastructures.

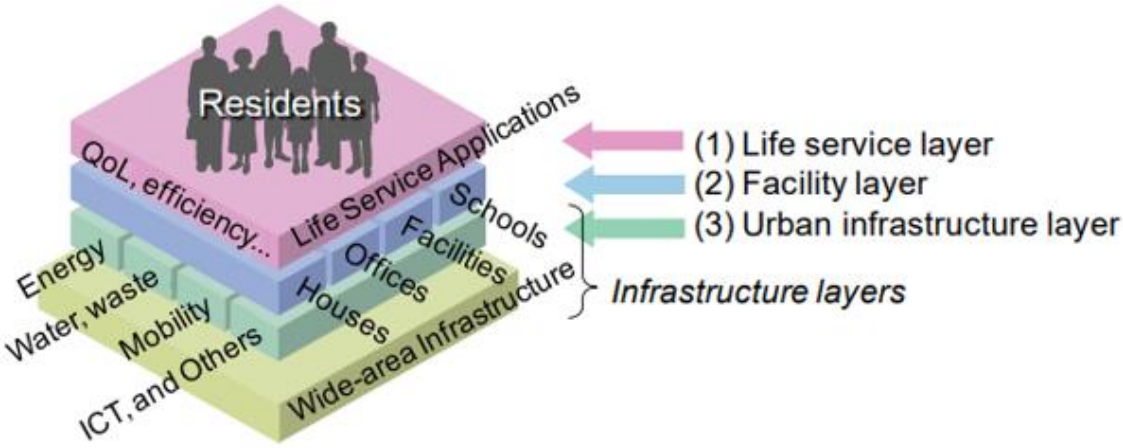


Figure 20. Three-layer model of city functions (European Commission, 2011)

One of the main concepts adopted by the subcommittee is the three-layer model depicted in Figure 20. When we consider the smartness of a city, we have to take into account the smartness of the various functions of a city's infrastructures, such as:

- Basic infrastructures: energy (electricity, gas), water, mobility, information and communication infrastructure (ICI), etc.
- Public services: healthcare, education, police, etc. We can classify these functions into the following three-layer model of city functions. Each layer is defined as follows.
- Life service layer (community services): necessary services for urban life such as healthcare, education, police, etc., mainly provided by city administration.
- Facility layer (community facilities): facilities such as housing, offices (buildings), transportation facilities (stations), schools, where infrastructure services are provided and also used.
- Urban infrastructure layer (community infrastructures): infrastructures which provide fundamentally necessary physical substances for daily life, such as:

a) energy (electricity, gas),
b) water (drinking water),
c) waste,
d) mobility (public transportations, city train, bus, car), and
e) ICI. Beneath the urban infrastructure layer, there is the wide-area infrastructure which connects the cities wide-area energy grid, intercity transportation systems, etc.

In the context of making the city smart, the renovation and further sophistication of each function is necessary. And according to this classification, we infer that the categories of stakeholders' using each infrastructure are different. The legislation/regulations administering these various infrastructures are also different. The community infrastructure layer is managed and operated by the infrastructure operators (public/ private).

The community facilities layer has two key facets, as a place where services are provided (such as a transportation hub, station), and as a place where services are used (home, office (building), commercial

facilities). For example, the word “smart building” is usually used as a smart energy consuming building, so it is different from a smart grid or smart mobility which provides for a smart functionality.
The community services layer is usually managed and operated as a city administration service, so it is related to the improvement of legislative structure. For example, when we build new hospitals and schools, while such constructions entail an improvement of medical care and facilities, they also necessitate an improvement of medical systems and quality of doctors, education systems and teaching.

3.5. Bohai Innovation City (Beijing)

Over the past decade, smart city ideas have emerged as a platform for ideas about how new technologies can improve efficiency, improve city functions, and increase competitiveness. It may also offer new ways to address the problems of spatial degradation based on environmental degradation, imbalanced access to public infrastructure, and economic segregation. The essence of the idea revolves around the need to adjust and integrate technologies that have been developed separately from each other but have distinct synergies into the program mix. They need to be interconnected, so there are many new opportunities that can improve the quality of life of the inhabitants. This study is based on a carefully planned new urban design project in southern Beijing using a comprehensive strategy and is implemented in an economically rational but environmentally sound way.

3.5.1. Urbanization in Beijing and emerging new cities

After the reform and open-door policy, the urbanization policies in China were intended to develop core cities as nodes for rapid economic growth instead of balancing development in rural areas. Tianjin and Tangguh was strategically connected to the international port cities, The mega-city of Beijing. This was intended to expand the Bohai economic belt by linking emerging new cities via intercity rail and highway networks. This mega-city and concentrated development concepts based on theories of “Getting Rich First” and “All Rich Together,” intensified the urban development of Beijing to gain global completeness (Choi, 2013) but it also caused various social problems like urban migration falling quality of urban life.

3.5.2. Increasing demand for new cities in response to rapid urbanization

In 2012, Beijing’s economic growth rate was 7.7%, the lowest level in 13 years, (China National Human Development Report, 2013) but the government tried to use this opportunity to improve the sustainability of its growth. This process was geared towards not only stimulating economic growth, but also promoting attention to new sources of investment, providing better public services with equal accessibility, improving transport, and infrastructure networks, and enhancing more efficient use of resources. However, the soaring office rent in Beijing CBD from $130 per square meter in 2011, to $195 per square meter in 2013, accelerated the flight of multi-national firms from the downtown. Despite the high office rent, the shortage of offices in CBD seems likely to continue due to the investment and growth of foreign companies. In addition, the continuing rise in population density with increasing urban population is deteriorating accessibility to the urban center by companies and individuals, as well.

3.5.3. Rapid increase in population

The return to the cities of those once expelled during the Cultural Revolution, and the increasing migration from rural to urban area due to mitigation of household-registration system have resulted in the over-crowding in urban areas and the deterioration of urban function. “The natural rate of population increases and the rate of population movement in Beijing are 1.19 and 13.49, respectively. This is much higher than in rapidly growing cities in the Bohai economic belt (e.g., Tianjin 0.72 and 5.04. respectively)”. This Quick

increase in urban migration contributes to the current industrial system in Beijing, but most unskilled employees are spread around in shadowy urban areas, even in illegal communities in the green belt area.

3.5.4. Problems and solutions of a new city design

- Urban growth in China

The unplanned urban expansion in such a short period brought excessive population density, excessive demand for physical space and quantitative control, which resulted in blocking the diversity in urban spaces. This monolithic spatial organization in turn, causes deterioration of traffic and living conditions, and difficulties in management of the urban infrastructure. Most new town development caused severe spatial segregation of society by income level and upscale housing developments pushed the lower income employees to the outskirts of the city.

Problems	solutions
- Environmental degradation - Loss of agricultural land - Pressure on natural resources - Pressure on housing and employment - Consumptive patterns - Urban sprawl - Social alienation - Damaging urban-rural linkage	- Driving forces in economic development - Efficient use of energy and infrastructure - Easier delivery of health and education services - Centers for culture and tradition - Efficient use of natural resources - Creative social capital - Potential centers of innovation and experimentation

Table 6. Cities as problems and solutions (Karen, 2009).

The Beijing new town developments took on an important role in preventing excessive population density, and were fairly successful in terms of industrial distribution. However, they failed to redistribute the population, so job and housing discord got worse (Zhu, 2007). The 12th Five-Year Plan (2011-2015), particularly put stress on the quality of growth, and looked for creative methods for rational distribution of elements composing the urban character. This new plan, based on urban diversity, calls for a new urban planning strategy, as well as a wide functional and spatial network connecting neighboring regions to improve functional congestion in the central region. For the success of this new plan, an integrated urban design is needed, in which the various resources of the urban area can be allocated in a comprehensive fashion.

- Strategies for smarter growth

The promise of advancements in engineering and technology has yet to provide systemic change in the urban environment. In part, this is because of the limited application of technology and the piecemeal adaptation to readily available opportunities. Now there are many cities in which digital technology is imbedded from the outset, by which we might create environmentally smarter cities. What if we aligned urban form and architecture with technology and responsive infrastructure? Could we create a city that positively encourages community as well as environmental sustainability?

City planners and designers have already discovered a wide range of approaches and descriptions that promote the concept for a smarter city. Mostly, these suggest the implementation of cutting-edge infrastructure involving mobile apps, interactive monitoring, citizen-initiated sensing, real-time data collection/display, urban mapping/analytics, and even public art installations. What is commonly missing is the view of the city as a larger framework (Enquist, 2015) By looking at the ecology as well as the economy

of the city, using systems thinking and holistic strategies, it is possible to design a city that is not only technologically innovative, but also smart in every aspect of contemporary urban living and sustainability.
The success of a smart city can often be measured on multiple levels. Interestingly, the cities most identified as being successful are those that place great importance on achieving and maintaining the highest quality of life for those who live, work, and visit. Most of these cities adhere to the importance of city planning and the alignment of resources to support the civic elements that offer real value in the daily life of the community. (Skidmore et al., 2014). As a result, this focus and prioritization have extended their value to attracting people, talent, and investment while creating distinctive positioning to be the best in the global competition. Regarding urban design practices (Table 7), several common relevant themes have become associated with livable cities that have demonstrated innovation, and cultivated a high-quality urban environment.

Issues of Urban Design in China	The Strategies for Smart City Design
1-Quantifiable area-based design control – Site coverage, population, FAR, green ratio, height limit	1-Performance based design
2-Maximum development under allowable land use permit	2-Compact and walkable development
3-Disconnected single land use character	3-Higher density with convenient transportation that is aligned with a mix of land uses
4-Limited research and planning within a project boundar	4-Transit as the first choice and the first investment
5-Rely on centralized urban infrastructure and government service	5-Innovative design adapted from regional context and an authentic sense of place
6-Public service followed by demand	6-Networked public spaces of all kinds and scales
7-Design from a Tabula rasa	7-Information based public service
-	8-Visible display of “newness” and making technological innovations feel approachable
-	9-Holistic commitment to sustaining the quality and integrity of the larger ecosystem
-	10-Aesthetic consideration and locality

Table 7. Urban design strategies for smart city (Juntaek and Uoo Sang, 2015).

- To compact walkable districts and connected neighborhoods efficient use of comprehensive Transit Network

The strategies for the new city design pursue creation of flexible frameworks that provide smart platforms. These are intended to support not only emerging new technologies for infrastructure but also to enhance the performance through a comprehensive system of networks.
In the Bohai Innovation City, the urban design strategies for a smart city (Table 8) are applied to its urban spatial design to maximize the strategic advantage of the Bohai region and to provide better quality of life and sustainable urban development. The network idea is critical for organizing other smart design strategies that were developed for this project:
- Comprehensive transit network for compact walkable district and connected neighborhoods.
- Integrated environmental network with interconnected Green Infrastructure.
- High-performance urban design for resource management.

3.5.5. Bohai Innovation City as a Smart City

The Bohai Project follows a Smart City concept rather than the Mega City concept. This allows urban diversity by existence of various functional and spatial networks among regions, reduces social expenses (e.g., traffic congestion), excessive land price, and urban environmental pollution, and secures predictable urban management systems.

Figure 21. Aspects of development of Beijing: Developments of new towns (Juntaek and Uoo Sang, 2015).

Figure 22. Aspects of development of Beijing: Regional function and spatial networks (Juntaek and Uoo Sang, 2015).

The master plan framework modifies the street grid to incorporate existing road alignments, to enhance connectivity to the high-speed rail station and surroundings, and to create special view corridors to landmark developments. Neighborhood streets are realigned to a north-south grid to optimize residential development and reduce energy consumption. “A variety of block sizes is provided to allow for various development typologies, with smaller blocks in the urban core and larger blocks in the surrounding neighborhoods”.

Figure 23. Compact core and neighborhoods (Juntaek and Uoo Sang, 2015).

Figure 24. Land use plan (Juntaek and Uoo Sang, 2015).

Figure 25. Development density and function (Juntaek and Uoo Sang, 2015).

Figure 26. Comprehensive transit network (Juntaek and Uoo Sang, 2015).

All modes of transit serve to optimize transit coverage through the district. To provide convenient connections to external modes of transit for fast connections to the Beijing-Tianjin region, internal transit systems is applied. All streets are designed to accommodate bikes and pedestrians and land uses are distributed such that walking and biking become primary means of circulation. In the future, the Beijing Bohai Innovation City will become a major crossroads for access to both of Beijing's airports and the South Rail Station.

- Integrated Environmental Network

The fabric of a city is the result of many intertwined ecological systems of relations between nature and artificial environments. One of the key insights for understanding the city is in understanding the structure of these networks of various ecological and infrastructural systems.
In terms of the urban environment, the health and environmental indexes indicate poor conditions in the Beijing region. There is also conflict between economic development and environmental protection that results in unbalanced resource distribution.

- Environmental Sustainability

China's urban green land area per capita was only 11.18 square meters (China National Human Development Report, 2013). Compare this to 25-30 square meters per capita for international cities around the world considered densely populated along with significant tourist attractions, and highly livable. At present, with the acute shortage of construction land, expanding and protecting green space has become an urgent and arduous task throughout China. The Beijing Bohai city plan aims to ensure that the city is people-centered. This means creating enough public open space for leisure and recreation, and providing safe pedestrian walkways and connected bike paths. This entails mixed-use development so that residents can work and shop in the communities where they live. This project will provide open public space of about 760 ha including 145 ha of water bodies. This will provide residents with about 32.84 m2/capita of open public space. In addition to this, there is a requirement for 30% green space on developable land that is expected to provide open space and living conditions comparable to those in noteworthy international cities.

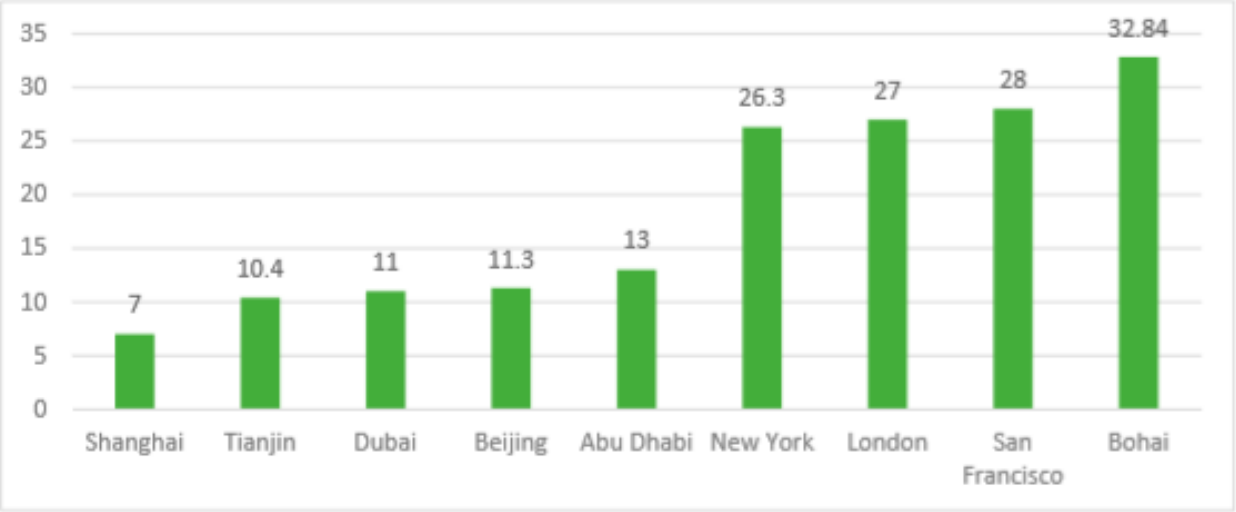


Table 8. Public urban green land area per capital (Skidmore et al., 2013).

Networks are the infrastructure by which this plan is intended to provide collective reduction of costs while increasing density with great efficiency. However, increasing urbanization in certain areas causes tension surrounding the compromise between reliability and resilience. An enhanced district utility network allows a closer look at each utility provided, to discover expanded uses for each resource, to optimize redundancies, and to minimize energy use. Services that are traditionally produced at the building level can be better provided at the district level by achieving economies of scale. An enhanced utility network with interconnected district nodes provides cooling, heating and power to the entire development. It also supplements the city utility grid with on-site cogeneration systems involving renewable energy, rainwater management, and vegetation.

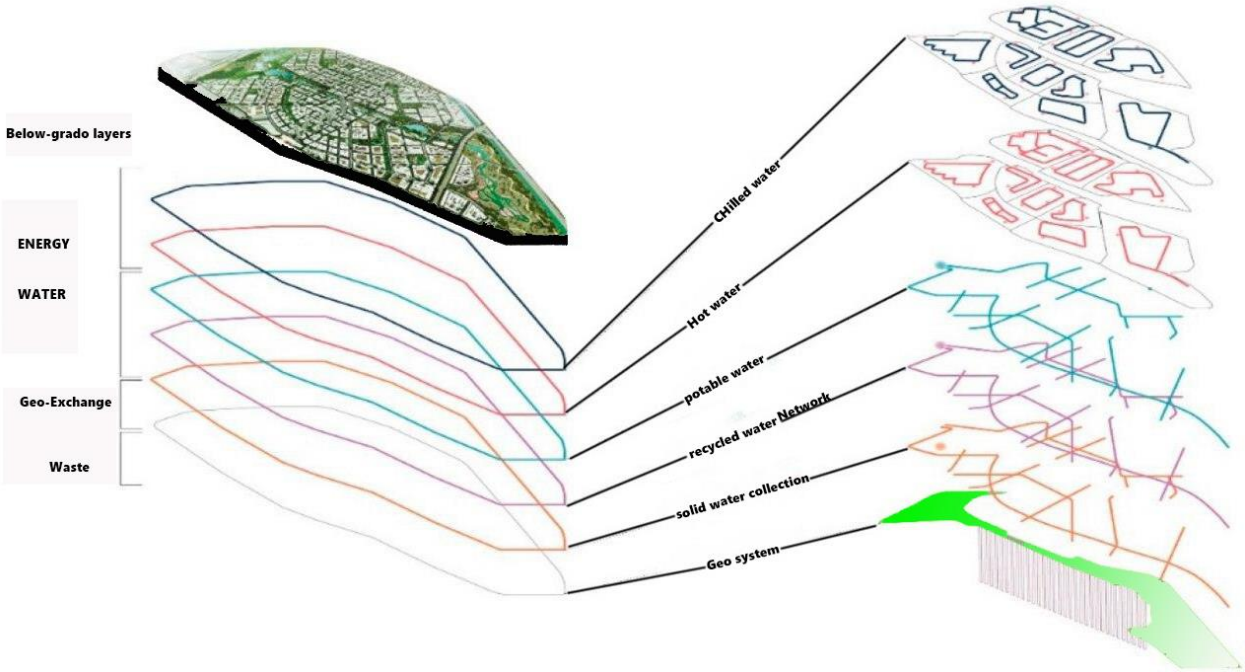


Figure 27. Interconnected infrastructural system (Juntaek and Uoo Sang, 2015).

In addition, an interconnected green infra-structure is essential for keeping water resources reliable and for maintaining quality in the wider ecological system in this region. The Green Infrastructure Network, in particular, is counted as a key design element organizing the other infrastructural networks listed above, to create a livable urban environment as a part of a regional eco system.

- High Performance Design for smart resource management

- Green infrastructure intervened with water management system

Water scarcity in China is not a new issue since 20% of the world population here, must share only 7% of the water in the world. However, in Beijing, this critical issue has been rapidly getting worse. Even though rapid urbanization has reduced surface water by 35% in the last 50 years, the population is expected to double in 25 years (to 20 million). It is evident that, not only could this hinder the growth of city, but would also decrease quality of life. It is of great concern that water and air quality have already become major issues related to urban migration. To ensure that this city has an attractive sustainable living environment, the plan provides for a smart water-management system with an active green infrastructure network to address:

1- Scarcity (harvest, reuse, efficiency)

2- Flooding (natural and open system storage)

3- Quality (treatment)

- Enhanced Green Network System

In Bohai City, the green areas are designed to form a green network system that connects open spaces with nature systematically through the Green Infrastructure System (Benedict and Mcmahon, 2006). The Green Infrastructure can be classified into plane type and linear type: The plane type is composed of parks, forests, wet lands, farmland, virgin land, and public facility outdoor areas. These will be organically linked through the Linear Type Green Infrastructure (e.g., pedestrian paths, green streets, water streams, and eco-corridors).

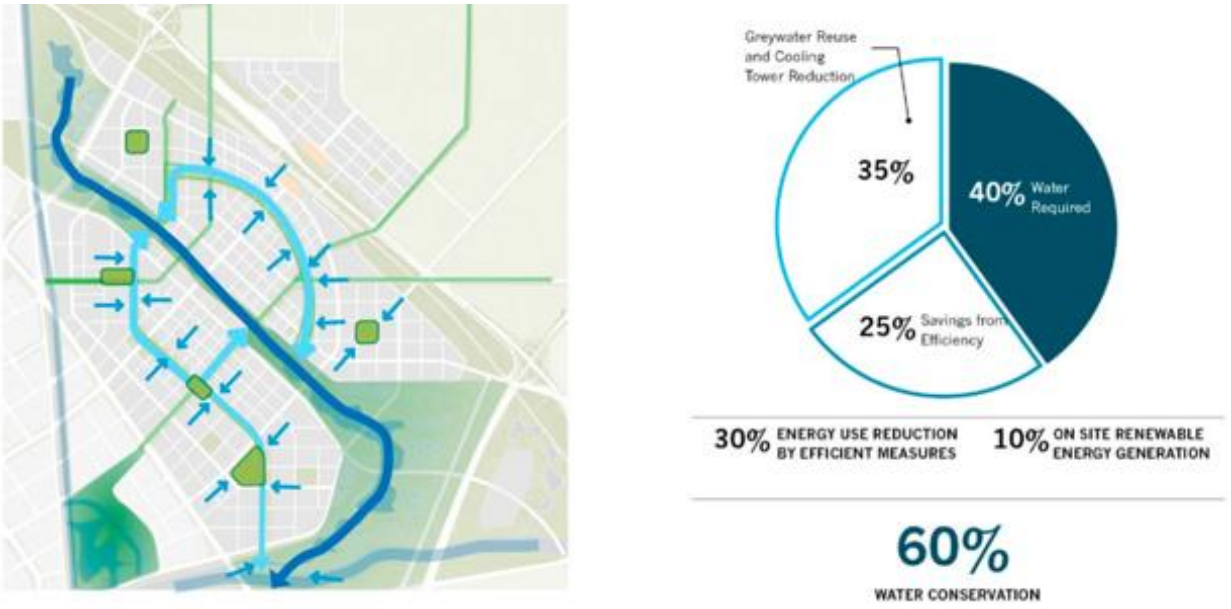


Figure 28. Smart water management system (Juntaek and Uoo Sang, 2015).

Figure 29. Various public open spaces and Green Infrastructure Network (Juntaek and Uoo Sang, 2015).

-Plane Type: An expanded network of green spaces, including the iconic Crescent Park running through the core, allows additional opportunities to collect and clean storm water run-off through natural systems. Helping to conserve precious water resources and the energy typically needed for water treatment, this comprehensive water-based landscape will become a model for sustainable urban landscape plan. Wetlands are proposed to be located at both the South and North ends of the city. They will occupy 23% of the total area, and provide 55% of the open space. The largest manmade wet area among new cities planned around Beijing, this wetland will be able to maintain biological diversity and perform as an urban micro climate control. The wetland also functions as a detention facility to protect against flooding disasters caused by the Summer Monsoon.

Linear Type: As connectors among the major plane type open spaces, this green infrastructure includes eco-corridors, wind-corridors, view-corridors, water streams, promenades, and green pedestrian paths. These open spaces provide essential green connections between various open spaces to support natural systems and essential wind flow patterns. The various kinds of open spaces are to create an integrated network to amplify the synergy. Here again, the connection types of the green infrastructure proposed by network theory can be divided into two groups. One is the branching network type commonly observed in the natural landscape; the other is the circuit network type which includes most network types found in urban settings (Jing and Kunhyuck, 2010).

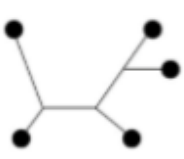
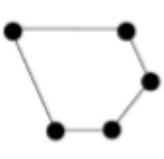
Branching Networks			Circuit Networks		
Paul Revere	Hierarchical	Least Cost to Builder	Traveling Salesman	Least Cost to User	Bechman Typology
					

Figure 30. Greenway network typology (Hellmund et al., 2006).

The Green Infrastructure Plan (Figure 31) introduces two different types of linear connection. Type “A” reinforces the idea of connectivity to expand to a regional-scale ecological system, and to provide continuous natural ecological paths, like a central water channel. Type ‘B” emphasizes the idea of community, accessibility and sociability using linked small blocks and neighborhood parks connected with green streets.

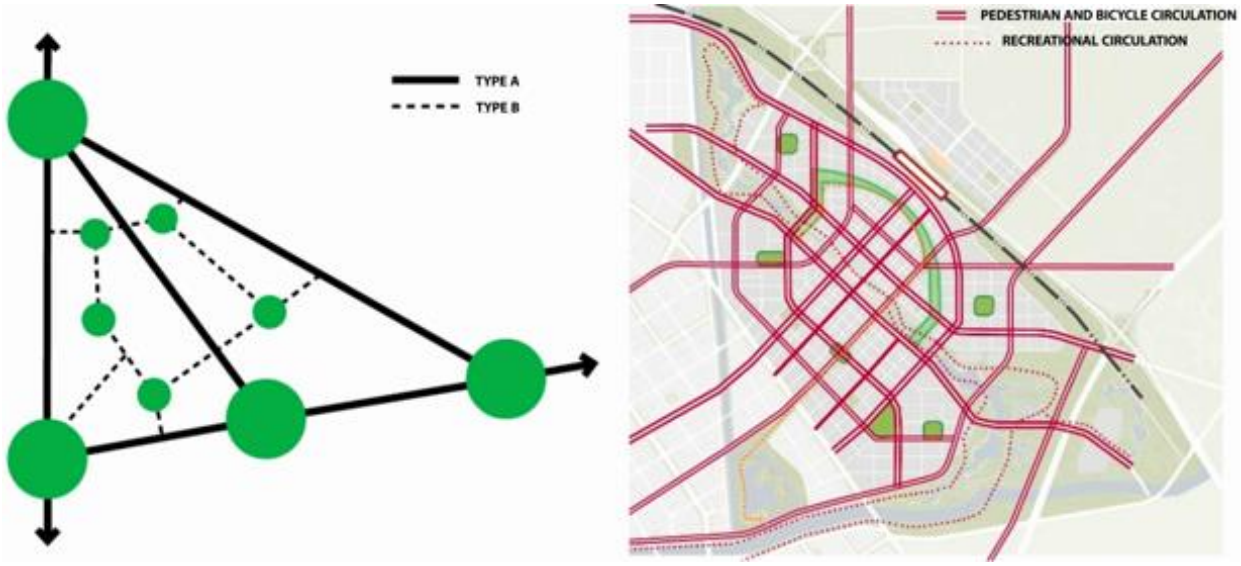


Figure 31. Open space typology and pedestrian and bicycle network (Juntaek and Uoo Sang, 2015).

The type A is more like “Traveling Salesman” which will be more suitable for recreational purposes, in that it leads back to the start point. The type B is closer to a modified “Bechman Typology ” that could improve the connectivity of green infrastructure and also enhance the public approach to each open space in terms of providing convenient connections between the neighborhood nodes.

Chapter 4
Research Methodology

Nowadays With regard to increase of population and the needs of new technologies and industries in the world, and in the other way with considered climate change and energy efficiency necessary for the cities, planning sustainable smart cities can be a good platform for tackling environmental problems in urban development.

I will implement the smart criteria model by looking at the positive and negative factors of existing smart/sustainable city initiatives from a managerial perspective. Such a perspective offers important considerations to governments when investing in and implementing smart city projects in the future. As any research effort, this study has a limitation that it relies on a theoretical analysis of documented data from secondary sources. Thus, further empirical examinations can provide rich insights into the outcomes of this study.

In recent years, Iran has faced many problems such as groundwater depletion due to lack of rainfall, drought in many areas and villages, drying rivers and lakes, air pollution, and climate change. These problems caused a huge movement of rural people to cities, an increase of city population and lake of facilities for citizens, which more and more it requires implementing some new technologies regard to sustainable planning to solve these problems.

4.1. Materials and methods

This research aims to be operational in the sense of exploiting existing methods and data rather than developing a new town. The literature and data reviews and the consistency with neighboring regions explain the methodological choices. Each method presented in this section is the result of a research process comparing available techniques and testing new adaptation in terms of data and algorithms, but this project makes use of the whole potential of shiraz infrastructure to integrate the results in a solution including six steps:

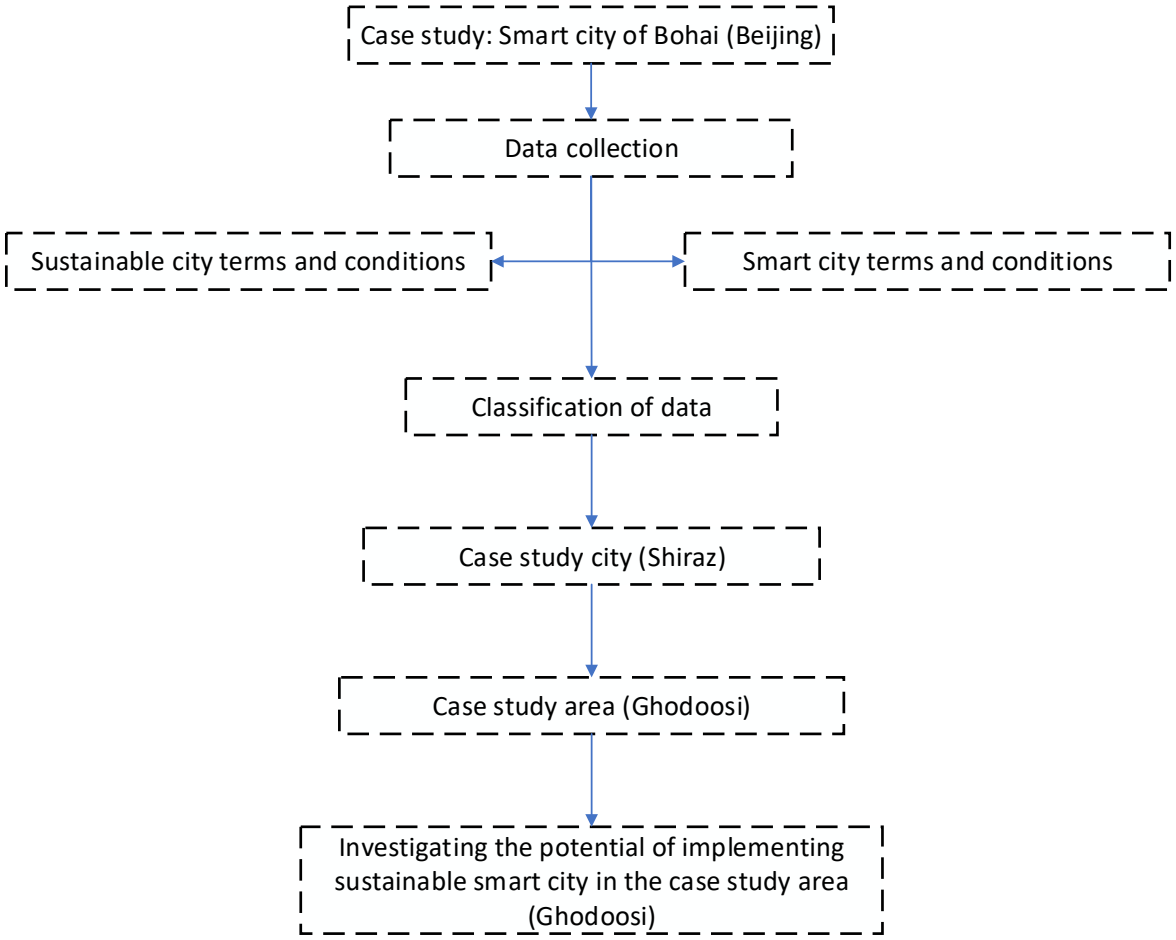


Figure 32. Flowchart showing the methodology for sustainable smart city planning adopted in the city of Shiraz (Source: Author).

4.2. Data collection with Questionnaire and Results

This Questionnaire includes 7 questions in total. The survey was conducted through face-to-face interviews with 10 residents and 100% of residents responded to the questions and they expressed their problems and their desires.

- What do you think about sustainable smart city planning in shiraz? People response:

A. Very good (40%) B. Good (30%) C. Not bad (20%) D. No good idea (10%)

- What do you think about the promotion of Shiraz as a self-sufficient city? People response:

A. Very good (20%) B. Good (50%) C. Not bad (20%) D. No good idea (10%)

- Do you think Shiraz can be a good destination for a tourist in the future? People response:

A. Yes (90%) B. No (10%)

- Do you think Shiraz has a good infrastructure to become a sustainable smart city? People response:

A. Yes (100%) B. No (0%)

- What activities and functions your organization applies for addressing the problems that Shiraz faces as a tourist destination? People response:

A. Social (0%) B. Economical (10%) C. Cultural (0%) D. Sport (10%) E. Green areas (10%) F. Lack of appropriate infrastructure Other (50%) G. Other (20%)

- What are the main problems and Challenges of Shiraz city to become a sustainable smart city? People response:

A. Infrastructure (60%) B. Population (0%) C. Traffic (10%) D. Lack of appropriate urban planning (20%) E. other (10%)

- What are the advantages of Shiraz city to become a sustainable smart city? People response:

1. Vicinity to natural resources 2. The high potential of developing city 3. Good connecting to green areas 4. A high potential for sustainable energy saving 5. Available local materials 6. Good ventilation because of local gardens 7. Resilient city

- In your view, which are the improvements that your organization should make in order to increase Shiraz efficiency and for Shiraz as a sustainable smart city? Some of People recommendation:

1. Smart technology 2. Tackle with air pollution 3. Applying sustainable energy 4. Waste management 5. Use of local materials 6. Traffic controls 7. Increasing public transportation and avoid to use of own car in traffic hours.

4.3. Case study City (Shiraz)

Shiraz is most likely more than 4,000 years old (Lonely Planet, 2008). In the Achaemenian era, for going from the city of Susa to Persepolis palace and Pasargadae place the road was connected by the city of Shiraz and this city was on the way. The Persian Emperor Artabanus V expanded his rule over Shiraz, again according to Shahnameh, and Based on many Iranian mythological traditions, shiraz was originally arisen by Tahmures, and afterward fell to ruin (Conder, 1827). It should be mentioned that the oldest sample of wine on clay jars which related to about 7,000 years ago was found and recovered around the city of Shiraz (World's Earliest Wine, 1996).

After the Arab invasion, Shiraz became the capital of Fars province for a while and then from 945 to 1055 the Buwahid Empire ruled it as their capital, and they build new buildings, library and an extended city wall in this period (History of Shiraz, 2008). Between the important Iranian prominent figures born in Shiraz were the Saadi and Hafez (Khorramshahi, 2002), in the part of mystic there were Roozbehan, and as a philosopher was Mulah Sadra (Rizvi, 2002). Therefore, Shiraz was called "The Athens of Iran" (The Guardian, 2005).

Figure 33. Pillars of the Apadana palace, Persepolis [12]

Figure 34. Qoran Gate in the entrance of shiraz from Tehran highway [13]

[12] https://dissolve.com

[13] https://stock.adobe.com

Figure 35. Timeline (Elaborated by the Author)

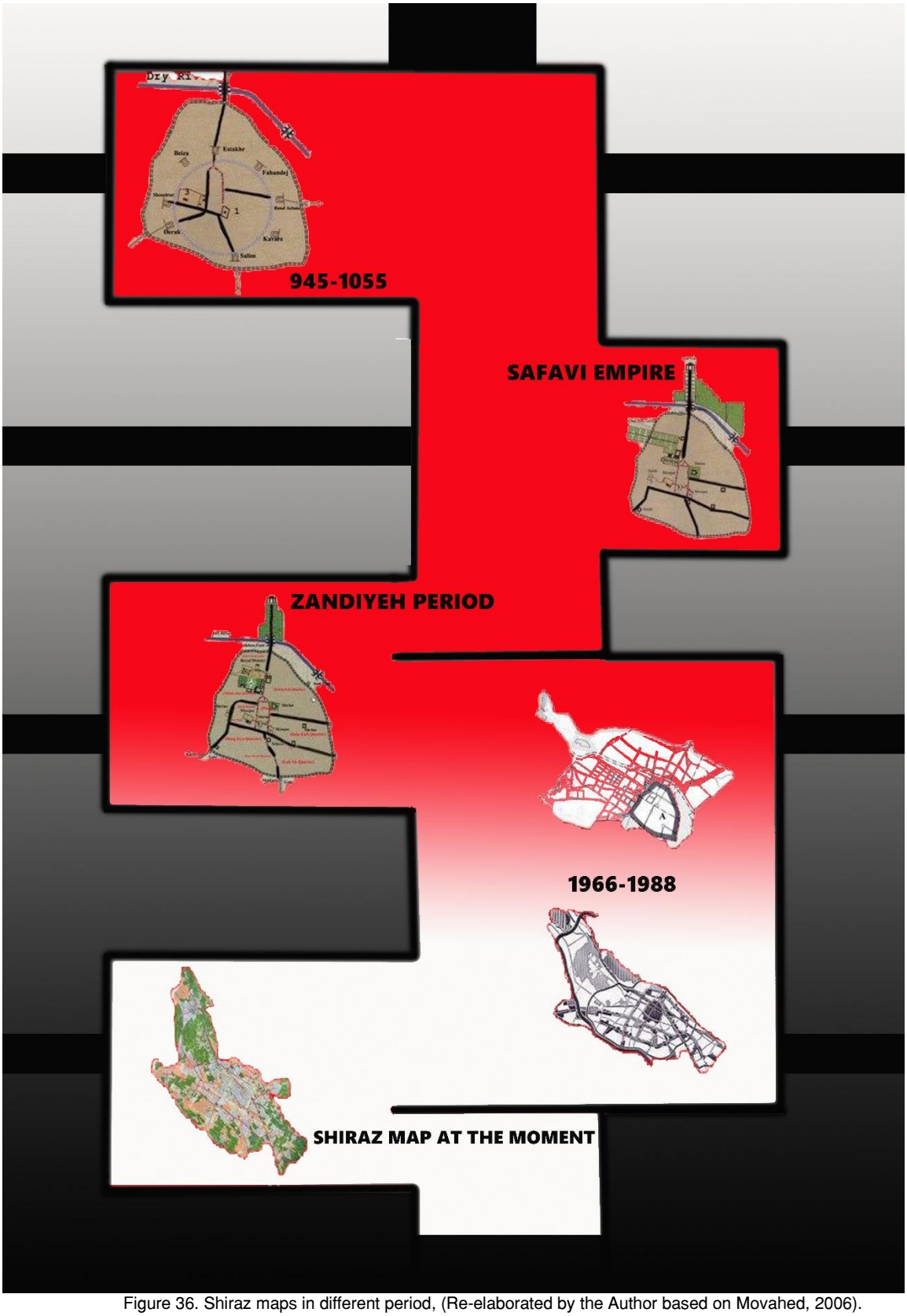


Figure 36. Shiraz maps in different period, (Re-elaborated by the Author based on Movahed, 2006).

The city of Shiraz has different urban structures, old and modern. The old structure consists of different gates and districts at different times. The modern structure especially has been set up all around the old regions and areas in suburbs. The main purpose of all changes in the Shiraz was to build new appropriate streets that accountable for a vehicular network (Movahed, 2008).
The process of Shiraz urbanism data; demonstrates that the expansion of Shiraz is 46 times, but the population growth is only 15 times since 1921, which shows that Shiraz has lost its compactness in these days. And also, data shows of about 200 hectares/year as the yearly average expansion of built-up areas. This growth has occupied former agricultural land and rural areas especially in the recent 80 years, and more importantly and sadly agricultural lands were arbitrary for its expansion. It resulted in ruining agricultural activity and displaced it to less productive areas. Many villages and regions have joined in this activity around Shiraz and they lost its cultivated area (Movahed, 2008). Anyhow, Shiraz is among the sixth most popular cities in Iran had 1,455,073 inhabitants in 2009.

- Shiraz traditional core and first modern period

First modern period of my analysis is before 1921, that time walls surrounded the city and there were ten quarters inside it which had their own gates to the exterior of the city. The main gate of the city opened towards the mountains and the city entrance was along the main Qanat, which watered the Charbagh around it and then ran into the city.

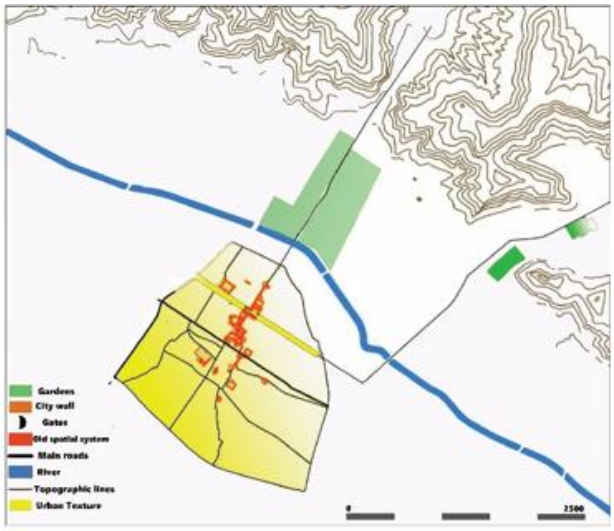


Figure 37: Shiraz traditional core (before 1921). (Elaborated by the author.)

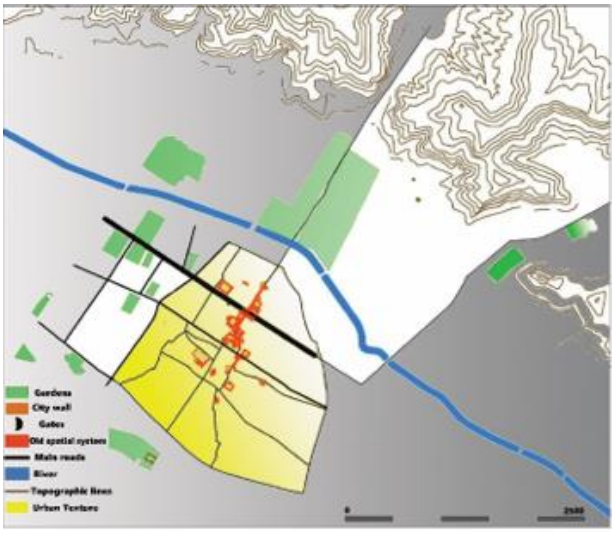


Figure 38. Shiraz first modern period (1921-1941). (Elaborated by the author.)

- Shiraz second and third modern period

The third period runs from 1941 to 1979, and I call it the second modern period. It begins with the Second World War that caused economic crises in Iran and reduced the quality of life. The law of land modifications (White revolution) was approved. This law was about the ownership of rural land and based on it, Shiraz hosted a large number of Immigrants from rural areas. On the other hand, the water supply network made the city growth easier.

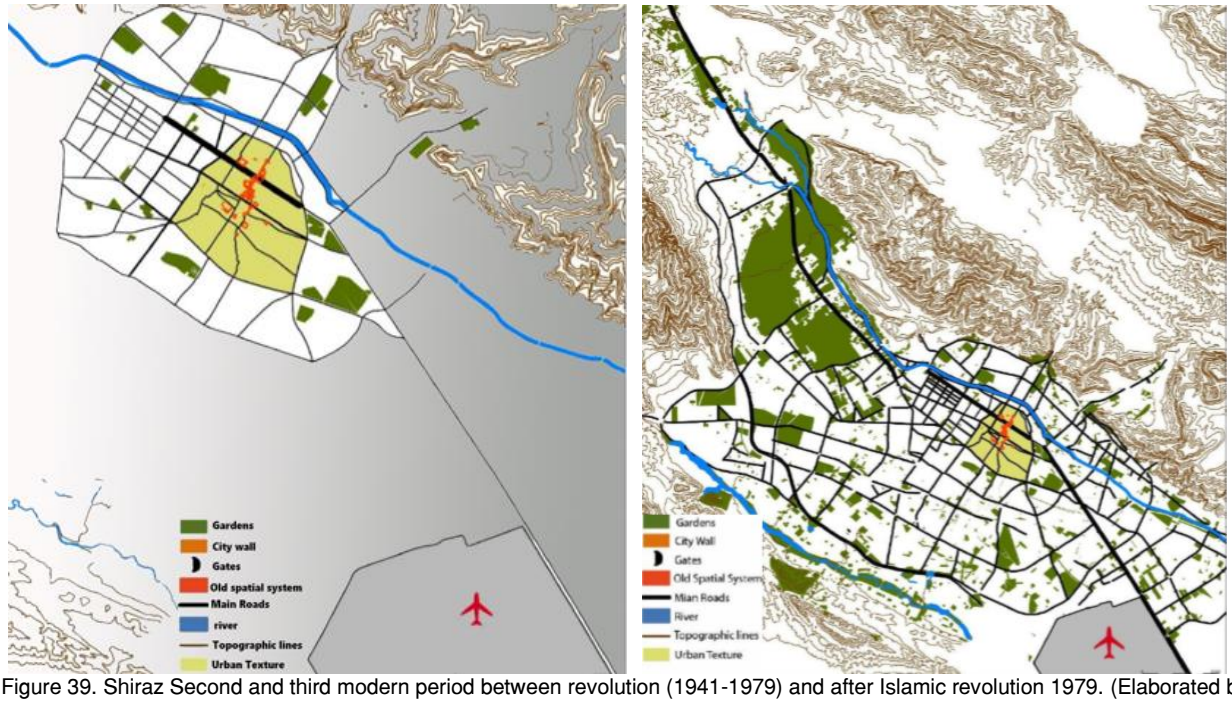


Figure 39. Shiraz Second and third modern period between revolution (1941-1979) and after Islamic revolution 1979. (Elaborated by the author.)

- Shiraz Township

It is necessary to say some modifications in the process of work were done like no preparation of environmental units and using current land-use map. In this research, current method of systemic analysis for preparation of environmental units was not utilized for assessing the ecological capability maps and land-use planning of quantitative model. It may be used only for assessing the small areas with low diversity (e.g., small watershed). Hence, for assessing the larger areas (e.g., large watersheds, counties and provinces), preparation of environmental units eliminates a lot of information used in the ecological capability models. So, in the present study all indicator maps related to different ecological capability models were overlaid in GIS. Other modifications in the process of work done for assessing the land-use planning model included: a) Prioritization of each use was done based on the highest score derived after summing the scenarios' scores (ecological, economic, social, area) (54 Makhdoom, 2001). But it should be considered appropriate (suitable) capability for the utilization with highest score. B) To use current land-use map in assessment mainly because of the socio-economic compulsions of the population especially in rural area. Like to hold the following land utilizations in the end of land-use planning process: 1) Irrigated lands with suitable capability. 2) Settlement lands (urban, rural and industrial area). 3) The Forest lands with canopy cover more than 25% and those with conservational role. 4) Lake and river bed. Finally, land-use planning maps of the Shiraz Township were developed considering the ecological and socio-economic characteristics of the area.

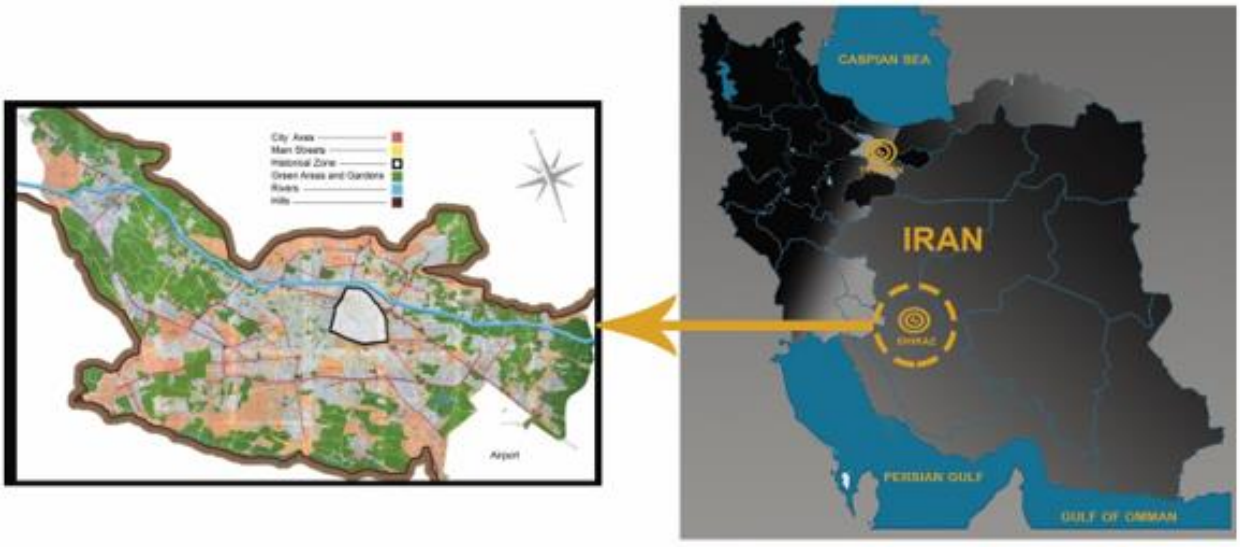


Figure 40. Position of Shiraz township in Iran (Re-elaborated by the author based on (https://fa.maps-iran.com/)

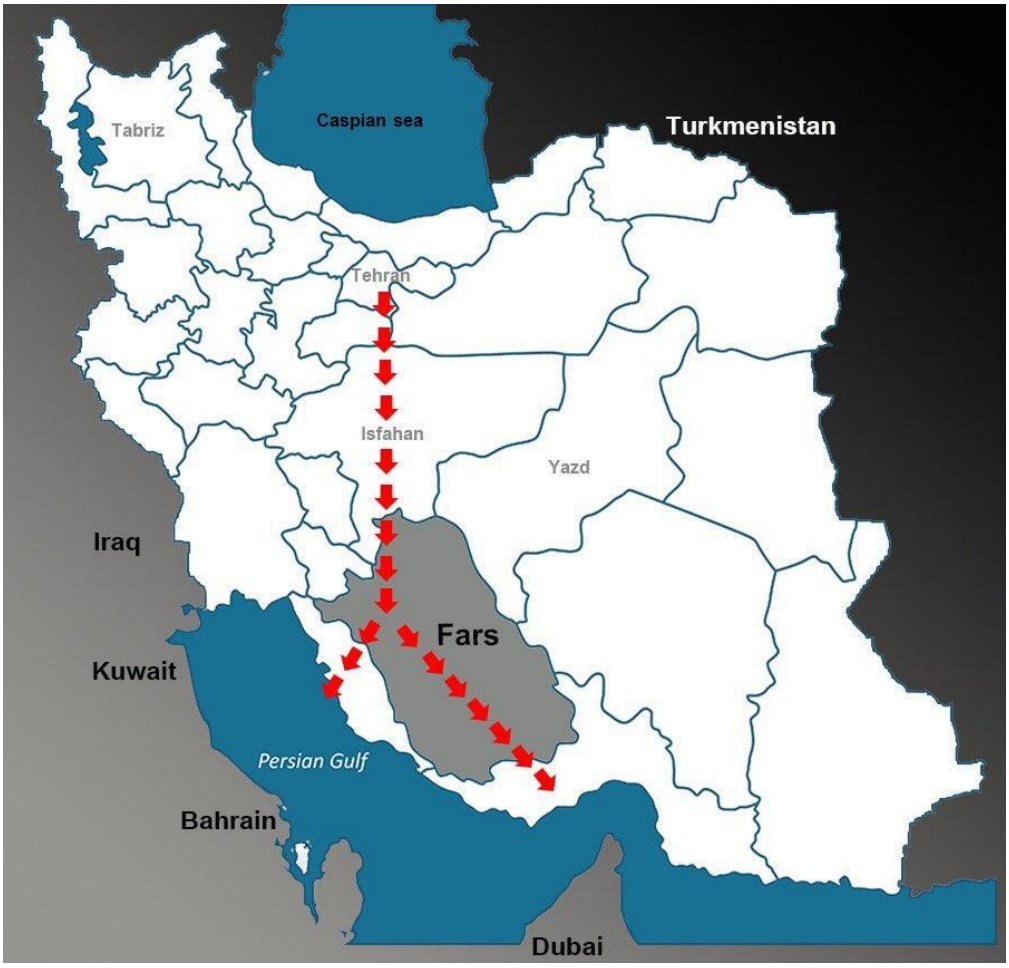


Figure 41. shiraz location and connection to other cities and ports (Re-elaborated by the author based on (https://fa.maps-iran.com/)

- Shiraz city of poets, gardens, tower of saints and abode of knowledge

Shiraz has been for many centuries famous not only for their poets, but also for their saints who lived in pleasure gardens of Shiraz or calm mountain around the city and reflected Shiraz as a paradise in their poems or writings.

This title of “Abode of knowledge” has come from the story of khan school in Shiraz. According to Oliver Leaman, Mulla-Sadra is arguably the single most important and influential philosopher in the Muslim world in the last four hundred years and the school was made for him. This school became one of the best ones of its times and it is still used as educational place. And still today Shiraz keeps its tile by many university campuses, especially Shiraz University.

Figure 42. Tomb of Hafez (www.iranroute.com)

Figure 43. Shiraz university campus before Islamic revolution (Source: www.shirazu.ac.ir)

4.4. Comparison of case study (Shiraz) with Curitiba (Brazil)

In this study, we will compare the city of Shiraz with a sustainable Brazilian city (Curitiba) in the case of city infrastructures and urban development. On the other hand, we will make a comparison between Shiraz and a city in Iran (Isfahan) with the same architectonic methodology in history in case of gardens and a relationship with sustainability.

4.5.1. Curitiba, a model for a sustainable city

Curitiba is the capital city of the Brazilian state of "Parana". It was founded in 1530 as a gold-mining camp and officially became a town in 1812. Its current metropolitan area comprises 26 municipalities with a total population of 3.2 million (IBGE estimate in 2011). The city sits on a plateau at 932 meters above the sea level. It is located 105 kilometers west of the sea port of Paranaque. The humid Curitiba has a maritime temperate climate. It has flooded areas contribute to its mild and damp winter. The city has a surface of 432.17 km2 with the population of 1.8 million people.

Curitiba is one of the most reputable cities in terms of sustainability achievements which can be categorized into six integrated subjects: integrated urban planning, effective public transport system, local environmental consciousness, pedestrian and public priority in the city, social justice concentration and local waste management system (Mills, 2006).

- Curitiba urban planning form

Since Curitiba was declared as the capital of Parana in 1854, the city has gone through several major urban planning projects to manage uncontrolled sprawl. In 1940s, Alfred Agache, cofounder of the French Society for Urban Studies, had introduced the first city plan. The plan emphasized a star of boulevards, with most of the public services in downtown, an industrial district and sanitation infrastructures. In 1964, Jaime Lerner led a team from the Universidad Federal do Parana for urban planning of Curitiba with a number of man objectives including strict controls on urban sprawl, a reduction of traffic in the downtown area, preservation of Curitiba's historical sector, and building a convenient and affordable public transport system based on express buses (Moore, 2007). This plan was adopted in 1968 Instead of a few large-scale planning proscriptions; hundreds of small-scale practical solutions were established to enhance urban qualities.

In 2010 the city was awarded with the "Globe Sustainable City Award'. Integrated urban planning (political, social, environmental, economic, cultural and technical) and implementation of goals by utilizing practical design solutions are key points in this achievement. Curitiba's Master Plan has integrated urban development with transportation and land use planning. It limited the city area growth, whilst have encouraged commercial activities along five transport axes radiating out from the city center. The city center was partly closed to vehicular traffic and pedestrian streets were recreated.

Mixed land use based on high density residential buildings is allowed alongside to transport axes. The density limitation of an area is directly based on its availability to public transportation. Linear development along the "arteries" road cause a considerable decrease in downtown movement need as well as providing new opportunities for commercial and light industries to be located near fast transport thoroughfares. A new industrial city was built in the west side of the city near the sea shore where includes low-income public houses as well (Smith and Raemaekers, 1998).

- Curitiba development

Public transport system in Curitiba is extremely based on buses, which is twisted of development of city. Low cost of installation and operation, fast and easy construction process are the main reason of selecting bus transport system in Curitiba. “In eight years from 1974 to 1982, the bus transport system was expanded from two express bus lanes to five express axes in addition to inter-district bus lines”. The three-part road system in main axes has two one-way streets moving in opposite directions which surround a smaller two-lane street exclusive for express buses (Goldman and Gorham, 2006). Five of these roads form a star that converges near the city Centre.

In 1980s, the RIT (Rede Intergrade de Transported: Integrated Transport Network) was created, allowing transit between any points in the city by paying just one fare (Moore, 2007). The long express buses are split into three sections and stop at designated elevated tubes with disabled access. People pay for tickets at the bus stop so the urban travels become easier, faster and cheaper. The system is used by 85% of Curitiba’s population (Smith and Raemaekers, 1998). It becomes the source of inspiration for many other cities around the world to use their local potentials for transportation instead of costly and time-consuming large-scale systems. The population has doubled since 1974, yet car traffic has declined by 30%. The system reduces the fuel consumption and air pollution as well as environmental costs of urban mobility. Roads are categorized in four hierarchical types: structural (main axes), priority (traffic roads), collector [commercial streets] and connector [industrial connection to axes]. They have a hierarchy regarding to public transport accessibility and land use legislation. Urban terminals are built at the end of each express bus lane with social services and smaller terminals which are located every 1400 meters. The innovative and local public transport system is considered as the pioneer of urban development in Curitiba (Goldman and Gorham, 2006).

Figure 44. Five basic transport axes in Curitiba and development restrictions (solutions-site.org, 2010)

- Local environmental consciousness and citizens' participation

In the early 1970s, when Brazil was welcoming mass industry, Curitiba accepted only non-polluting industries. It also has constructed an industrial district containing a considerable amount of green space that was called "Golf Course". Builders get tax breaks if their projects include green space (Leitman, 1996). Curitiba is referred as the ecological capital of Brazil, with a network of 28 parks and tree-planted areas (in 1970, there was less than 1 square meter of green space per person, but in 2010 there were 52 square meters). Citizens' participation has a great role in this greenery development movement (Brendan, 1998). They have planted 1.5 million trees along city streets. It is a highlighted example of citizens' participation in urban environmental sustainability achievement. There is even a local environmental legislation to control industries, which are desired to be located in the industrial city, to serve environmental quality. In order to achieve the goal of having 52 square meters of green space per inhabitant in 2010, the city has paid careful attention to preserving and improving its green areas. This greenery strategy implementation is closely related to legislations, long term environmental vision and citizens' participation (Goldman and Gorham, 2006).

- Local waste management system

Combining waste management systems with social and environmental purposes provides multidiscipline sustainability for Curitiba. In the "garbage that is not garbage" program, 70% of the city's trash is recycled by residents. The city's paper recycling preserves the equivalent of 1,200 trees a day. The purchasing of garbage program (green exchange) focuses on social and environmental benefits. Low-income families, living in areas unreachable by trucks, bring their trash bags to neighborhood centers, where they exchange them for bus tickets, food and agricultural products. This means less litter, less disease and less garbage dumped in sensitive areas such as rivers. It provides a potential job for the poor. There's also a program for children where they can exchange recyclable garbage for school supplies, chocolate, toys and tickets for shows. The innovative 'Purchase of Garbage' program gives the opportunity of trading the waste for bus tickets, food and agriculture instruments to poor citizens who live in limited-access areas of the city (because of Curitiba's topography and high levels of underground water, some areas are not able to have sewage systems and some are not accessible by garbage track collectors). This strategy provides environmental responsibility as well as social and economic promotion for poor citizens. The city environmental and ecological information Center and city botanical garden were established to enhance the local environmental awareness. Curitiba's sewage treatment system utilizes the local lagoons (located near the river) as a water refreshing system (sewage is recycled in three steps: anaerobic, aerobic and discharging treatment). This system in addition to parallel open-air canals is used to control the seasonal floods as well (Brendan, 1998). New lakes in public parks are designed to solve the problem of seasonal flood.

- Pedestrian priority and heritage rehabilitation

Refurbishment of the city center into a heritage realm in the authority of pedestrians has begun in 1970s. Old buildings were allowed to be rehabilitated with new functions, whilst the public squares were empowered by commercial and cultural facilities. Historical urban elements of Curitiba are used as shopping mall, theatre, creativity center, cultural documentation service, museum; some operate 24 hours, 7 days a week. Downtown area was transformed into pedestrian public space with shops, restaurants and cafes, and the Flower Street (Rua das Flores) which was an urban recreational place (Brendan, 1998). As mentioned formerly, the priority had been given to public transport rather than private cars.

- Social justice, quality of life and public health

Improving the quality of life has been a guideline for Curitiba's municipality. Since 1980s the city has begun a project called the Faróis de Saber (Lighthouses of Knowledge). These Lighthouses are free educational centers which include libraries, Internet facilities, and other social resources. Job providing programs and sustainable income policies are followed in the decision-making process as well as action plans. The concentration of social programs is on poor citizens to provide social justice. The city's public housing program has built one of the largest plots of available lands as the home for 50,000 poor families called Novo Bairro (New Neighborhood) (Smith and Raemaekers, 1998).

Besides environmental benefits, money raised from selling materials goes into social programs. City employs the homeless and recovering addicted people in its garbage separation plants (Brendan, 1998). Sanitation and waste management programs are developed by utilizing local prescriptions to improve citizens' welfare and social justice. From the Curitiba example it becomes clear that social, environmental and economic solutions can be integrated with holistic approaches to promote the quality of life.

- Learning from Curitiba

Table 12 compares the differences exist between Curitiba and Shiraz in terms of some basic urban and transport characteristics. It sounds that two cities are similar in density level, however, Curitiba has better figures in those items related to sustainability: Green space (per capita), recycled waste, public transport usage.

Population density (person per hectare)	Car ownership (per household)	Green space per capita (m2)	Green space per capita (m2)	Recycled waste (percent)	Public transport share
Curitiba	102	0.85	52	70	83
Shiraz	94	0.92	17	3	19

Table 9. Comparison of Curitiba and Shiraz City, (Soltani and Sharifi, 2012).

- Integrated sustainability approach

The Integrated sustainability approach based on "social democracy" is the success point of Curitiba.

City sustainability achievement has three dynamic factors: sustainable decision making, environmental sustainability and social sustainability. Shifting the emphasis on transport system or economic is due to the context of each city. City as a unity needs an integrated sustainability approach with comprehensive and continuous long-term planning and practice.

- Applying sustainability principles in Shiraz

Integration of planning process with concentration on local opportunities and small-scale changes are milestones of the proposed system, which aims to apply extracted sustainability Shiraz with the special consideration on its historical zone.

- Historic district preservation and regeneration

There are several shortages in infrastructural services (sewage system, gas, etc.) and efficient public transportation especially in Shiraz historical zone. This shortage in addition to social problems and land development policies force original occupants to emigrate from the central zone. They are replaced by occasional resident as well as poor dwellers. These new occupants have not deep relationship with the local heritage and also have low incomes. So, the area faces a serious social-economic situation.

There are more than 200 historical houses, 10 palaces, 7 historical gardens, and 30 famous mosques and schools in the historical zone of Shiraz. Although some of them have been used as museums and cultural organization, but the majority of these historical buildings are free of urban functions. Furthermore, the lack of appropriate accessibility affects the daily life. Utilizing the tourism industry is considered as a multipurpose solution for a number of historical zone problems. In this proposal, historical houses are revitalized as small-scale hotels. Because of special pattern of the historical zone, there is an opportunity to combine a few houses to shape bigger tourist-oriented areas. Bazaar-Vakil is a 2 km sheltered-linear shopping area with the plenty of supporting small productive industries in the heart of the historical zone. It can be rehabilitated and empowered by a few numbers of small-scale acupunctural changes in its entrances. Bazaar shops are mostly owned by original occupants of the old town, and it is an opportunity to utilize Bazaar as an activity generator in urban regeneration and citizens' participation. Tourist Oriented Planning (TOP) provides new job opportunities for occupants, which can lead to more sustainable and vibrant society and local economy. He existing areas which have not spatial values can be redesigned to serve essential functions. Some related urban organizations such as architectural consultant companies, social welfare institutions, cultural organizations, traditional restaurants, souvenir shops, and small-scale educational centers can be relocated in this zone. The TOP can be utilized in the whole city. Shiraz has a moderate climate; however, there is only one-hour flight to rich Arab countries which have very hot and arid climate. Therefore, Shiraz can be a destination for many travelers and this can bring new opportunities for the local economy. On the other hand, Fars province has lots of famous historical sites and natural tourism attractions. These all together make a potential ground for tourism development. They can be considered as great heritage interests to promote local social and economic situations.

- Pedestrian-oriented urban design

Shiraz has some problems to serve daily transportation. This causes some urban projects to widen the streets in the central zone. In reality, however, because of private ownership of surrounding properties, the strategy has not been implemented in many cases. Furthermore, the widespread patterns of physical growth have been acted as a motivator to use private cars more. So pedestrian and bike-oriented strategies are practical solution for the long term. In addition to opportunities for people to be connected to the identical built environment, it has some advantages to preserve old buildings from further damages. Car accessibility for emergency usage is available through "needle access". Pedestrian realm of the city is a great opportunity for citizens to reconnect to their history, environmental identity and cultural activities. It represents a different view of life to visitors which is safer, more beautiful and more convenient.

- Integrated transport system

Shiraz city transportation needs to be equipped with collective fast modes such as BRT and subway. Construction of "Shiraz Metro System" (train access) has begun in 2002 to decline the traffic congestions and high mobility demand in the whole city. It is estimated to be operational by 2015. The needle-access streets will be connected to two city express lanes which consist of express buses in addition to the metro system. Each express lane will be supported by two slower traffic lines besides.

- Environmental preservation, riverside and productive gardens

Shiraz has over 400 hectares of fruit productive inner-city gardens inside its metropolitan area. Most of these gardens are located in North- West of the city in "Ghasr-Dasht" area. A few of these gardens have expensive buildings within them. Lemon and orange trees are traditionally grown in private properties (e.g. Bagh-e-Eram) as well as public areas as. There are also local plantains trees grow up without any special care. There is a cultural event in each February (Bahman) when people plant trees one month before the

spring, the so called “planting ceremony” (jashn-e-derakhtkari). It is suggested that the city municipality must provide some tree plantation in this festival. Such location can be used as public green space and as mentioned formerly if local trees are utilized, they do not need special care to grow.
The city river that is a seasonal waterway has a landscape which needs to be promoted as a linear recreational space for citizens. The city bike line is currently stretched through the river and by some small changes in landscape design and safety promotion, it has potential to improve citizens’ health.

Figure 45: Qasr-Dasht garden area of planted gardens in shiraz (Source: isna.ir)

- Waste management system, agriculture and local industries

Environmental sustainability will not be achieved without separating waste in cities it is suggested that household waste must be separated into four section including food waste, paper waste, plastic waste, and material and glass waste. Food waste can be composed into garden fertilizers; paper waste can be recycled locally in paper industries; plastic waste can be recycled in packaging of goods; metal and glass waste can be reused in related industries (Lehmann and Crocker 2012).

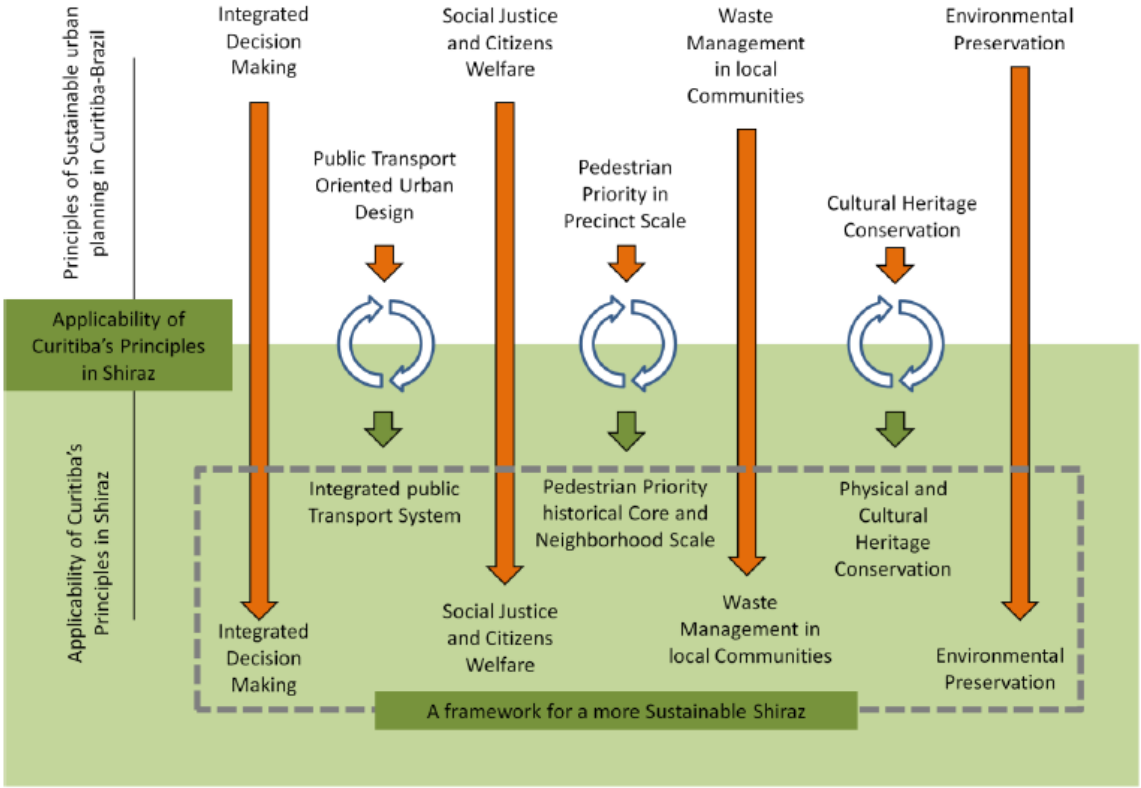


Figure 46. How sustainability principles in Curitiba can be practiced in Shiraz, (Soltani and Sharifi, 2012).

Shiraz has fertilized soil and is one of agricultural centers of the country. It has numerous food production industries, as well as the potential to improve it further. It is suggested that the waste management system, food production and packaging industries must be taken into consideration in an integrated manner.
The concluding diagram for how/what Sustainability principles in Curitiba can be practiced in Shiraz situation can be like Figure 46.
In Iranian historical cities, because of their unique role in country's urban network and their heritage potentials (monuments, sites, and events), the role of social-cultural aspects is stronger. In practice, all of the sustainability aspects should be considered in an adaptive process. In Shiraz case, because of the specific environmental and building characteristics the sustainability framework was shaped along with tourism industry development. Although this sustainability framework can be applied to other historical areas, but it needs to be localized in each context. Priorities need to be changed due to contextual, social, and environmental specifications. The key points are integration of urban planning and implementation of effective actions.
Sustainability of cities can be achieved by balancing four integrated factors: sustainable decision making, sustainable society, sustainable environment and sustainable economy. The balance between these factors is totally related to the context potentials in local, regional and global scales. Every urban environment has its specific opportunities and constraints, but still there are many things to learn from other cities'. Crucial is to investigate successful principles based on existing precedents, analyze them with the consideration of their local context and moderate them in order to apply in other contexts. In the case of Shiraz, it has developed from a historical core, which arise strong social, cultural and economic opportunities for the city. As such, the practiced sustainability principles in Curitiba need to be moderated to some extent to be able to match Shiraz specific context. It is also vital to consider limitations of case study research findings regarding to generalization and application of findings. Due to complexity of physical, social, cultural and environmental systems in sustainable urban planning, strategic planning for a city needs to inspire from several successful precedents and contextual opportunities and constraints. Implementation of strategies is the other vital criteria which need to be investigated locally.
The "principles" behind Curitiba's many success stories are described as physical planning strategies. As a result, the application of Curitiba-like strategies to the context of Shiraz is theoretically limited. Curitiba and Shiraz are both governed and planned by technocracies, their political contexts are different. What emerges from this more critical strand of thinking is that Curitiba is not that different from other Brazilian metropolitan areas (in terms of its spatial and environmental contradictions). Moreover, considering the paper's emphasis on qualitative and context specific analysis, much analysis on actors, institutions and the planning and management framework in the city of Shiraz are possible through further research. These are crucial for a deeper understanding of the possibility of the Curitiba narrative "to travel" to Iran. In other words, it is important to identify the drivers which have positive and/or negative influences on the process in each of the two case studies. The sustainability principles need to be directed according to the identified drivers.

- Traffic control management

Establishing traffic control zone is one of the methods and policies used in some large city centers to reduce traffic flow. Recently with the decision of the State Traffic High Council it is expected that some major cities in Iran including Shiraz implement traffic control zone in near future.

Figure 47. Zand cross street, which completely ordered, based on automobile around 1960 (Source: www.nescafe.ir)

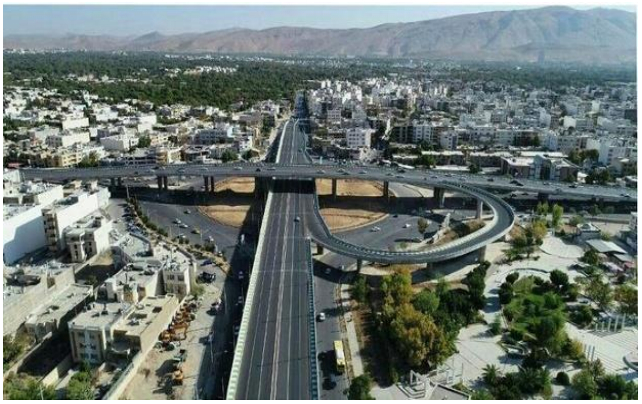


Figure 48. Street network for reducing the traffic in Shiraz (district 1st). (Source: jamaran.news)

4.5. Sustainable traditional gardens in Shiraz and Isfahan (Iran)

The history of creation of Persian garden dates back to 6 (BC)[14]. During the Acamenid era and the garden design in Iran had evolutionary process during the history till the 19th century. The studies show the first Persian garden was built in Passargad near the Shiraz by Cyrus the great in 6 (BC). This archetype of Persian garden is called Chahar-Bagh, which means four gardens. The ancient royal gardens of Acanemid emperors with the palaces which were opened to the green spaces are called Pardice. “Pardice” means garden in Farsi and this word entered Semitic languages getting the form of, Hebrew Pardes, Arabic Ferdous and it is adopted in English as “Paradise”, expressing such gardens which have been closed with features based on climatic conditions and sustainable principles. The reminders of stone channels in Passargad were discovered by archeologist David Stronach during his excavation of that historical site and in his first depiction of Passargad (Fadaie & Mofidi, 2012); the rectangular Passargad garden has also pavilions and water channels (Figure 49). Until only a few years ago, there was a still prevalent opinion that the celebrated garden carpets of the sixteenth-century Safavid Iran provided the oldest extant evidence for the form of the early Persian garden.

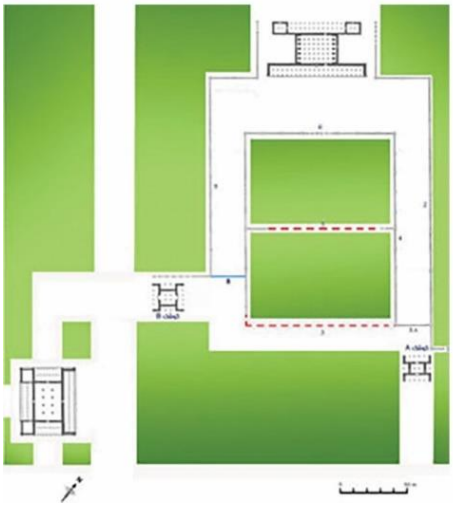


Figure 49. Pasargad garden, Archtype of Persian garden, depicted by David Stronach (Source: re-elaborated by the author, Khansari et al., 2004)

[14] BC abbreviation of Christian’s era and stands for: before Christians.

- Hasht-Behesht and Chaharbagh gardens

According to archeological findings described above, along with historical sources and also observations of current gardens of Iran, it can be concluded that the main design elements of Persian garden which are nearly the same in all of them are the grids of natural elements: water, vegetation and the built elements, pavilion which usually occupies minor axis and walls. Walls acted as borders between inside and outside. Other ancillary elements like service spaces (bath, stable) are also considered for arrangement of gardens. The compositions of natural and built elements in design are with

The selected case studies are two existing gardens in two different cities in arid regions of Iran. Selected gardens, previously used for royal ceremonies in Isfahan and Shiraz, are nowadays used as public gardens for leisure. Hasht-Behesht is the only surviving garden alongside the Chaharbagh Avenue (Hooshangi, 2000). This Avenue built in the Capital city of Isfahan in 17th century during Safavid era, was surrounded by extensive royal gardens and pavilions (Figure 39 and 40). Hasht-Behesht garden, also called Bolbol (nightingale) garden, was used for royal ceremony during hot summer days. During the history, many parts and elements of Hasht-Behesht garden and also the gardens, located around it, were demolished and nowadays, Hasht-Behesht garden with its historical pavilion is the surviving part of the vast royal Safavid garden.

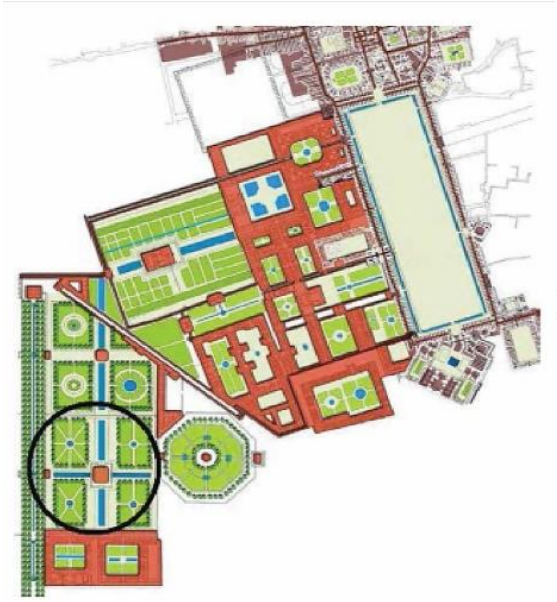


Figure 50. Hasht-behesht garden (Source: Re-elaborated by the author, Iran cultural heritage organization of Isfahan, 2013)

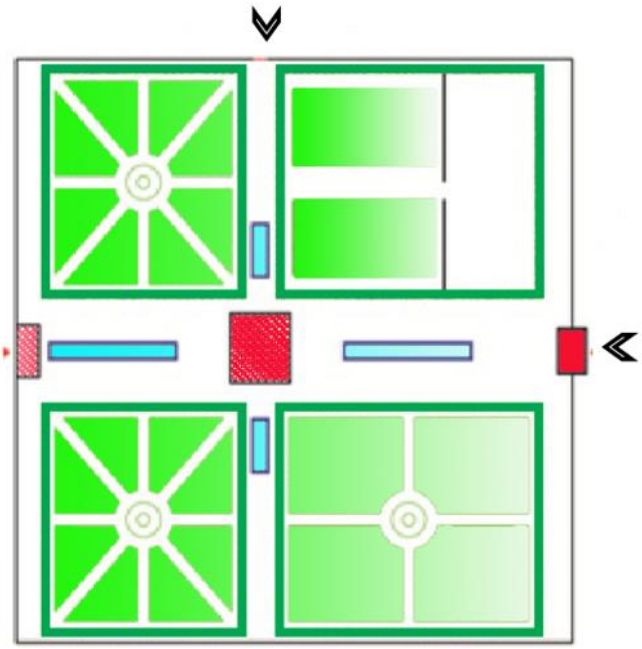


Figure 51. royal chaharbagh avenue during savafid era Isfahan (Source: Re-elaborated by the author, Iran cultural heritage organization of Isfahan, 2013)

- Jahannama garden is one the oldest surviving gardens of Shiraz

First, it was built in the 14th century but the garden was reconstructed and its main pavilion was created in 18th century during the Zandieh era, when Shiraz was the capital city of Iran. The garden was located outside the city, alongside the main road between Shiraz and Isfahan at that time, but gradually after the development of city, it has become an urban green space (Figure 52). According to description of French traveler, Chardin (17th century), the road was the main Avenue of the city, which connected the Quran gate (main entrance gate of Shiraz) to Bazaar and the gardens placed opposite to each other alongside the road (Noroozborazjani, 2004).

Figure 52. plan of Jahan Nama garden in Shiraz (Source: Iran Cultural Heritage Organization of Fars, 2012).

Figure 53. Jahan nama garden in Shiraz 2012, (Source: Photo by Amir Hossein Z.)

- Sustainable Features of Garden's

- Natural elements:

Water and vegetation are natural elements of Persian gardens, which are acted as key ingredients in garden design. Since the gardens have been built in arid regions, water is used as an important design criterion to create a comfortable microclimate in Iranian gardens by channeling breeze over the existing water to reduce air temperature and increase humidity. Moreover, the extent of garden has followed the amount of it. Another important modifying element is vegetation, which has been utilized to guide and filter the breeze and to increase evaporative cooling by planting suitable vegetation, and also to provide shade and to absorb radiation by strategic location of them. Except for the central axis in Hasht-Behesht and Jahannama gardens, on which the pavilion is placed, the entire garden area is covered by vegetation. The vegetation in these gardens is used not only to increase the humidity, but also to create a comfortable environment by making shade and shadow. In both selected gardens, there are two items related to existence of water which have effective roles in creation of gardens as microclimates.

City	Altitude	Annual Temperature	Temperature in Hottest Month	Annual Humidity	Annual Rainfall in Wettest Month of Winter	Annual Rainfall in Driest Month of Winter	Annual Rainfall in Wettest Month of Summer	Annual Rainfall in Driest Month of Summer	Conclusion
Isfahan	1550	16.6	29.2	35.5	46.3	4.4	1.5	0	BWks
Shiraz	1484	18.8	31.2	37.9	94.4	54	2	0	BShs

Table 10. Climatic conditions of Isfahan and Shiraz [15]

[15] Weather statistics used in this paper are retrieved from synoptic station statistics of Iran's weather website during ten years (1995-2005): http:// irimo.ir/statistics/synop-H/index1.htm.

- Built Elements

Pavilion In spite of the most traditional urban buildings in the arid regions that are introverted, in the gardens like Hasht-Behesht and Jahannama, the built spaces like pavilions are extroverted. The reason could be the existence of massive texture of vegetation and water in the garden to create a desirable microclimate. The garden pavilions are analyzed from these points of views:

- Location and Orientation

The pavilions of Persian gardens are located on the main axis, from center to the end of the garden. In Hasht-Behesht garden, the main pavilion, used as summery residence for royal family, was almost located in the center and in Jahannama garden, the pavilion was placed in the center of garden. In both gardens, the pavilions stood on the stone- faced platforms to prevent the entrance of dust in to the buildings. Both pavilions were opened in to four sides to utilize breezes from all direction, and also, they were orientated to southwest, following the orientation of their gardens.

- Passive Cooling Strategies of Pavilions

The most important strategies for passive cooling in building' s design in arid regions are: to provide shading and natural ventilation by wind and water. The mentioned strategies have been noticed for Persian pavilion design by creation of appropriate spaces and evaporative cooling elements for many centuries.

- Water Pond and Streams

In both selected gardens, there are central ponds inside pavilions for evaporative cooling in spaces. Although the physical effect of evaporation is essential, the psychological effect of water is even greater. The sound of water inside the building is known to bring relief. Furthermore, in both selected cases, the existence of ponds and water canals around the pavilions can modify airflow (Fig.8 and 9). Hot air can be cooled if passed over the water. The pond with its fountain in the northern Iwan of Hasht-Behesht pavilion makes the weather cooler and more humid during the hot summer days and in the southern Iwan, the flowing water from the pond in upper level, poured on the wall and then flowed into the pond of central space of ground floor (Tafazzol& Bahramian, 2013). In Jahannama pavilion, because of the location of building on 120cm platforms, the water from inside pond flowed in to the outsides ponds via four cascades. The placement of water ponds inside and around the both selected pavilions made the weather more pleasant for their residents.

- Shading Devices

Use of shading devices is an important strategy in sustainable design. They should be designed to reduce direct solar radiation and prevent reflection onto any part of the building or opening (Fadaie &Mofidi, 2011). Both selected pavilions are protected from the intensity of sun by arcades and porches as shading devices. Moreover, in the pavilions placed in such hot and arid climates, the porch provides link from the building to the outside, keeping the sun off those under its roof and shading the structure it adjoins (Hooshangi, 2000). Another shading device in Persian Garden is wall, which acts as a shading device by creating shadow and also has other climatic functions such as protecting the garden against hot dusty winds while preserving humidity inside the garden (Shahcheraghi, 2010).

- Building Materials

The main material used in selected pavilions is brick. Choosing brick has several factors to be considered: it has high thermal resistance, high thermal capacity and sun absorption. It doesn't require much energy to produce and also has the potential for reuse if the building is demolished. Furthermore, another vernacular material such as tile was utilized in some parts of Hasht-Behesht pavilion. These vernacular materials can be found resourcefully in arid regions.

- Architectural comparison between Hasht-Behesht and Jahannama Gardens

From the above discussion and table indications, this information is obtained: Both selected gardens are orientated according to wind directions; The placement of pools all around the pavilions in both selected cases is the strategy for evaporative cooling in Persian gardens as sustainable green spaces in arid regions; In both selected gardens, the pavilions are orientated according to garden orientation; As tables1and 3 indicate, in the hotter city, Shiraz, the amount of water in pavilion is more than that in Hasht-Behesht pavilion in Isfahan; Since the intensity of solar radiation in Shiraz is more than Isfahan, the area percentage of semi-closed spaces in Jahannama pavilion is more than that of Hasht-Behesht pavilion.

Figure 54. Hasht-behesht pavilion in Isfahan (esfgard.ir)

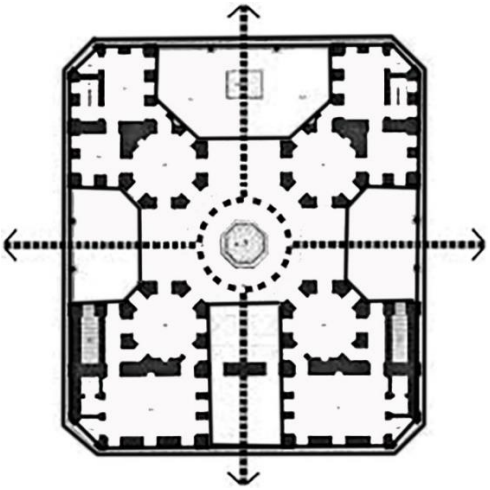


Figure 55. plan of Hasht-behesht pavilion (Source: Iran cultural heritage organization of Isfahan, 2013)

Chapter 5.
Strategies and challenges toward sustainability (Shiraz)

Prior to modernization, Persian cities were generally formed under the influence of internal features. In other words, the main goal of these cities was to serve the basic needs of the people. The materials used in their construction came from their own origin, and it was from a local culture that designed and built the city. Therefore, the process of formation and development of Persian cities is influenced by three main factors:

- Natural environment
- Historical and commercial events
- Socio-political structure

Based on these factors, the Persian cities situated where it could make the most of the benefit of nature. Shiraz is surrounded by mountains and takes advantage of the good conditions of these fertile plains. These mountains also played a powerful defensive role.

All these factors would be more impressive when the city finds an important political role and in this time the city needs more social, religious, cultural, educational and political services to serve the important urban population. Shiraz is one of the Persians cites that has passed through all this processes. (Karimi, 1997)

This study focuses on the potential of implementing sustainable smart cities in the current position of the city of Shiraz. Therefore, it is important to consider what strategies can make the city a sustainable city and, on the contrary, what challenges will have an impact to become a sustainable city.

5.1. Shiraz population analysis

Chart of population level and growth rate for the Shiraz, Iran metro area from 1950 to 2020. United Nations population projections are also included through the year 2035.

Shiraz's 2020 population is now estimated at 1,651,362.

In 1950, the population of Shiraz was 127,552. Shiraz has grown by 112,789 since 2015, which represents a 1.42% annual change. (United Nations – World Population Prospects). These estimates represent the Urban agglomeration of Shiraz, which typically includes Shiraz's population in addition to adjacent suburban areas.

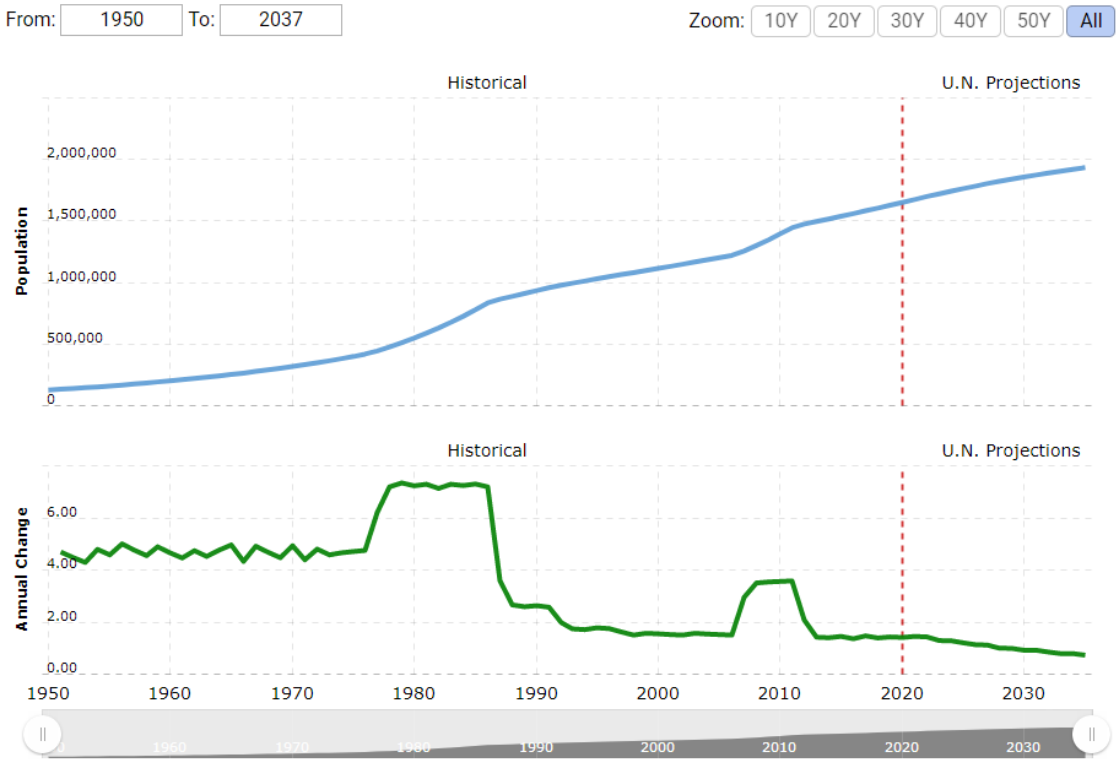


Figure 56. Shiraz population growth from 1950 to 2020 (United Nations – World Population Prospects)

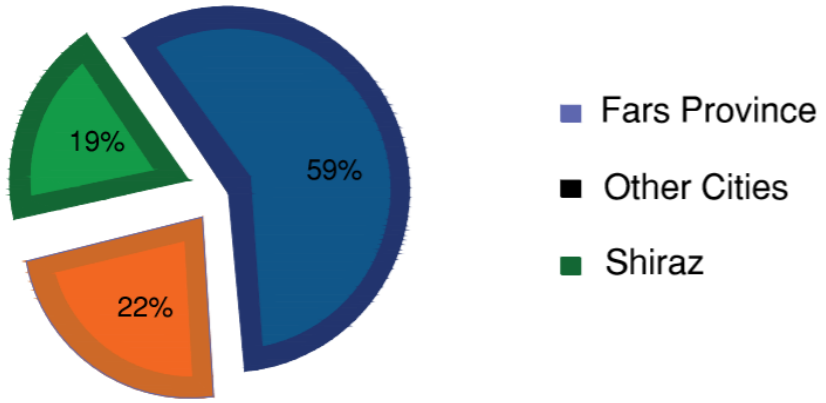


Figure 57. Shiraz population in comparison with Fars province in 2017 (Annually statistic of Shiraz population by Shiraz Municipality, 2013-2018).

Different reason based on Shiraz population: (171 United Nations – World Population Prospects)

• Productivity rates can be the leading reason of population enhancement in Shiraz

• Departure from smaller areas and rural regions to Shiraz

• Government helps such as financial public assistances for the fundamentals that support businesses, new housing and residents.

Ghodoosi area is situated in 1st district of shiraz city and in figure 46 it has shown by blue color, (172 Sarvestani et al.,2011).

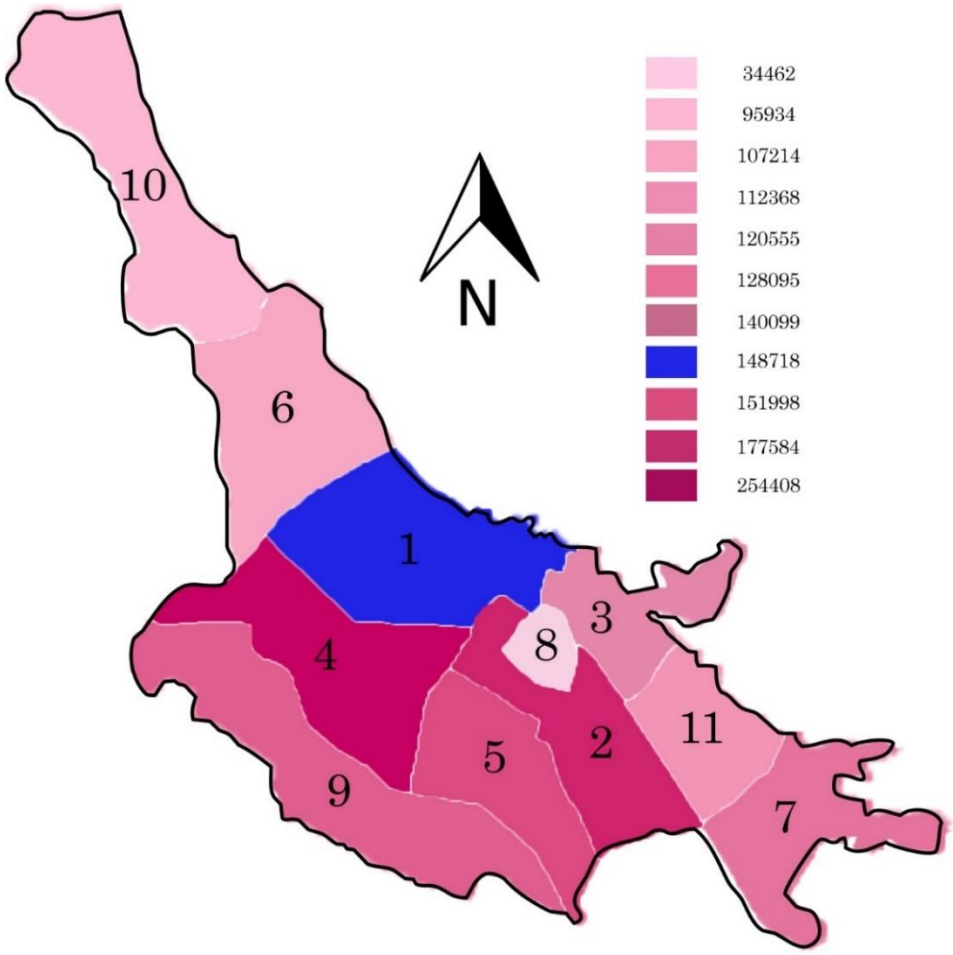


Figure 58. Distribution of Shiraz population districted by governments 2017, (Sarvestani et al.,2011).

The area of Shiraz city increased from about 2,200 hectares in 1956 to around 18,623 hectares in 2011. The growth of Shiraz city in last 65 years has occurred on former agricultural land and rural areas especially, agricultural lands which have been ideal for its expansion. Urbanization has displaced agricultural activity to less productive areas. Many villages around Shiraz have joined to it and they are not as cultivated area as once they used to be any more. Figure two shows the growth of Shiraz from 1956 to 2011. (Movahed, 2012.)

Looking at charts (47, 48, 49), it simply shown that 1st district of Shiraz has approximately moderate ratio of population and density of population in order to its area.

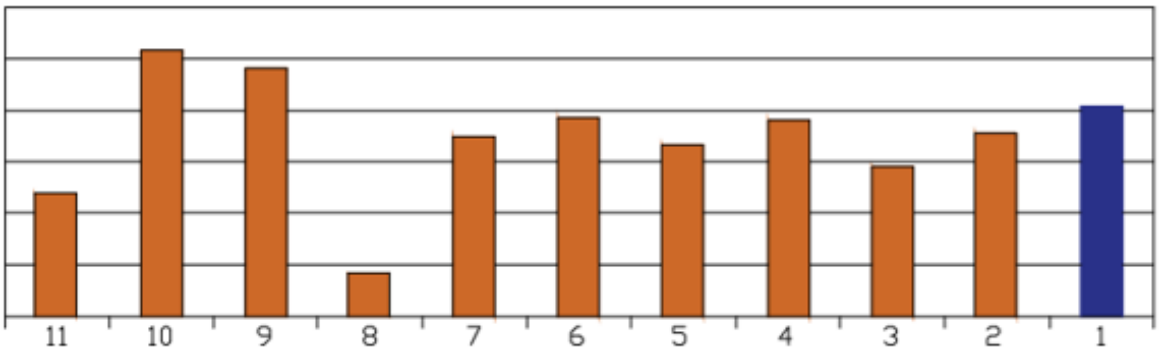


Figure 59. Comparison chart of different areas of Shiraz municipality, (174 Annually statistic of Shiraz population by Shiraz Municipality, 2013-2018).

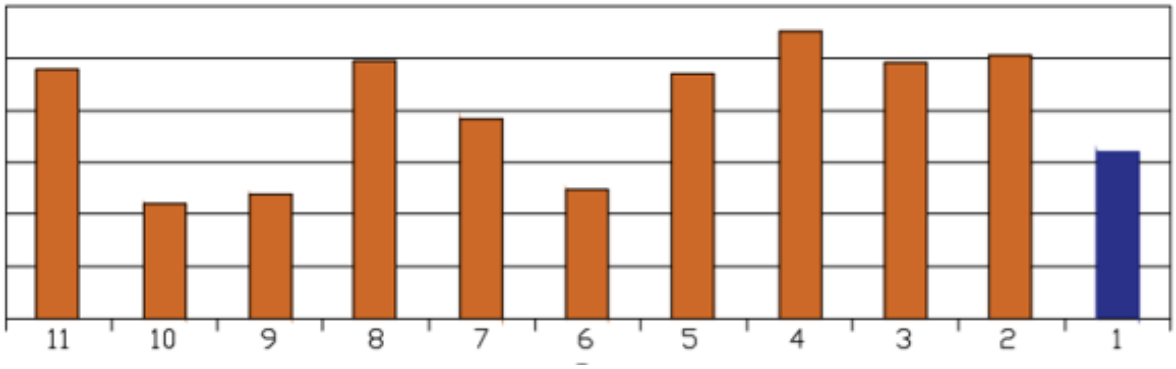


Figure 60. Comparison chart of population density of Shiraz municipality, (174 Annually statistic of Shiraz population by Shiraz Municipality, 2013-2018).

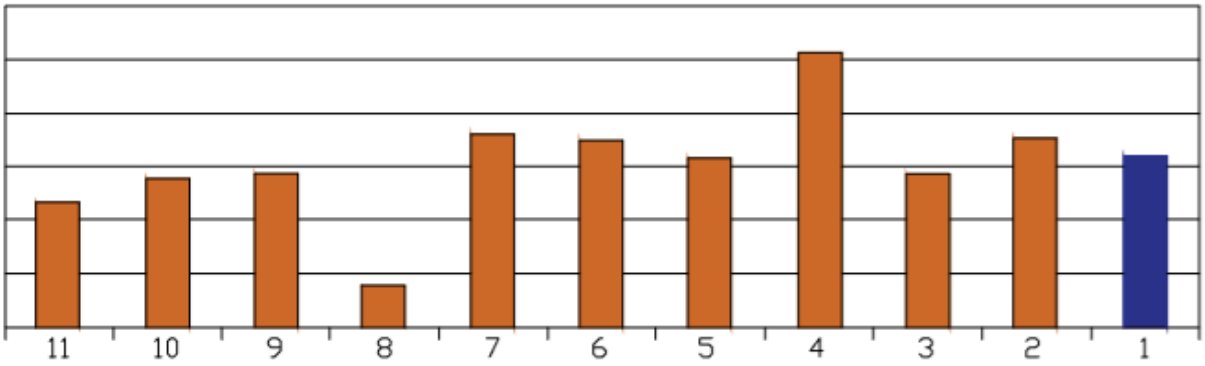


Figure 61. Comparison chart of population of Shiraz municipality, (174 Annually statistic of Shiraz population by Shiraz Municipality, 2013-2018).

5.2. Problems of sustainable urban planning (Case of Iran)

The basic concern of city-town planning is the internal form, structure, function, and appearance of urban areas.

Iran's sustainable urban planning faces increasing public spending, increasing traffic, environmental issues, housing spending, economy, and transportation. These issues can actually contribute to increased public costs due to these changes in infrastructure and buildings Can affect housing costs and high debt levels contribute to savings. In relation to these general issues, we have classified some of the basic urban planning challenges in Iran.

- Scope and dimension of the problems

The major responsibility of the urban planners and designers in Iran is to plan new sustainable towns and lodge the increasing population successfully. The sustainable development requires good placing and setting of the new towns regarding the necessary natural resources, particularly the water resources and provision of urban infrastructures. I agree with several scholars for example Ning and Hoon who believe that sustainable new town planning and design has many difficulties and dimensions (Ning and Hoon, 2011). In Iran the sustainable urban planning and design has dimensions originated from the particular regional characteristics. To list those dimensions for the case of Iran I shall name knowledge, planning, physical design, architecture and aesthetic, infrastructure, natural resources, environmental components, climatic hardness, and socioeconomic conflicts. Table 11 categorizes the regionally experienced and observed problems in different groups as follow:

Categories of problems to meet sustainable city urban development
1- Non-sustainable
2- Knowledge and new technologies
3- Natural resources
4- Environment
5- Planning
6- Physical and skeletal design
7- Firmness, resistance and duration
8- Infrastructures
9- Functionality
10- Architecture and aesthetics
11- Culture and traditions
12- Poverty, fairness and rationality

Table 11. Different problems to meet sustainable new town planning and design, (Ning and Hoon, 2011).

- The cities are not sustainable

Planning of sustainable new towns plays a significant role in the human communities. Wheeler on his article defines sustainable urban development “Sustainable urban development improves the long-term social and ecological health of cities and towns” (Wheeler, 1998).

Generally, sustainable development refers to a city’s ability to meet its needs. Michael Kinsley writes on the meaning of the sustainability.” A sustainable development means stewardship; careful, economical, and long-term management of land, community, and resources” (Kinsley, 1997). In the case of Iran, the rapid urbanization threatens the health and productivity of cities. There are intimate links between poverty, economic development, natural resources assets, adequate infrastructure, and sustainability both in theory and in practice. In the process of urbanization, it is impossible to consider one problem independently from the whole obstacles. The need for adequate and sustainable human settlement leads planners and designers directly to many questions. Where does the potable water come from? Where do household wastes go? Who does pay for the services? There are still important questions about the social rights, combating poverty and the provision of urban infrastructure that are linked to the sustainability of a city. In discussing the outlook for the sustainable city, principles and regulations are needed. The regulations and acts shall respect local particular situation as well. Therefore, the sustainable city does not have a one definitive form and every new town parallel to the international agreed standards is related to its particular natural and social conditions. So, the scientists highlight some dimensions of the sustainability depended

to the region. As a sample Orrskog believes that a city is sustainable when it obeys the ecosystem: “The city, understood here as a built environment in the landscape, should obey the following necessary rules: save ground, leave the ecosystem as gene banks and build with a regard for the carrying capacity of the locality” (Orrskog, 1993).
To save the ecosystem the city’s technical support systems should keep natural resources while it is robust, flexible, and versatile. Several scholars believe that we will meet a sustainable city when the inhabitants participate in the process of planning. For instance, Mahdavinejad and Abedi applied the quality function deployment, QFD, as a new method used to provide the public participation. “QFD technique creates a specific link between customer preferences and design guidelines. It uses the demands of the citizens as the major determining factor in the process to plan and design sustainably” (Mahdavinejad and Abedi, 2011). Clearly, the urban planners and designers must solve the all said problems and other incoming problems to meet sustainable results.

- Sustainable new town planning requires new knowledge and technologies

One problem in sustainable new town planning is non-existence of new knowledge, information, technologies, experts and modern work styles. The regional developers need new knowledge, technologies, and skilled engineers to solve the increasing urban critical problems. There are many technologies in the world that could contribute to better works and better outcomes, but the region does not access to them. Trying out of new knowledge and the use of advanced technologies in urban planning and design is almost a new phenomenon. Therefore, I understand well when Seto and Christensen suggest to the developers everywhere using new technologies for better results. “Satellite remote sensing is not only useful for consistent aggregation across scales; it lends itself to the development of consistent datasets that can be examined as a large statistical sample of urban areas” (Seto and Christensen, 2013). Several scholars discussed on the issues related to use of knowledge and new technologies and creativity to improve the outcomes. I accept that the lack of knowledge and the technology causes many unsuccessful urban planning and design. Thus, the regional planners need to boost the infrastructure network for knowledge provision. I believe that many urban crises are emerging because of the absences of knowledge bodies while planning and designing new towns. I think that the knowledge infrastructure network provides information to optimal urban planning and possible the exchange of knowledge between regions to use their experiences.

- Shortage of natural resources

One major problem in Iran is degradation of natural resources and disappearing of the little water resources by the time passing and raising of population density. So, the problem stops the regional new town projects. While the new town building requires adequate water resources, the planners concern on water resources. Iranian planners may recognize well when Merret becomes concerned over the global problem of water assets. Merret reflects the concern as “In addition to the increase in the world’s population in the early years of the new millennium there is a second source of anxiety on the future availability of global water resources for people” (Merret, 2002).
Generally, the degradation of natural resources happens because of drought. Drought is caused by the lack of rainfalls and precipitation. From the other side in the arid and semi-arid regions of Iran the sun shining and high degree of temperature produces water vapors. Worse, water vapor and strong regional winds make soil erosion. Thus, both water and land become degraded. While these combined factors do not support precipitation volumes enough to reach the surface of lands, the result is a drought. Again, as a loop, this can be triggered by high levels of reflected sunlight and above average prevalence of high-pressure systems and winds. This loop repeatedly happens with different frequencies. The regional

developers shall overcome the cycle and try to prevent the drought and desertification periods. To overcome they shall give necessary natural resources to plan and build new towns. I see the correlation between the problem of unplanned sharp rising of the population and the need for water resources to build new towns in the region. As Sergio and Cuadrat believed commonly “Humans can directly trigger exacerbating factors. The issues of over farming, excessive irrigation, deforestation, and erosion adversely impact the ability of the land to capture and hold water”, (Sergio and Cuadrat, 2007). When regional drought persists, the lack of water resources is worsening not only gradually but with a high speed, and the undesirable impact increases. The result is a drought worse than the agricultural drought, a hydro drought. (Hogan, 1973) defines the hydro drought as “Hydro drought is brought about when the water reserves available in aquifers, lakes, and reservoirs fall below the statistical average. Hydro drought tends to show up more slowly because it involves storing water that is used, but not replenished”. Planning, designing, and constructing of the new towns require adequate water resources which is a real problem in Iran.

- Environmental crises

Damaging of the environment is another sensitive problem in Iran. Compacted mass population harms both social components of the built environment and natural components of the living environment. The ultimate responsibility is environmental protection. The regional planners shall try to mitigate the impact of development projects on the society and decrease the overall effects of development on the local and global environment. Protection of environmental components will be possible with the help of the climatic architecture. (Vadiati and Kashkooli, 2011) suggest ways for the institutions to get to grips with the environmental sustainability: “Environmental sustainability is established on the following aspects:

- Conserving of the earth’s vitality and diversity.
- Conserving of life support systems.
- Use renewable resources
- Minimizing non-renewable resources.
- Minimizing of pollution and damage to the environment and the health of living creatures.
- And conserving of the cultural and historical environment” (Vadiati and Kashkooli, 2011)

Transportation and traffic will continually produce much noise and poisonous gases. Hogan considers noise as an urban pollution source. “In urban planning, sound is usually measured as a source of pollution” (150). Since noise pollution and toxic contaminations are at a high degree in Iran’s cities, the urban planners shall have to mitigate the problems as well.

- Planning difficulties of sustainable new town building

It is strange that many new town projects do not follow the academic and classical ways to conduct feasibility studies first. Social pressures of demands for homes and urban spaces force the decision makers to address the demands when they build a new town. This is a self-automated development without ex ante and ex post analysis. In Iran, there is a game between power, planning, and people. People produce social pressures and power bodies invest less in public and new town projects. From the other side experts and scientist urban planners insist on working with knowledge and new technologies to meet their targets. The urban planning process in Iran does not include a suitable relation among the authorities, the knowledge bodies, and the people (Ziari, 2006). I think that the planning ideas of Sager cause public participation when stated “It makes sense to let the various interests have their say before the developer’s ideas about the project become set in stone” (Sager, 2001).

Amongst the various ideologies on the planning process, the region does not have the communicative model of planning, while more useful for the new town development projects. The currently used model of

planning does not focus on communication to help different interests in the process of planning and designing. The region needs public participation to include a range of voices in the process of plan making. As Lane suggested the inhabitants shall be the core of the model of planning. “In this model of urban planning, participation is fundamental to the planning process happening. Without the involvement of concerned interests there is no planning” (Lane, 2005). Several scholars discuss whether the communicative model of planning is a rational method or not. During the recent decades, the rational models of planning have been the most widely accepted models. The aim of the rational planning model is to make planning coherent and systematic as possible. However, the struggles among power, knowledge, scientific planning, and communicative drafting of urban planning are still unsolved in Iran.

- Physical and skeletal design

Since the majority of people are poor and the state does not invest in the urban development projects, skeletal and physical shapes of the cities are usually undesirable and unhealthy. Particularly, the informal urban districts, which have been built by self-automated forces, suffer the skeletal problems. Since the plazas, streets, and passages had not been planned with the help of architectural design, the geometrical shapes of urban places are problematic. The areas lack the needed urban infrastructure and services and when people try to supply the infrastructure, their attempts cause uncommon, irregular and twisted urban cityscapes.

- Resistance and duration

Natural disasters of floods and earthquakes are major sources that threaten the cities in Iran. Unfortunately, the cities cannot be protected against the threats and cannot tolerate the earthquakes either. Table 12 reports the frequency of the most powerful earthquakes in Iran.

Cycle of return (Richter scale)	Magnitude of earthquake
Every 2-4 weeks	4-5
Every 2 years	6.5
Every 5-10 years	7

Table 12. Earthquakes with more than six Richter during the last century in Iran, Source: (Tasnimi, 2001)

The table states that Iran is home for repetitive strong tremors which are very often so powerful that they kill many people. Table 2.3 shows a list of the recent earthquakes with their human and physical damages. The table reports the mortality outcomes of major earthquakes during the last century. It shows the importance of the problem, but the figures could be higher since the statistical data may fail to report the reality. Therefore, the developers must plan and design the cities to be resistant against the problem of natural disaster attacks. This problem urges the urban planners and designers to find logic and rational answers to the following questions:

- Where and on which landscapes shall people build their homes and other urban spaces to face less damage when an earthquake happens?
- In what form shall people build their buildings to stand against

earthquakes?

- Which structural system must they apply to produce tolerant buildings?
- What building material shall people use to produce light and safe buildings?

The general way is to urge people to accept the earthquakes as naturally recurrent events and live with them, but with a new look at urban planning, design, and construction.

Year of earthquakes	Place of earthquakes	Magnitude	Description of losses
1909	Silakhor	7.4	Killed 8000 people, damaged 64 villages
1911	Ravar	6.7	Killed 700 people, damaged 4 villages
1923	Torbat	5.6	Killed 770 people, damaged 5 villages
1923	Bojnord	6.5	Killed 157 people, damaged 10 villages
1923	Kerman	6.9	Killed 200 people, damaged 5 villages
1927	Baluchistan	6.5	Unknown
1929	Koppe dagh	7.1	Killed 2200 people, damaged 88 villages
1930	Salmas	7.2	Killed 2415 people, damaged 60 villages
1931	Zangzor	6.5	Unknown
1934	Baluchistan	7	Unknown
1935	Mazandaran	6.3	Killed 480 people, damaged 26 villages
1941	Birjand	6.4	Killed 680 people, damaged many towns
1945	Chabahar	8.1	Killed 4000 people, damaged 12 villages
1947	Doostabad	8.2	Killed 400 people, damaged 5 villages
1952	Semnan	?	Killed 183 people, damaged 200 villages
1956	Gode	6.3	Unknown
1957	Mazandaran	7.4	Killed 1500 people, damaged 150 villages
1957	Bakhtaran	7.3	Killed 1130 people, damaged 200 villages
1958	Nahavand	6.7	Killed 191 people, damaged 110 villages
1960	Lar	6.1	Killed 400 people, damaged 75% of the city
1961	Dehkoye	6.8	Killed unknown numbers, damaged40%
1962	Boyin Zahra	7.2	Killed 12200 people, damaged 300 villages
1968	Dasht bayaz	7.2	Killed 10000 people, damaged 61 villages
1968	Ferdos	6.4	Killed 750 people, damaged many villages
1979	Bampoor	6.7	Unknown
1970	Marave tappe	6.7	Killed 200 people, many physical dammages
1972	Gheer	7.3	Killed 5010 people, damaged 50 villages
1974	Bandar abbas	6	Killed 6000 people, damaged 2655 villages
1976	Makoo	7.3	Unknown
1977	Bandar abbas	7	Killed 128 people, damaged many villages
1979	Tabas	7.7	Killed 18220 people, damaged 85 villages
1980	Khaf	6.6	Killed 420 people, damaged 4 villages
1980	Bolyabad	7.1	Killed 130 people, damaged 150 villages
1982	Golbaf	6.7	Killed 1100 people, damaged many villages
1982	Sirj	7.3	Killed 1300 people, damaged many villages
1991	Roodbar	7.4	Killed 35000 people, damaged many towns
1994	Sefidabe	6.6	Killed 6 people, damaged 300 homes
1997	Bojnord	6.8	Killed 100 people, damaged 10 villages
1997	Ardabil	6.1	Killed 965 people, damaged 3 villages
1998	Ghaen	7.3	Killed 1560 people, damaged 100 villages
2011	Abhar	6.5	Killed 200 people, damaged 189 villages
2013	Saravan	8	Unknown

Table 13. Fatal earthquakes in Iran during the last century, Source: (Abolhasanzadeh, 2013)

5.3. Earthquake analysis in Shiraz city

As experienced in the recent past, e.g., the Tohoku earthquake in 2011, in Haiti in 2010, in China in 2008, and most recently in Nepal in 2015, earthquake events can be devastating, with a large number of casualties and economic losses. Similar to the case of weather-related risks also for earthquake risks, one key element for a sustainable disaster risk management strategy is the accurate assessment of potential future losses, corresponding event probabilities and capacities to cope with them.

To assess risk on various levels and to adapt to changes in risk, iterative loss estimation and management play a vital role as property values change over time, as do the costs of repair and replacement, also building materials, design and practice change along with new building codes. Therefore, new structures maybe more or less vulnerable to catastrophe events than existing ones which has to be taken into account in future planning (Grossi and Kunreuther 2005).

- Methods and materials

As experienced in the recent past, e.g., the Tohoku earthquake in 2011, in Haiti in 2010, in China in 2008, and most recently in Nepal in 2015, earthquake events can be devastating, with a large number of casualties and economic losses. Similar to the case of weather-related risks also for earthquake risks, one key element for a sustainable disaster risk management strategy is the accurate assessment of potential future losses, corresponding event probabilities and capacities to cope with them.

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Iran is a very earthquake-prone country, and risk management is seen as one key element to decrease current and future human and economic losses. The need to proactively engage in developing appropriate instruments is now widely accepted as very important for tackling emerging risks and for resilient development. In Iran, one prime focus is on structural mitigation measures which should reduce economic as well as human losses for today and in the future.

The last earthquake that happened near to the city of Shiraz it was in the end of January 2020, measuring 5.2 on the Richter scale. The epicenter of the quake was located at 41 km west Shiraz. (Seismological Center of the Geophysics Institute of Tehran University)

Most critical points of earthquake in Shiraz city has been shown in (Figure 62).

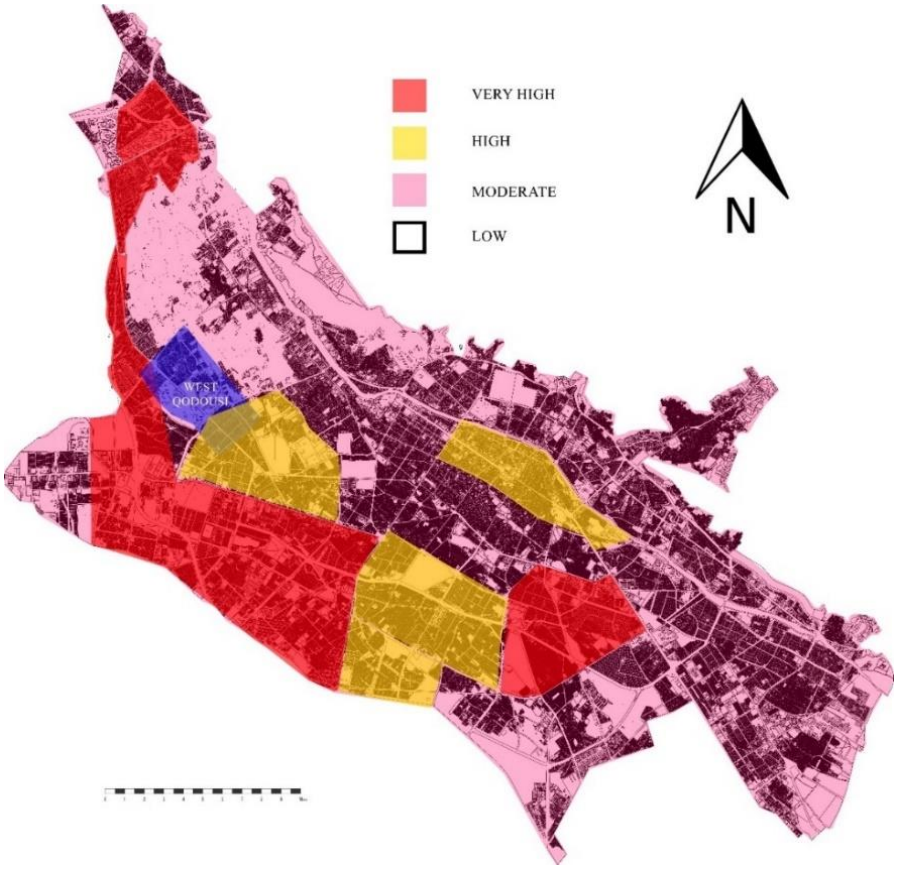


Figure 62. Critical points of earthquake in Shiraz city (source: Elaborated by the author)

Regarding the modeling approach which will describe economic and human losses related to seismic hazards, we apply two methodologies: earthquake risk modeling and probabilistic cost-benefit analysis (CBA). Earthquake risk modeling has been designed and implemented based on four main modules: hazard, exposure, vulnerability and loss. (Figure 63)

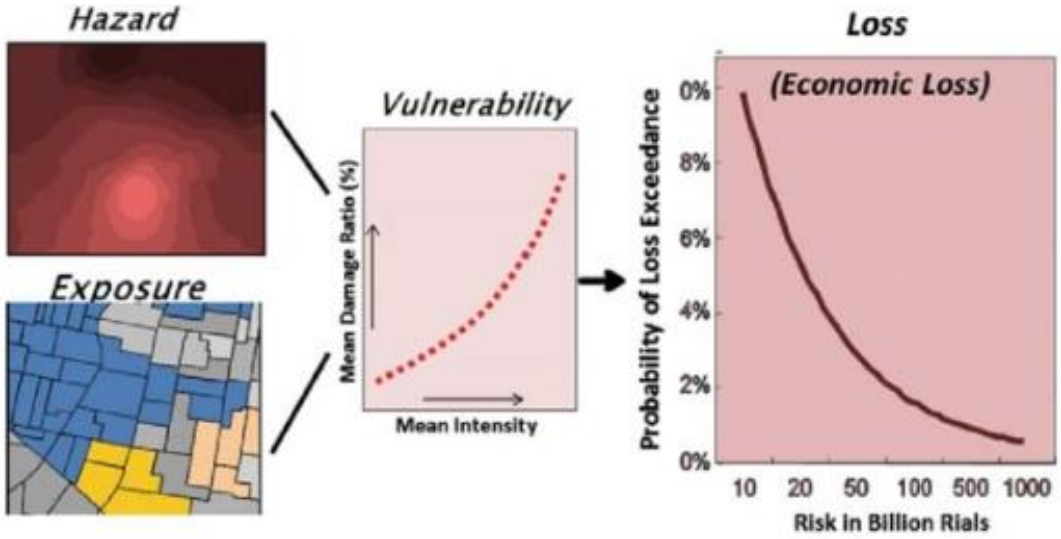


Figure 63. Earthquake risk modeling and analysis procedure (Ghafory and Ashtiany 2010).

- Exposure risk modeling

In the exposure module of earthquake risk modelling, the inventory at risk is modeled by performing a building taxonomy. A building taxonomy describes characteristics of an individual building or a class of buildings with similar characteristics. In order to do a building taxonomy, GIS-based data from Shiraz municipality were needed and had to be analyzed first.

Based on the various editions of Iranian seismic codes, two time periods for building's construction quality have been considered, before and after 1992 known as a lower and higher quality, respectively. Regarding to these classifications, eight classes are identified. Figure 62 in the Supplementary shows the distribution of building types, and Figure 63 a, 3D view of distribution of buildings in district 1st.

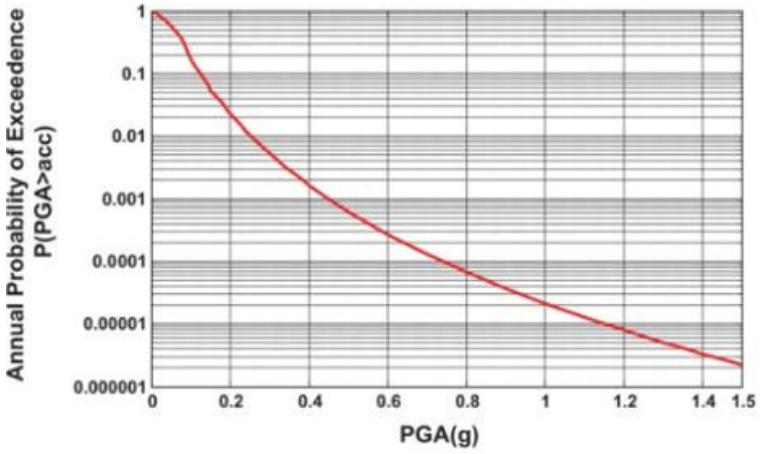


Figure 64. Seismic hazard curve for Shiraz district 1(Sadeghi, Hochrainer-Stigler and Ghafory-Ashtiany, 2015).

- Loss module

The loss calculation module links the ground motion, exposure, vulnerability modules and calculates the probability of having structural losses in monetary terms. Structural loss is defined here as repair and/or replacement cost of a structure. Regarding the importance of the assessment of human losses in earthquakes, the effects of different financial mitigation strategies on human losses are investigated by considering suggested parameters given by (Mansouri and Amini-Hosseini, 2012) for two different occupancies. In more detail, they investigated the residential occupancy rate for a 24-h period for a normal working day in large cities in Iran in order to have a better estimation of the human casualties in earthquakes. The night and day time occupancy rates for residential buildings are presented in Table 16.

Type of structure	Year of construction	Number of stories	Label
Steel	After 1992	Below 3	S1
	Before 1992	Above 4	S2
Concrete	All	Above 6	C0
	After 1992	Below 2	C1
	Before 1992	Between 3 and 5	C2
Masonry (brick and steel or stone structure)	All	All	Mb
Masonry (concrete block)	All	All	Mc
Adobe	All		Aa

Table 14. Shiraz building typology (Mansouri and Amini-Hosseini, 2012).

- Vulnerability module

The vulnerability component deals with the hazard potential to damage structures and their contents. It estimates the probability that building damage would exceed various levels as a result of ground motion (Field et al. 2012). For many types of structures, damageability may be defined in terms of fragility, defined as the probability that some limit states are exceeded, conditioned on an input level of demand. The graph of this relationship is represented as fragility functions. Unfortunately, there are no classified fragility functions for Iranian buildings available. However, due to the similarity of Shiraz to Tehran's buildings, vulnerability curves developed by the Centre for Earthquake and Environmental Studies of Tehran and the Japan International Cooperation Agency (JICA 2000) have been selected here. JICA vulnerability curves are developed based on the data collected before the year 2000 in the form of Tehran city blocks and by shifting the ATC-13 vulnerability curves through analog the intensity axis (JICA 2000 and ATC-13 1985). Figure 78 shows vulnerability functions reported by JICA 2000 for eight building categories.

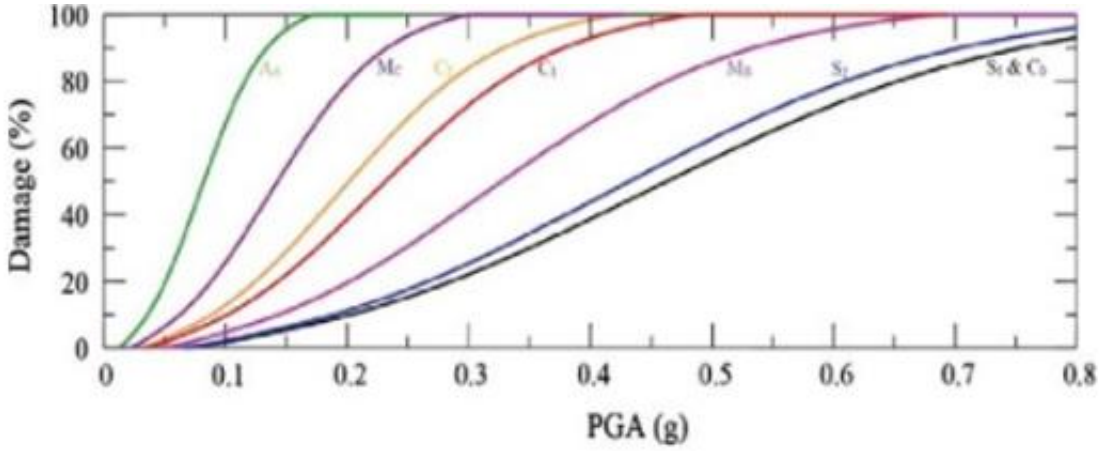


Figure 65. JICA vulnerability functions (Sadeghi, Hochrainer-Stigler and Ghafory-Ashtiany, 2015)

- Four Probabilistic cost-benefit analysis (CBA)

We focus on five different retrofitting loans offered by the government, banks or financial institutions perform mitigation measures for each household and use them for calculating corresponding CBA ratios. They were chosen based on suggestions from respective stakeholders as plausible scenarios, but can be also seen as a kind of sensitivity analysis (Michel-Kerjan et al. 2012). The options are based on the amount of costs for each of them. Payback of loans is assumed to be happening within 15 years, which is standardly offered in Iran (Table 16). Using the AAL and the estimates in AAL reduction, resulting from each mitigation strategy and annual expense in regard to the five loan options, the cost-benefit ratios can be calculated based on earthquake.

$$\text{BC ratio} = \frac{\left(\text{AAL}_{\text{Beforemitigation}} - \text{AAL}_{\text{Aftermitigation}}\right)}{\text{Annual expense}}$$

The annual expenses include the costs of upgrading the structures and average annual losses which are calculated as the expected loss for the given portfolio. Total average annualized costs are the summation of the annual loan payback and AAL. By taking no action (option one), the owner would have no out-of-pocket expense, but would have a relatively high risk of sustaining large losses in 1 year. By upgrading

buildings (options two, three, four and five), the owner would decrease risk and therefore relatively small losses in cases of earthquake events would occur and would need to be absorbed.

Options	Conditions of retrofitting loans
1 (No action)	-
2	4 % interest rate over 15 years
3	10 % interest rate over 15 years
4	15 % interest rate over 15 years
5	20 % interest rate over 15 years

Table 15. Different retrofitting loans for households, (Sadeghi, Hochrainer-Stigler and Ghafory-Ashtiany, 2015).

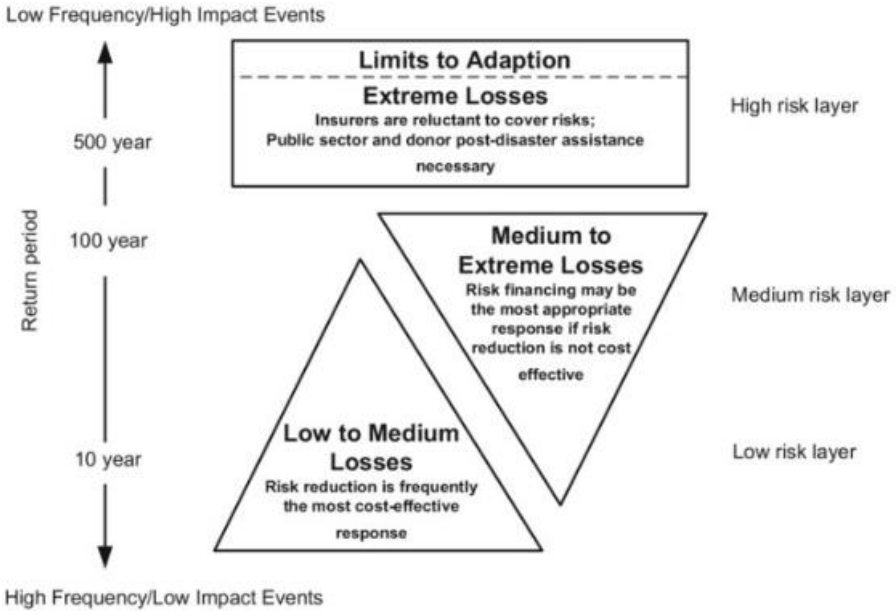


Figure 66. Risk-layer approach for managing extremes, (Linnerooth-Bayer and Hochrainer-Stigler 2014).

5.4. Flooding risk in shiraz

As before mentioned, Shiraz city located at the center of Fars province in Iran. Its altitude is 1486m. Locating next to the “Zagros” mountain. Its weather is moderate. The registered data of groundwater level variations are gathered from the published document by Fars regional water resources institute. The monthly data are registered at the end of each intervals from 29 observation wells. Also the discharge data of “Khosk” river are recorded in two separated (hydrometric) stations named station1 and station 2. The former is located at the west lateral branch of river and the latter is at the downtown, downstream the conjunction of two branches. The west branch, the location of ststion1, usually has current, meanwhile the branch that station2 is located, has no flow during half cycle of year.

- Flooding risk because of Khosk river

The discharge annual average value of “Khoshk” river during 1973 to 1998 is 2.8 m3/s and the annual average of groundwater level variations is 1505.5m, during the mentioned interval. The maximum value of discharge was happened at February 1998, so that such as the other research (Sommer and Ullrich, 2005) the data from last previous month to one year are used in the analyses.

Figure 67, Illustrates the low risk and high risk of flooding in the city of Shiraz.

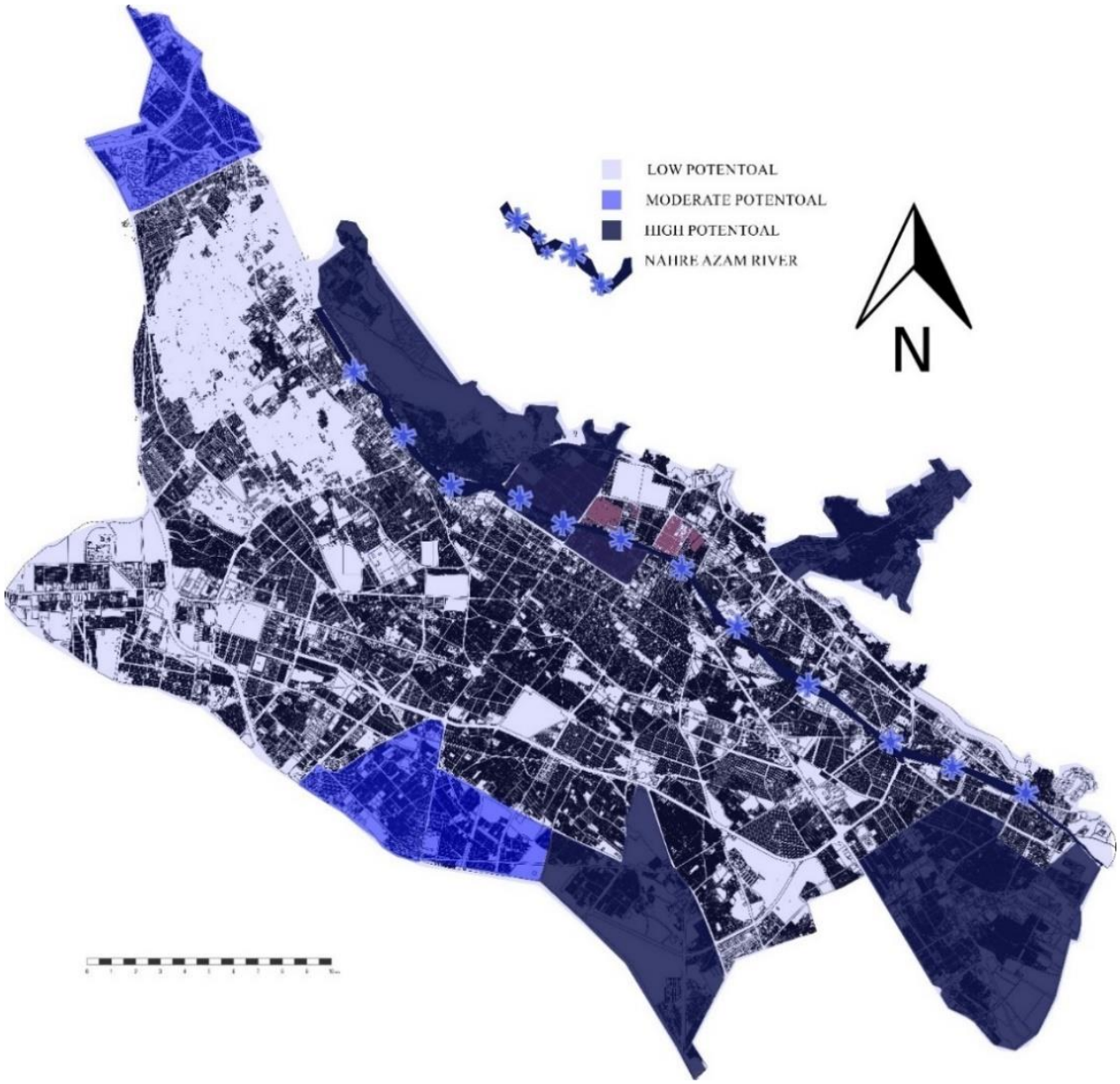


Figure 67. Critical points of flooding in shiraz (Source: Elaborated by the author)

At february1998, a relation has been observed between flood appearance and the average value of groundwater level. The discharge in station1 and station2 reached 8.o83 m s 3 and 25.865m s 3 respectively. Two months later (April 1998) the average value of groundwater reached highest level(1503.62m) (Figure 68).

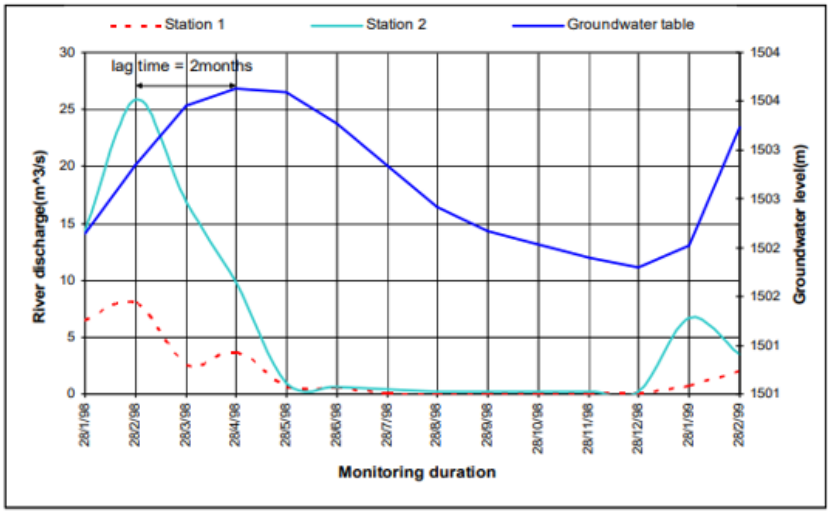


Figure 68. Comparison of discharge in "Khoshk" river and groundwater level in observation wells, Shiraz, 1998-1999, (Appl, 2013).

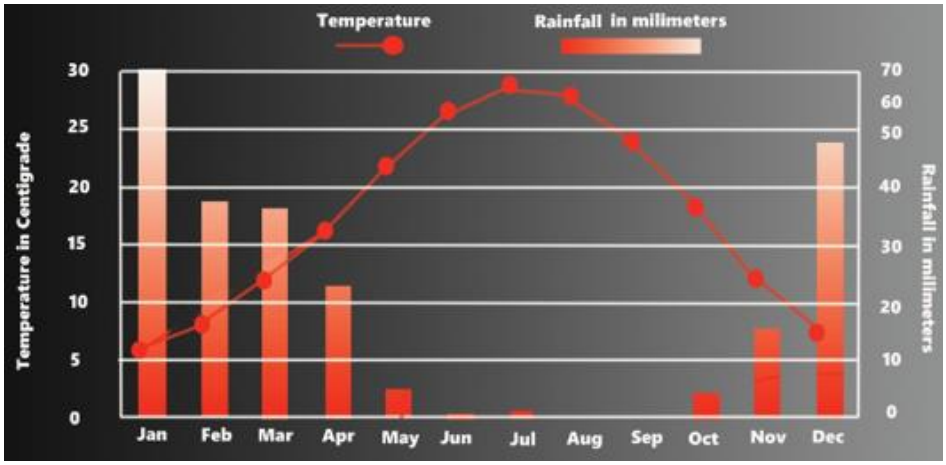


Figure 69. Average rainfall and temperature in Shiraz[16]

The effect of Fast flood on hydrographs of observation wells where located closed to river and also around the downstream, can be found out. Simultaneously heavy rainfalls cause fast infiltration into the soil and consequently rises up the ground water level. These effects can be observed on the walls which are far from the inundation borders. The dynamics of groundwater can be determined from the groundwater fast rise up, rising up the groundwater level far from the river, and long duration of remaining the groundwater at high levels. Figure 69 shows the hydrographs of two observation wells in various distances along the "Khoshk" river at february1998.

[16] Re-elaborated by the author based on https://world-climate.com

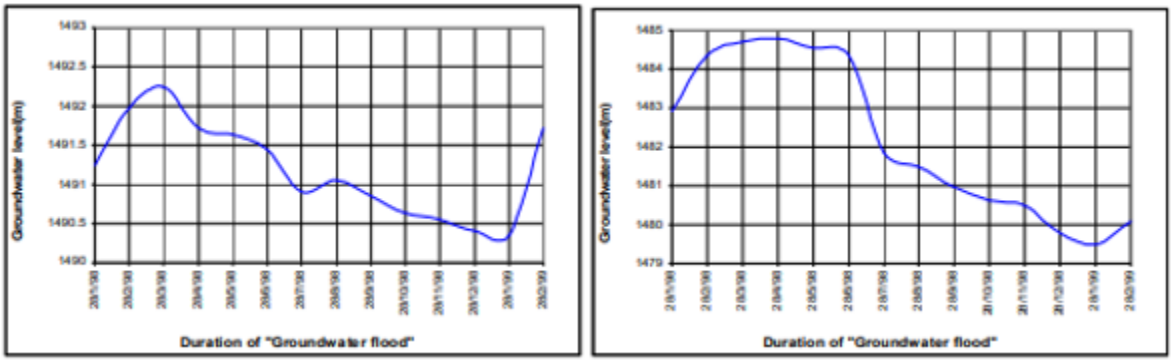


Figure 70. Hydrographs of “Khoshk” river and observation wells, (a) observation well 150m far from inundation border, (b) observation well 101resden. 4500m far from inundation border, (Appl, 2013).

- Last flooding and damage

On 25 march 2019 flash floods following heavy rains in Southwestern Iran in the vicinity of the city of Shiraz, killed 19 people, and injured more than 200 others (Moshtaghian, CNN News, 2019).

A brief but intense rainfall caused a sudden flash flood that submerged the main highway between Shiraz and Esfahan, trapping many travelers who had been leaving the city after Nowruz celebrations. City officials did not warn the people of Shiraz of the deadly weather conditions resulting in many deaths, (Moshtaghian, CNN News, 2019).

Figure 71. At least 18 killed, 94 injured in 2019 shiraz flooding, (iransource.com).

- The reason of 2019 flood in shiraz

The initial investigations of the Shiraz flash floods showed that a water canal adjacent to the Quran Gate was paved over in the early 2000s for use as a road by the Shiraz municipality. The road expansion did not include a sufficient drainage system, (Moshtaghian, CNN News, 2019).

Figure 72. Left, Quran gate current situation. Right, Quran gate before constructing on canal (iransource.com)

5.5. Resilient strategy

As a metropolitan city in Iran, Shiraz has undergone a rapid population growth over the past decades and the projections point out an exorbitantly rapid population growth in its urban areas over the next years. Population growth will result in a change in the land cover and an increase in the impervious surfaces in the entire urban region, thereby increasing the environmental effects. Investigating land dynamics over the next decades using impervious index and spatial metrics can, therefore, provide the managers and planners with a better understanding of planning of future programs for urban development in Shiraz.

- sustainable urban development in case of Shiraz

Shiraz is located in the southern subdistrict of Zagros in south of Iran. Its urban region is built at the foot of Zagros Mountains, extending from the north-west to the south-east. Regarding the hydrological consideration, it is located in Maharlu Basin with the minimum and maximum heights of 1470 and 3000 meters, respectively. With respect to its climatology, this urban region has the average temperature of 17.5 Celsius, the average rainfall of 392 millimeters, and a cold semi-arid climate in the De Martonne classification index.

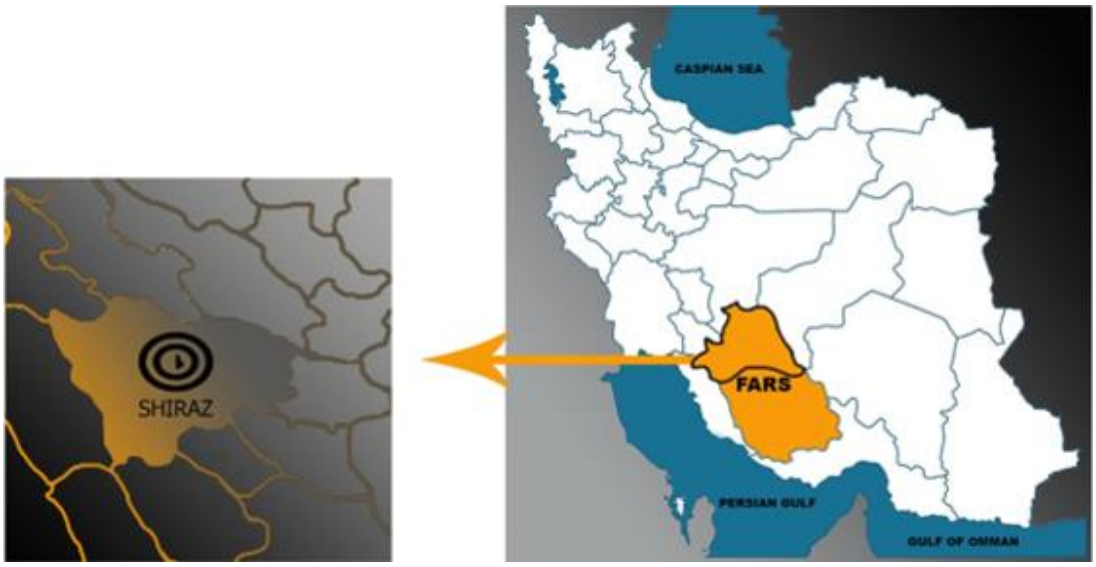


Figure 73. The location of urban region of shiraz[17]

Urban region of Shiraz inclines, parallel to Zagros mountain ranges, from the north-west to the southeast. Khoshk River is the only seasonal river in this urban region, which is responsible for drainage and leading water, particularly during high rainfall season, to Maharlu Lake. The precipitous growth in urban region of Shiraz has caused a number of habitats and farmlands to undergo a land use transformation into industrial and residential areas, consequently causing environmental problems such as habitat degradation, air pollution, water pollution, and a decline in the capacity of refining and absorbing pollutants and ecological services, in general. In this regard, measures need to be taken in planning and directing urban development by taking ecological approaches into consideration and urban development direction plans need to be formulated in different strategic and operational levels by considering the physical and environmental features of the urban region through modifying the landscape structure (Sotoudeh and Parivar2016)

[17] Re-elaborated by the author based on A. Sotoudeh and P. Parivar/Scientia Iranica, Transactions A: Civil Engineering 23 (2016) 1975-1983.

- Creating land cover map using satellite images

Landsat images and digital topographic map have been used to investigate the changes of impervious surfaces. The Landsat images have the advantages of wide and panoramic vision, and multi-spectral and covering repetitive images in different periods of time. For producing land cover map, firstly, regarding the location of urban region of Shiraz which, according to Landsat satellite index, is situated within 4 different scenes of 162-39, 162-40, 163-39, and 163-40, the satellite images concerning these 4 scenes in 4 different periods of time (1976, 1990, 2000, and 2005) were downloaded from United States Geological Survey website (USGS) (Figure 74).

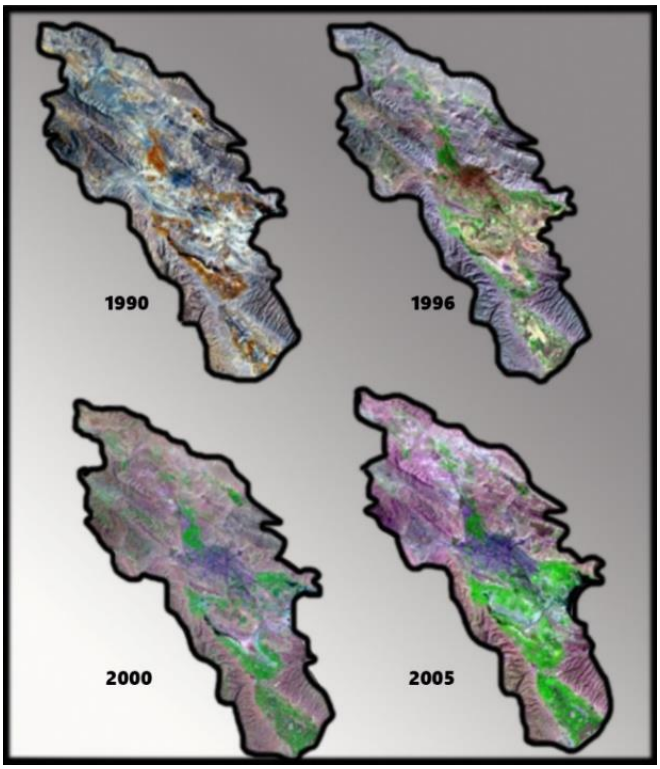


Figure 74. Landsat images of shiraz in (1976, 1990, 2000, 2005)[18]

After the provision of satellite data, in order to prepare the data to be processed and to extract efficient information, geometrical correction of images was carried out using ground control point method. Resampling was conducted using the Nearest Neighbor method (NN) and all of the bands were geometrically rectified through the use of NN method. Spectral rectification of images was performed in order to clarify the phenomena, improve the quality of images, and eliminate the adverse effects of light and atmosphere in images.

Land covers were then classified and impervious surfaces were extracted using decision tree method. Through the use of this method, green areas containing green vegetation were initially identified using Normalized Difference Vegetation Index (NDVI) and water surfaces such as lakes and wetlands were then identified by using infrared band. In the next phase, through visual interpretation and determining the

[18] Re-elaborated by the author based on A. Sotoudeh and P. Parivar/Scientia Iranica, Transactions A: Civil Engineering 23 (2016) 1975-1983.

threshold level for spectral reflectance, constructed and open surfaces were identified. Ultimately, by using the slope map, lands with a slope of more than 20%, which lacked constructed surfaces, were considered as open spaces. After the classification, land cover maps of Shiraz in four different years were produced. Regarding the purpose of the study and the types of region's land cover, 4 different classes were identified: man-made impervious surfaces (built-up area), open spaces, farmlands and green spaces, and wetlands and water surfaces (Figure 75). In interpreting the data, topographic data of maps in scale of 1:25000 and the experiences based on field work were also used. Finally, the land cover maps were checked for accuracy by field study and using error matrix method. (Sotoudeh and Parivar, 2016)

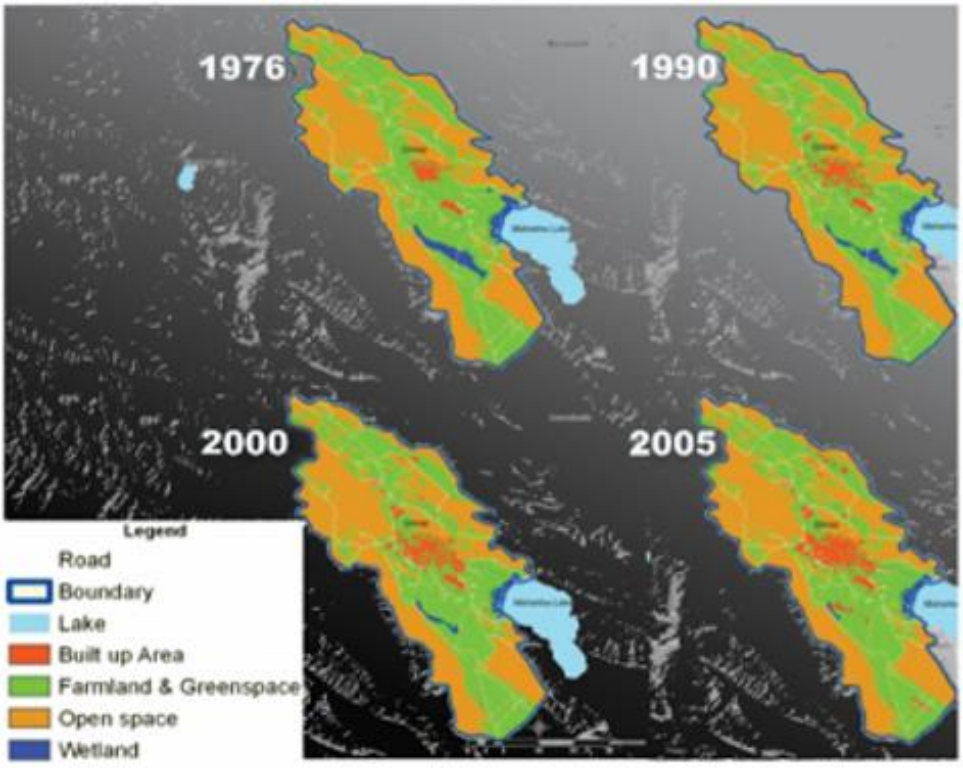


Figure 75. Landcover maps of shiraz urban region in 1976, 1990, 2000, 2005 [19]

- Modeling different scenarios

Uplan model (Johnston et al, 2003) was used in order to predict urban growth in Shiraz. Two scenarios were defined in this research. The first scenario, here referred to as \the status quo" or current growth, simulates urban built up area, using the current growth data along with criterion maps, and the built-up area development for 2021 is simulated. The other scenario takes smart growth criteria into account. Smart urban growth, with its ten principles, strives to make cities more sustainable. Implementing such an idea seems to not only provide better urban accessibility, energy saving, decrease in environmental pollutions, and waste recycling, but also prevent the loss of non-renewal environmental resources such as farmlands and open spaces and diminish the impacts of urban development on destruction and disruption of habitats (Smart Growth Network [SGN], 2015).

[19] Re-elaborated by the author based on A. Sotoudeh and P. Parivar/Scientia Iranica, Transactions A: Civil Engineering 23 (2016) 1975-1983.

Modeling smart growth scenario has been applied based on compact city pattern and also consolidated by using urban ecological capability evaluation model (Makhdoum et al., 2002).) and protection of vulnerable habitats such as wetlands. According to master plan's projection, the population of Shiraz will reach 1750000 by 2021. Finally, several steps were implemented toward achieving research objectives: Obtaining data layers of slope, roads, wetlands, farmlands, protected areas, non-developmental regions, and current land use; ˜ Converting data layers into raster format; ˜ Obtaining statistical data of the region, such as launch year population and target year population, household size, number of employed people in each family, mean area of each house, launch year employment rate, and target year employment rate; ˜Slotting raster maps and statistical data into Uplan model; ˜ Introducing attraction and discouragement layers for each scenario (Figure 76(a) and (c)); Introducing non-developmental layers into the model; Implementing the model. After implementing the model, two urban growth scenarios in Shiraz were prepared (Figure 76 (b) and (d)).

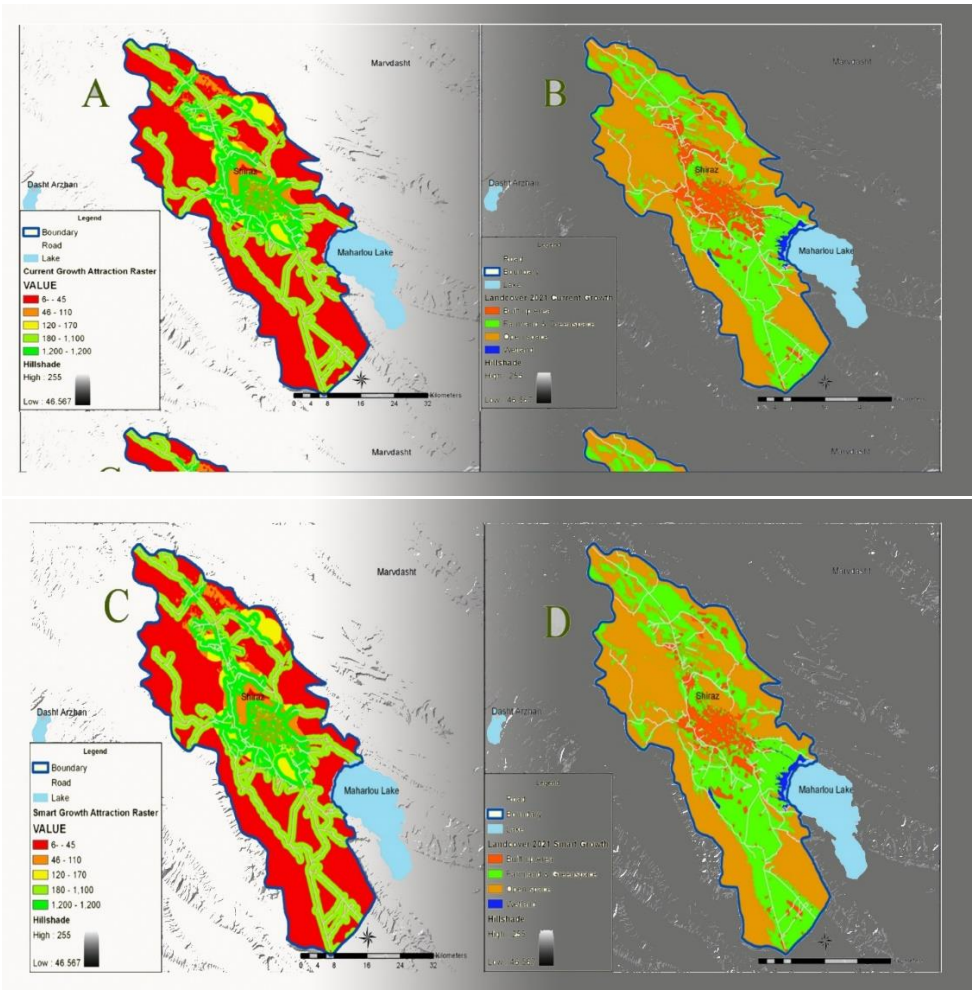


Figure 76. Attraction map in urban growth projection model and projected land cover for two scenarios 2021: [a] & [b] assuming current growth scenario; and [c] and [d] assuming smart growth scenario [20]

[20] Re-elaborated by the author based on A. Sotoudeh and P. Parivar/Scientia Iranica, Transactions A: Civil Engineering 23 (2016) 1975-1983.

- Employing landscape metrics

Quantitative description of landscape appears to be the prerequisite of studying landscape function and its structural changes. In doing so, various metrics are used in landscape ecology (Mcgarigal et al.,1995). Landscape metrics describe spatial structure of the landscape as a complex whole having a distinctive character in a specific period of time. They are beneficial in obtaining a primary classification of landscape patterns and also in bringing the language of urban planners and ecologists together (Botequilha et al., 2002). With regard to the issue in focus, spatial metrics can be analyzed in patch, class, and landscape levels.

Six spatial metrics were used including: Class Area (CA), percentage of landscape (PLAND), Number of Patches (NP), area weighted mean (AREA AM), radius of gyration (GYRATE), and Euclidean Nearest Neighbor (ENN). The selection of the metrics was based on their potentiality for explaining the spatial composition and configuration of landscape structural elements.

CA metric (Class Area) simply measures each class of landscape cover in hectares. PLAND metric (percentage of class area) calculates percentage of the landscape that consists of one type of land cover. PLAND is a measure of landscape composition and shows the ratio of a land cover class area to the whole landscape irrespective of its spatial configuration. This metric describes a major aspect of landscape structure and is, in a sense, the most important metric in explaining the landscape. This metric is able to show land matrix, the biggest patch of the landscape, and also small patches that although are small in area, they are ecologically important. When the landscape consists of one land cover class, PLAND value is 100 and when its area decreases, PLAND value approaches zero. NP metric (number of patches) indicates the total number of patches. Using this metric, one can work out the number of patches in the landscape or the total number of patches in a particular class. The corollary of landscape disruption is an increase in the number of patches in a type of land cover. Therefore, comparing the numbers of patches over the years is helpful in examining landscape disruption.

AREA AM metric (Mean Patch Size) measures either mean patch size in land cover class or mean patch size in the whole landscape in hectares. By examining the changes of this metric in a particular landscape over the years, we can identify landscape disruption. Forman argues that patch size affects biomass, primary productivity, nutrient storage per unit area, and composition and diversity of species (63 Forman et al., 1986). Accordingly, as the mean size of natural patch gets smaller or as the mean size of man-made patches, such as impervious surfaces, gets bigger, many of the processes might not happen and biodiversity might, therefore, be threatened. GYRATE metric (Radius of Gyration) is a metric that measures the average distance between the center of a patch and the outmost extent of its contiguous cells (i.e., a patch). As a measure of landscape configuration, GYRATE is essentially concerned with spatial properties and demonstrates the scope of a patch expansion along the landscape.

In equal conditions, bigger patches have greater values in this metric. In other words, in patches of equal areas, long and extended patches have greater radii of gyration. Through the use of this metric, landscape connectivity is measured. ENN metric (Euclidean Nearest Neighbor Distance) measures the shortest distance from one patch to another patch of the same type. It refers to the relative locations of patches. ENN could describe the spatial distribution of patches of a particular type and how they have changed over the time. For instance, the development of man-made patches (e.g., city) in a landscape increases the distance between other natural patches.

In this study, FRAGSTATS software (Mcgarigal et al.,1995) was used in order to compute landscape metrics in time scale of the research.

In class level, computation of the metrics in the class of impervious surfaces is described in Table 11 and illustrated in Figure 28. The results indicate that during the period of study, the CA metric of impervious surfaces has increased from 5478 in 1976 to 19548 in 2005. This means that it has quadrupled in less than 30 years while the population of the area has tripled in this period of time. The results of the two projection scenarios show a descending trend for both scenarios, which means the increasing amount and connectivity of impervious surfaces in landscape. This descending trend will be greater in the current growth scenario. PLAND metric shows that in 1976, impervious surfaces constituted 2.5% of the entire region and reached 9% in 2005. Noting that surfaces with a slope of 20% and impassable rocky regions constitute nearly 50% of the region, the increase in impervious surfaces has entirely happened in agricultural regions or other types of land covers such as wetlands. At this period of time, the area of wetlands has decreased from 3% to less than 1% and the area of farmlands and open spaces has decreased from 44% to 39%. The results of the two projection scenarios also indicate that impervious surface area will reach 9.3 in smart urban growth scenario and12.23 in current growth scenario and it will exceed 10% of basin threshold where negative ecological impacts begin. With respect to NP metric, as it is described in Figure 28, the number of patches initially had an ascending trend and from the year 2000 onwards, it has exhibited a descending trend. This has happened due to filling of empty spaces between impervious surfaces and continuity between these surfaces as a result of city growth. Also, other metrics such as AREA AM and GYRATE substantiate the phenomenon. The results of the two projection scenarios also indicate that the number of patches in impervious surfaces will reach 2163 in smart growth scenario and 2727 in current growth scenario. The mean of nearest distance between patches in impervious surfaces from 1976 to 1990 exhibits a descending trend with a steep slope. This metric has not undergone a considerable change between 1990 and 2000anditdemonstratesanincreasingtrendfrom2000 to 2005; this increasing trend denotes that impervious surfaces are being shaped in a greater distance from the old impervious surfaces.

The results of the two projection scenarios show a descending trend for both scenarios, which means the increasing amount and connectivity of impervious surfaces in landscape. This descending trend will be greater in the current growth scenario. Considering these results, it can certainly be stated that for both urban scenarios, the related metrics show only little difference for future development and mainly represent the final spatial conjuration of urbanized land. Only in the smart growth scenario, spatial metrics show a better composition and conjuration of natural lands, because the smart growth strategy is to protecting all open spaces such as farmland and wetlands, concentrating urban development near the old urban area and preventing road construction to minimize fragmentation of natural landscapes.[21]

Year	CA	PLAND	NP	AREA_AM	GYRATE_AM	ENN_AM
1976	5478.66	2.486	650	1515.132	1463.916	234.3122
1990	11312.73	3.1337	1040	2352.49	1987.1	82.1841
2000	15013.53	6.8131	1144	4476.096	2866.727	80.6345
2003	19518.54	8.871	973	6952.782	3578.708	116.0306
Smart growth scenario	20659.32	9.3752	2163	6685.577	3435.506	103.7735
Current growth scenario	27618.93	12.5334	2727	11832.94	4834.927	91.2659

Table 16. class level matrices of impervious surfaces for different years and two scenarios of current and smart growth (Own calculation)

[21] A. Sotoudeh and P. Parivar/Scientia Iranica, Transactions A: Civil Engineering 23 (2016) 1975-1983

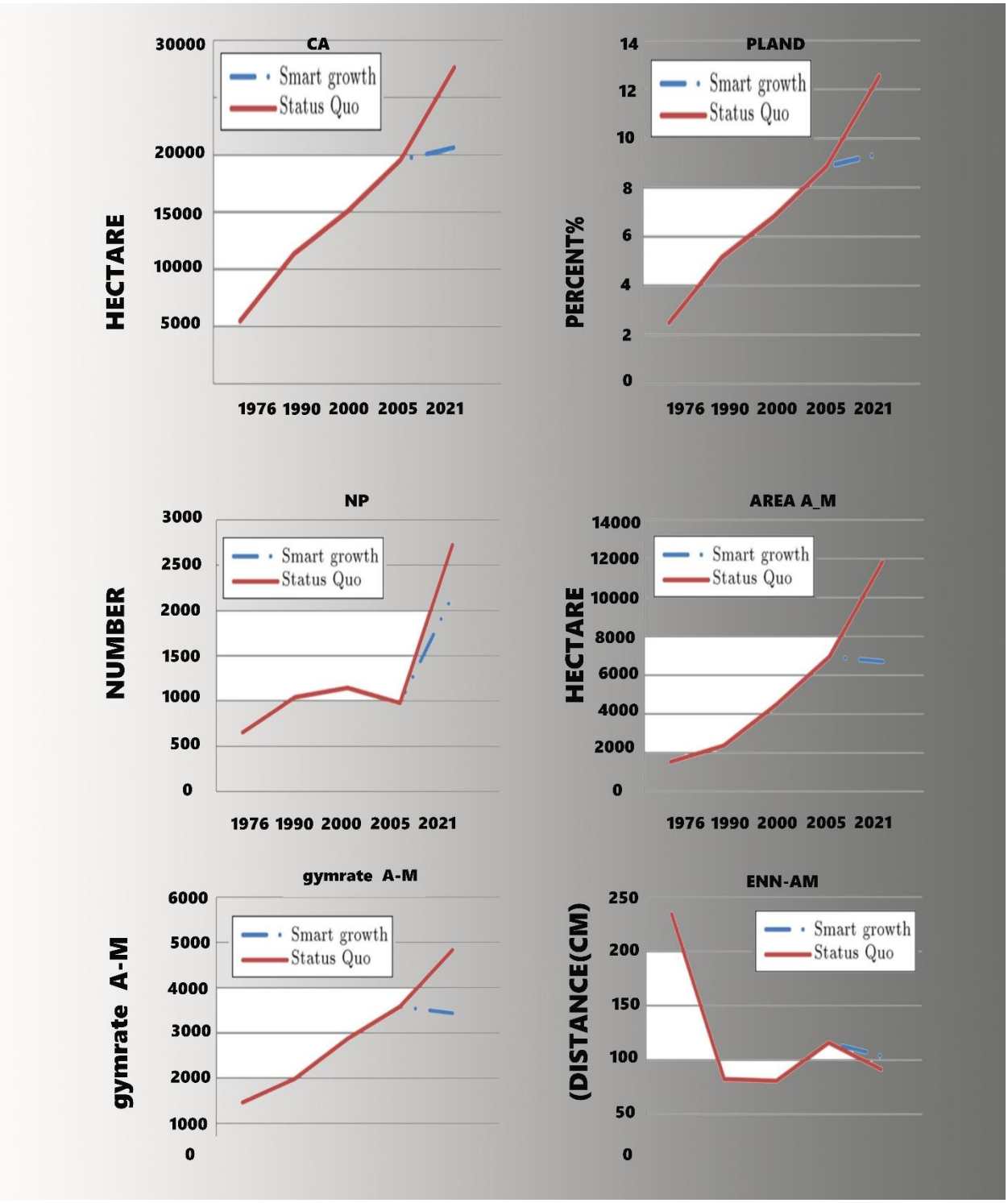


Figure 77. Results of measuring landscape metrics in class level for different years [22]

[22] Re-elaborated by the author based on A. Sotoudeh and P. Parivar/Scientia Iranica, Transactions A: Civil Engineering 23 (2016) 1975-1983.

5.6. Sustainable energy saving analysis

Due to increase of energy demands, providing new energy resources is one of the most essential government policies. Environmental issues significantly have affected patterns of energy consumption in Iran. Any future efforts to limit carbon dioxide emissions in the line of Kyoto protocol, by using renewable energy sources in the country would be very valuable. From a number of feasibility studies, Shiraz the capital of Fars Province in the southern part of Iran at latitude 29o 36′ N and longitude 52o 32′ E with 1550 m elevation from sea level, (195 Mokhtari et al., 2007) enjoys 3354 hours of sunshine annually with average daily irradiation of 20 MJ/m2 (Yaghoubi et al., 2009) can be one of the best palaces for Solar Thermal power plant.

After several tests and evaluations of thermal performance of Shiraz solar power plant, it is decided to construct and install a new collector and increase the capacity of the plant from 250kW to 500 kW (Azizian et al., 2011).

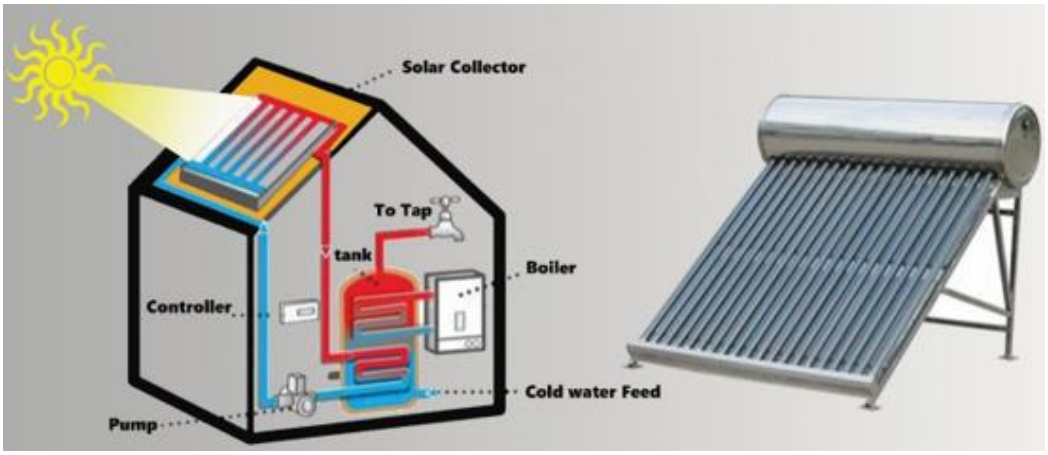


Figure 78. Solar water heating system [SWHS] (Azizian et al., 2011 and Abbaspouret al., 2005)

Figure 79 and 80 has been shown that, generated energy by PV panels are not enough to generate sufficient energy to cover all demanded electricity consumption in the neighborhood scale or in the selected building, but by installing the PV panel plants in smaller scale in the 1th region by some distances it is possible to produce required energy for all residential buildings in the Ghodoosi area.

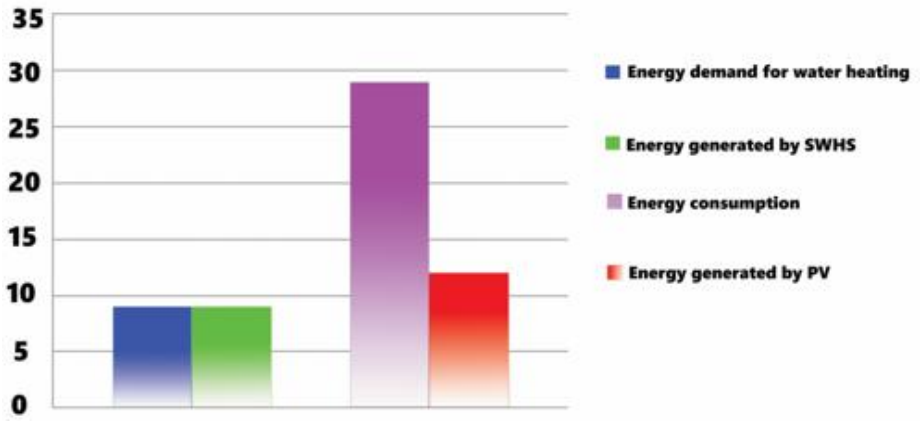


Figure 79. Total energy demand for randomly selected residential building, and energy generated thru solar power devices installed on this building rooftop. (Source: Own calculation)

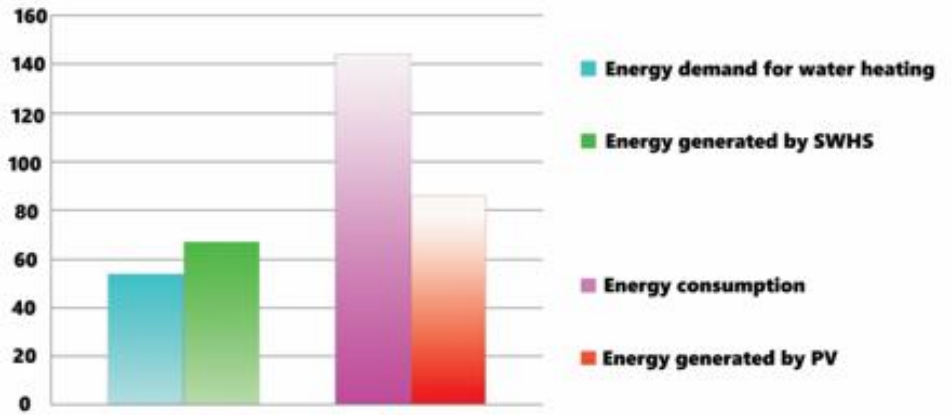


Figure 80. Total energy demand for neighborhood scale, and energy generated by solar power systems installed on building rooftops in this neighborhood. (Source: Own calculation)

In Iran the energy consumers in buildings are divided as follows: Heating, cooling and hot water is about 83% of the total consumption, appliances are about 8%, lighting and other elements accounts for 9%. Also, the great building energy consumption leads a considerable CO2 emission in Iran, mostly in the capital and big cities (Brebbia et al., 2011)

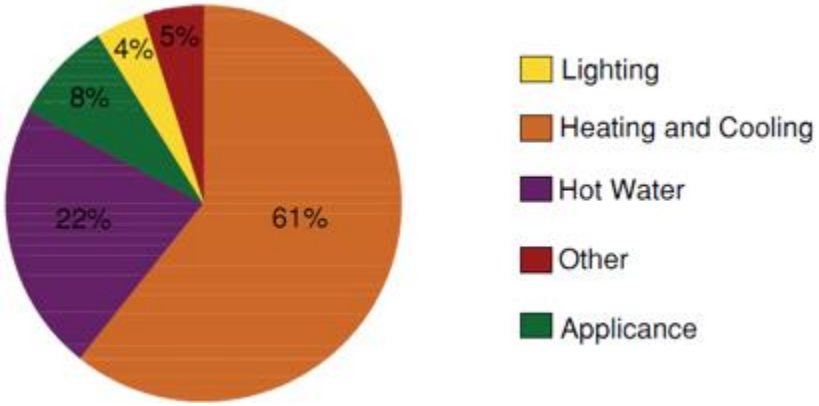


Figure 81. Share of energy consumers in building sector in Iran (Farahmandpour et al., 2008)

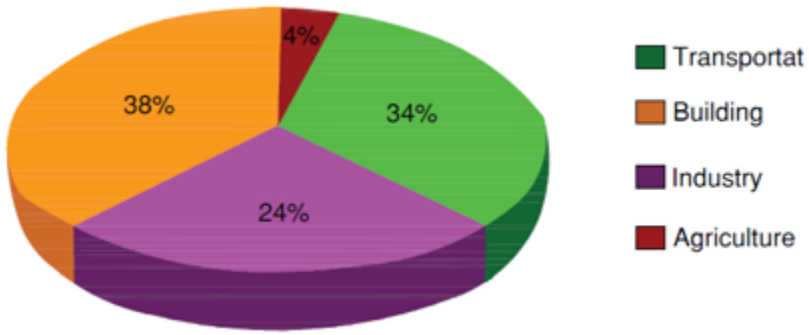


Figure 82. Share of CO2 emission resources in Iran [2008] (Farahmandpour et al., 2008)

Figure 84, has been shown monthly diurnal average of Shiraz where in summer season from Jun to August the solar radiation is in its peak of about 900Wh/m2, and for the same period of time high deference between the dry and wet

bulb temperature indicates that the humidity in ambient is in low situation, while in winter this difference of range is very low, which means in the winter in Shiraz there is a much of humidity in the air and in this period the solar radiation value is about 600Wh/m2.

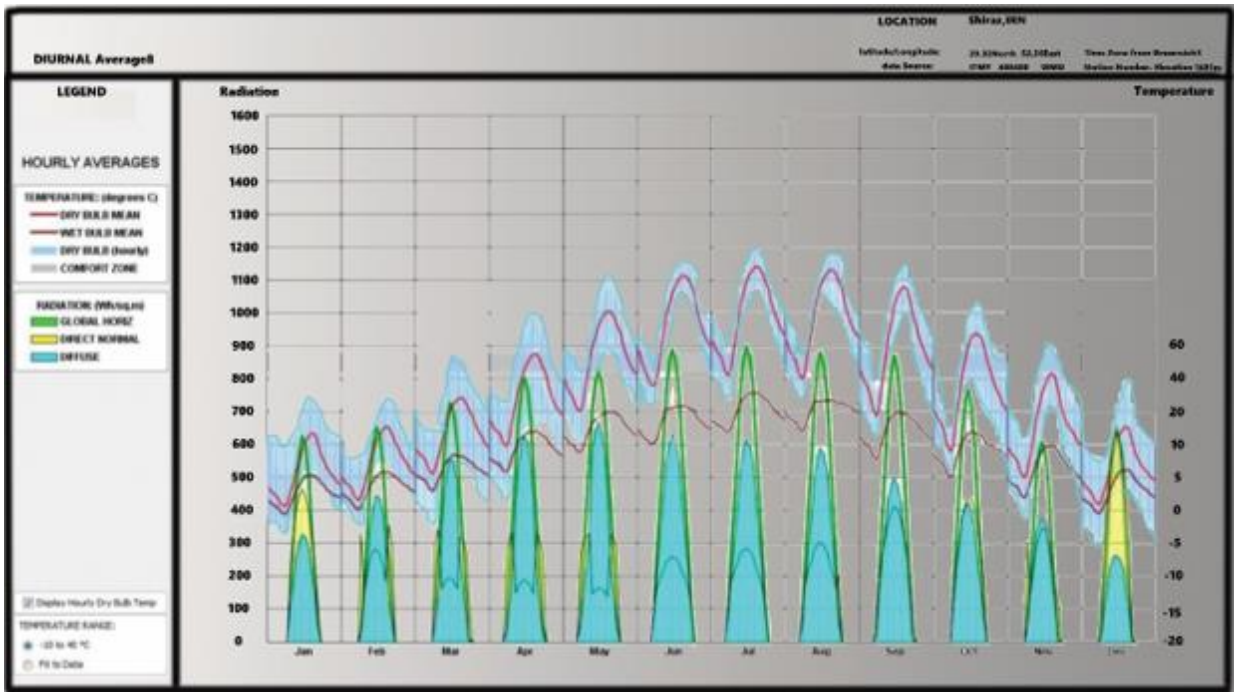


Figure 83. Monthly diurnal average of Shiraz (source: Own calculation)

Figure 84, has been shown the annual radiation average for portion of global horizontal and total surface the values are between 70Wh/m2/hr and 750Wh/m2/hr. And this amount for direct normal part is between 110 to 380Wh/m2/hr.

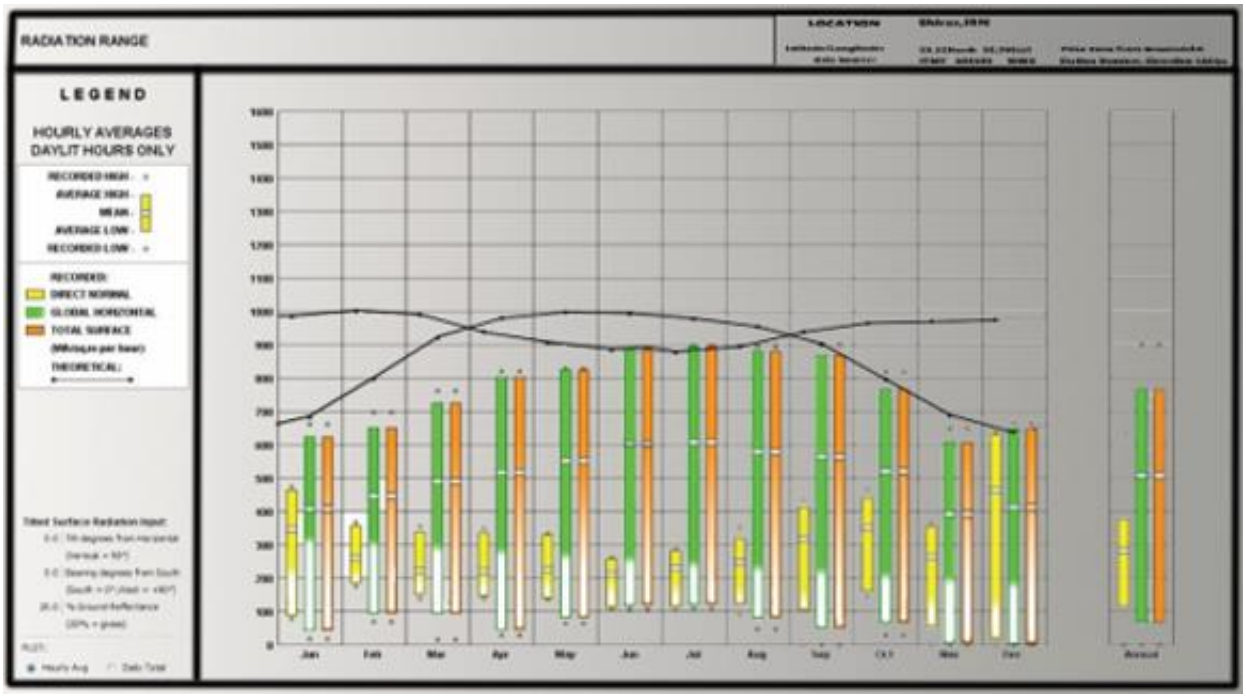


Figure 84. Shiraz radiation range (source: Own calculation)

Figure 85, illustrate that in early seasons of spring, fall and winter the highest wind speeds of Shiraz is allocated. The lowest speed is for January and November with same wind speed of 4m/s and the highest range is for December with wind speed of 17m/s and.

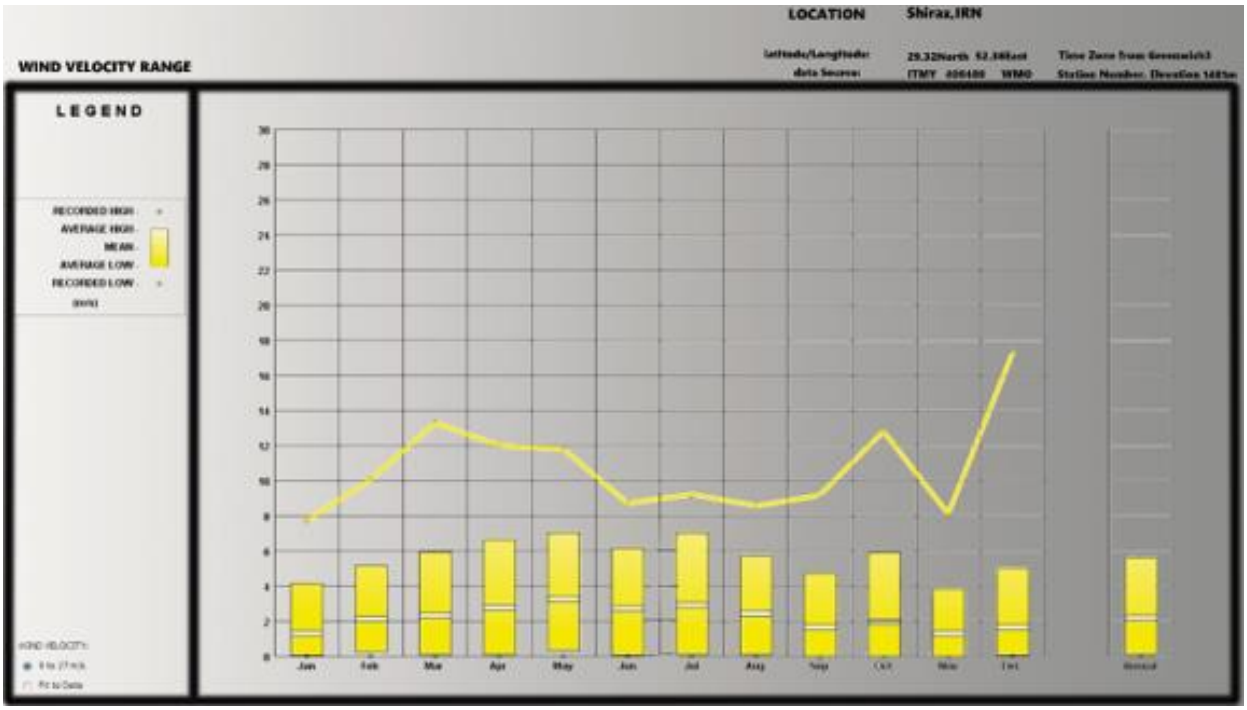


Figure 85. Monthly wind velocity range in Shiraz (source: Own calculation)

The major combined outputs and data such as city temperature, relative humidity and wind velocity and its direction has been shown in figure 86.

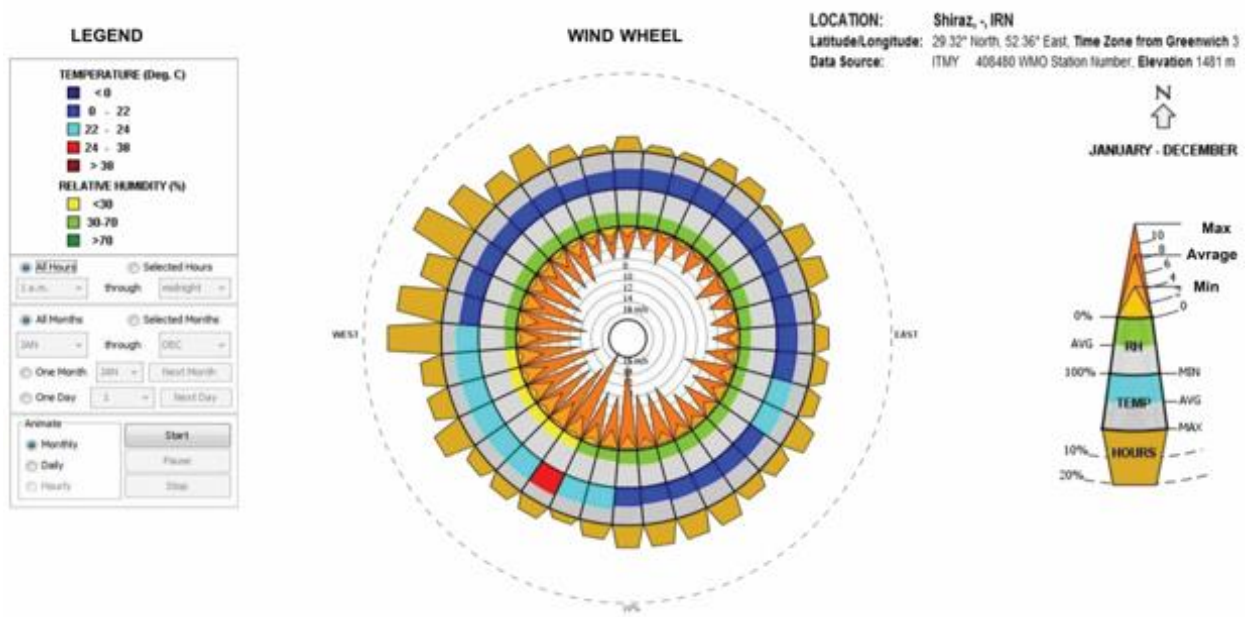


Figure 86. Wind wheel in Shiraz city (source: Own calculation)

Chapter 6.
Analysis of case study area (Ghodoosi)

To get more familiar to the scale of the site, it has been shown by this hierarchy (Figure 87). This hierarchy shows that district 1st covers a huge part of the city and western Ghodoosi is situated in this area in the north west of the city. Thus, adequate information, data and knowledge is required for a sustainable designing and planning for this region.

6.1. Urban analyzing

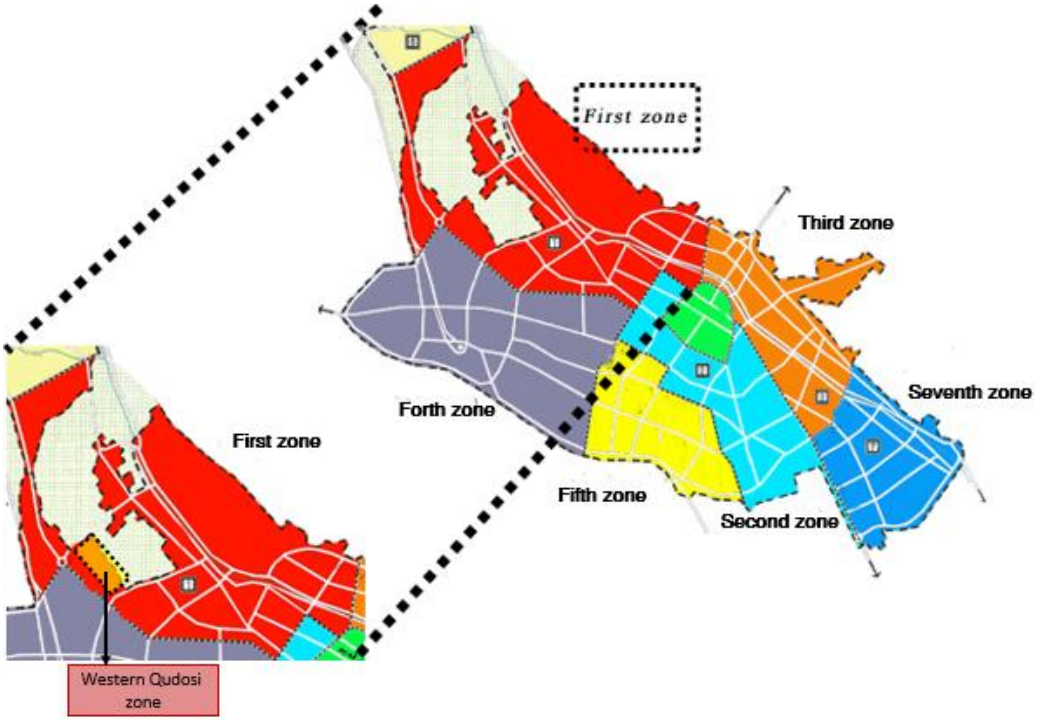


Figure 87. Distribution of Shiraz local areas (Source: Re-elaborated by the author)

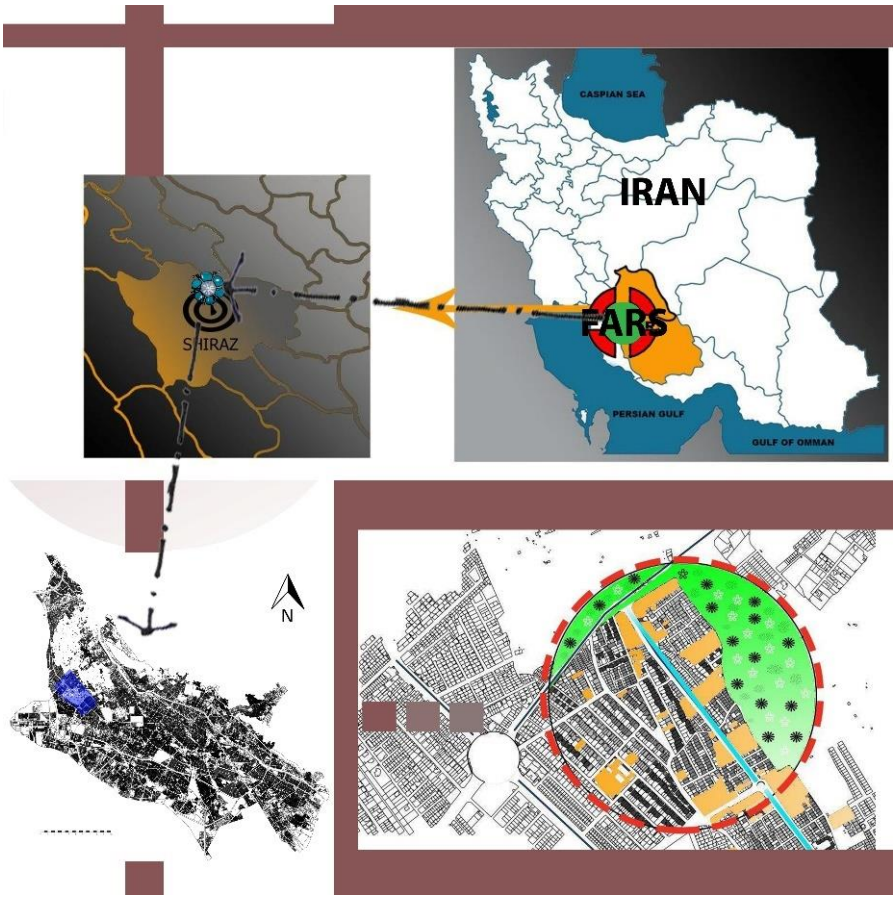


Figure 88. Ghodoosi area location in Iran (Source: Elaborated by the author)

As already mentioned, western Ghodoosi is located in the north west of the city which in recent years were developed faster because it is in the border of the city and city developing direction is to the north part because of good temperature, easily connecting to green area, far from traffic jam and air pollution. Thus, in the (figure 89) it has shown that the favorable wind direction is from North.

Figure 89. Location of study area and site analyzing [23]

[23] Elaborated by the author based on Google Earth 2018

- Accessibility

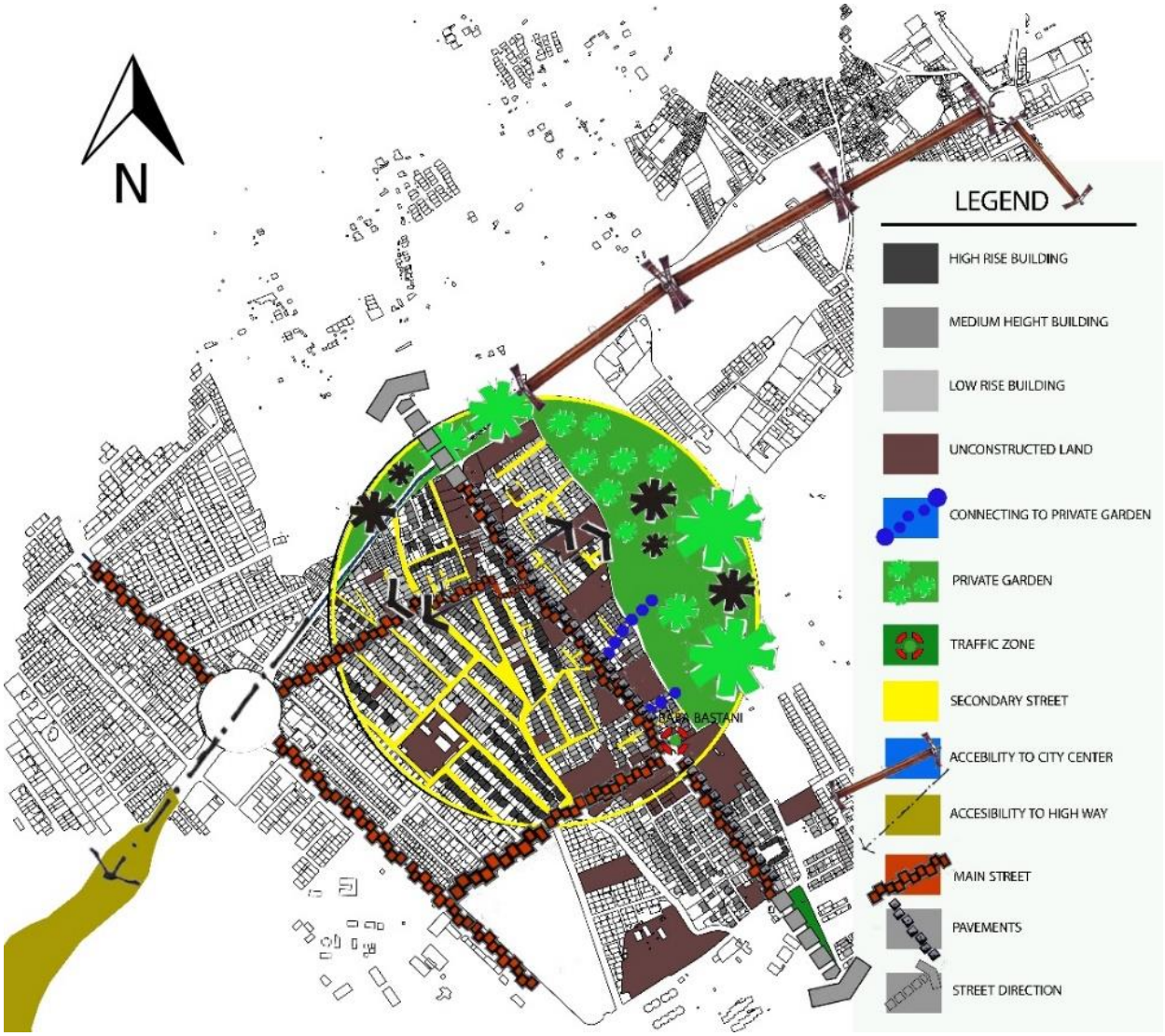


Figure 90. Accessibility and circulation of study area (Source: Author)

- Circulation of Shiraz metropolitan city

Shiraz metropolitan public transportation like many other metropolitan cities included taxi, bus and subway. Subway system included 6 lines which at the moment 2 mane lines were completed and first line connected south to north which has been shown by red color in figure 91- and second-line connected east to west which has been shown by color blue in figure 91.

Bus services is the cheapest means of transportation in the shiraz which is working 24 hours and connecting all the cities and sub urbans.[24]

[24] https://www.kojaro.com/2017/1/7/124301/shiraz-public-transportation/

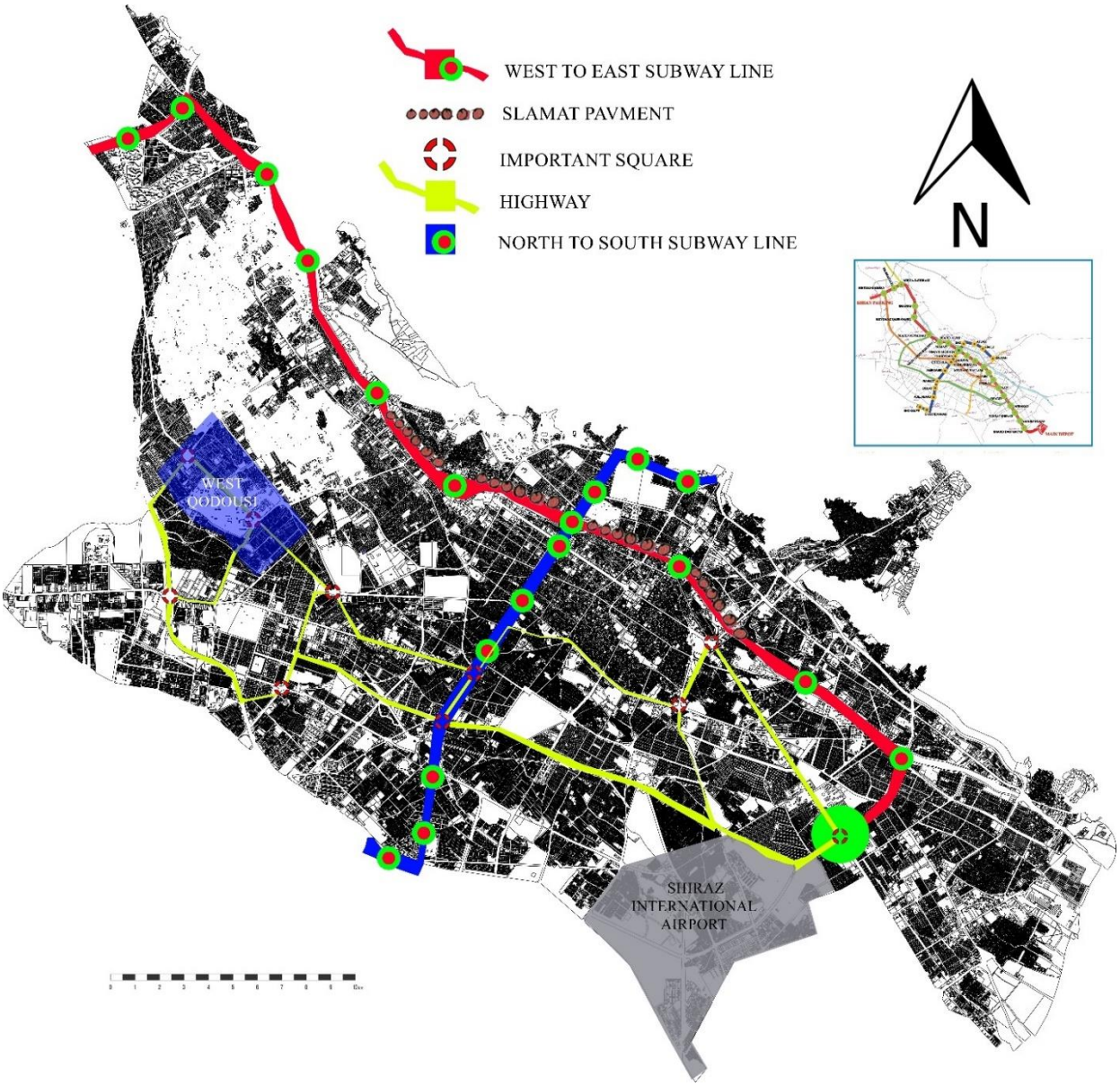


Figure 91. Indicative access of vehicles and public transport in the city and access to the district 1st (source: Elaborated by the author).

- Existing functions and Facilities

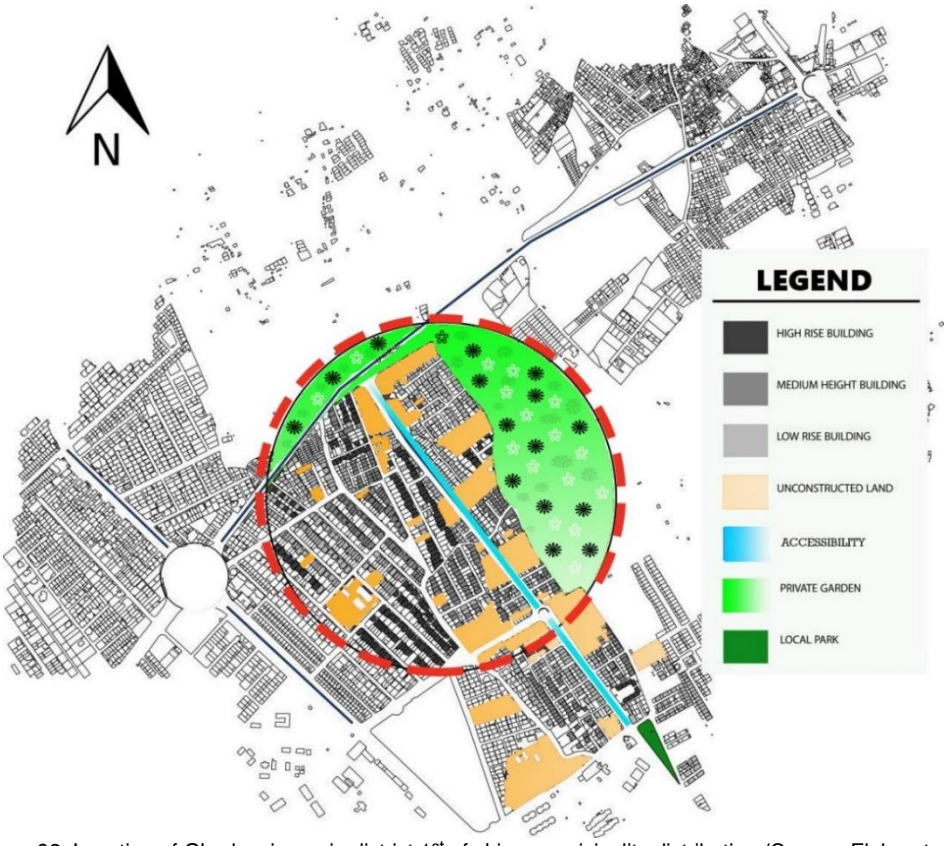


Figure 92. Location of Ghodoosi area in district 1st of shiraz municipality distribution (Source: Elaborated by the author)

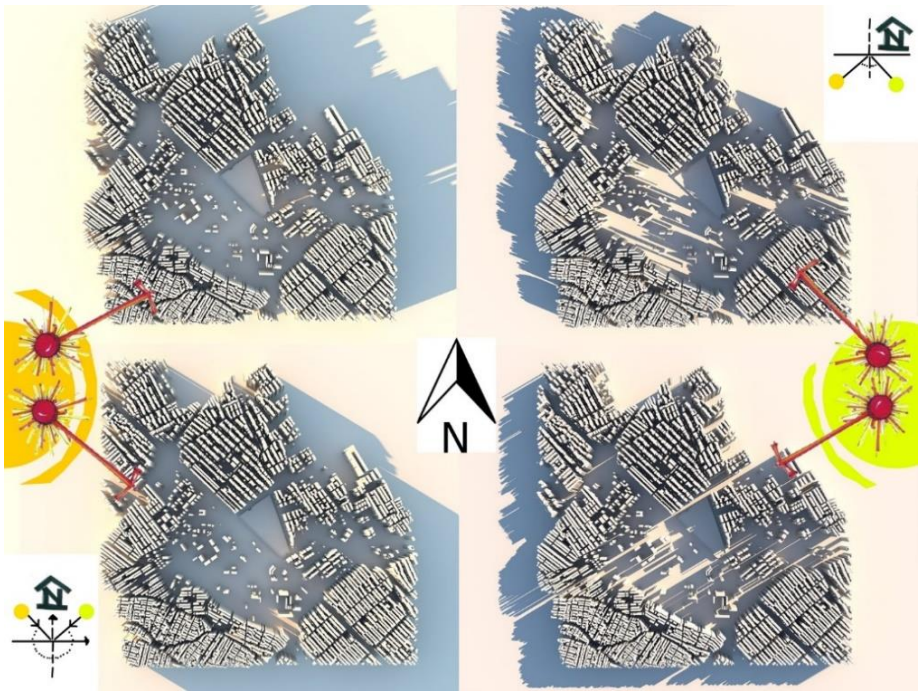


Figure 93. Shadow analysis (Source: Author)

Figure 94. position of existing functions in the area (Source: Photos by the author)

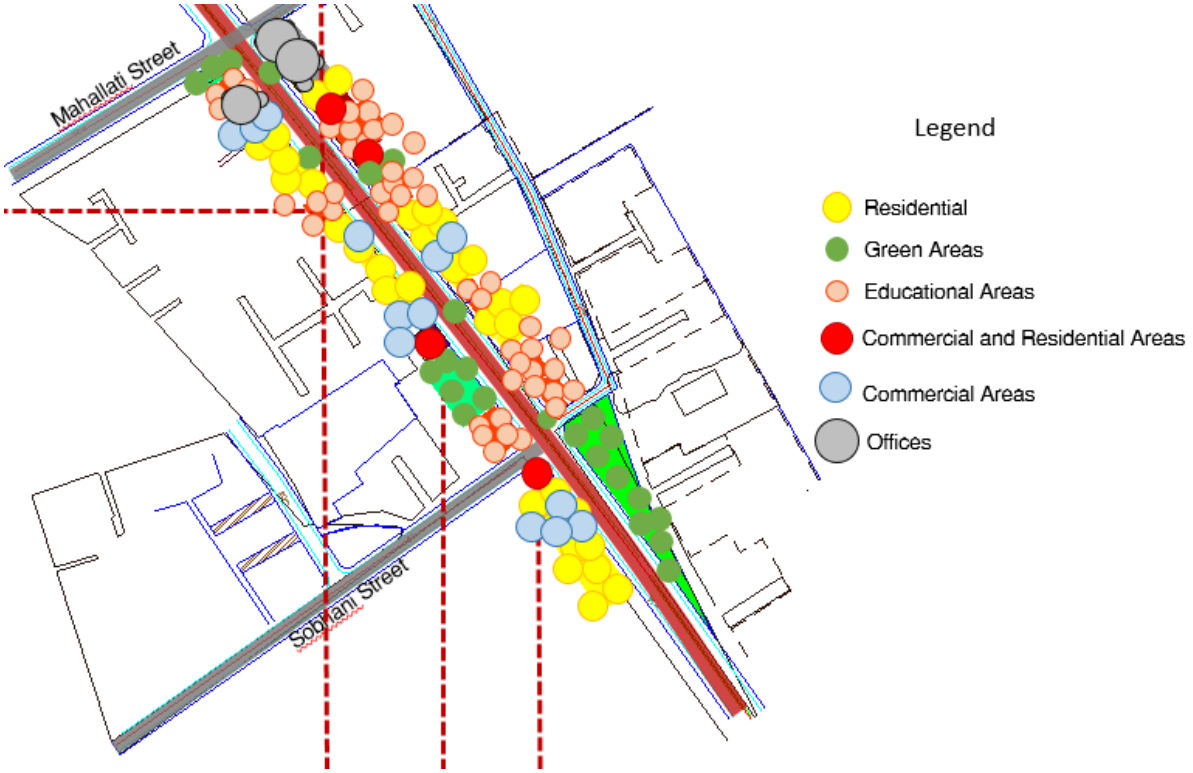


Figure 95. Urban analyzing (Source: Elaborated by the author)

6.1.1. Urban infrastructure shortages:

- Lack of street lighting in area and various neighborhoods
- Lack of asphalt cover at some pass ways
- Lack improved sewage system
- Lack of educational services at all levels
- Lack of sports facilities at all levels
- Lack of green space
- Lack of recreational facilities and amenities (Shiraz first district municipality official website).[25]

6.1.2. Integrated management problems in district 1st

- Lack of coordination between enforcement agencies in urban management

due to urban management and diversity responsible in their duties, in the city of Shiraz was the lack of coordination between the organization and management of the city has emerged.

- The lack of uniform guidelines for dealing with similar issues in different organizations
- Overlapping organizational tasks

Due to the multiplicity of organizations responsible for the management of Shiraz, there is not a lot of tasks efficiently divided between them. This has led in many cases interference with municipal organizations exist, which parallel work, rework, creating a vast bureaucratic structure, friction and disharmony in duties and lack of accountability is.

Figure 96. Lack of enough green areas and destroying Ghasrodasht gardens to construct buildings. (Source: Photos/Author)

[25] http://www.eshiraz.ir/zone1

Figure 97. Dividing facilities and functions can cause problem for people to provide their needs (Source: Photo/Author)

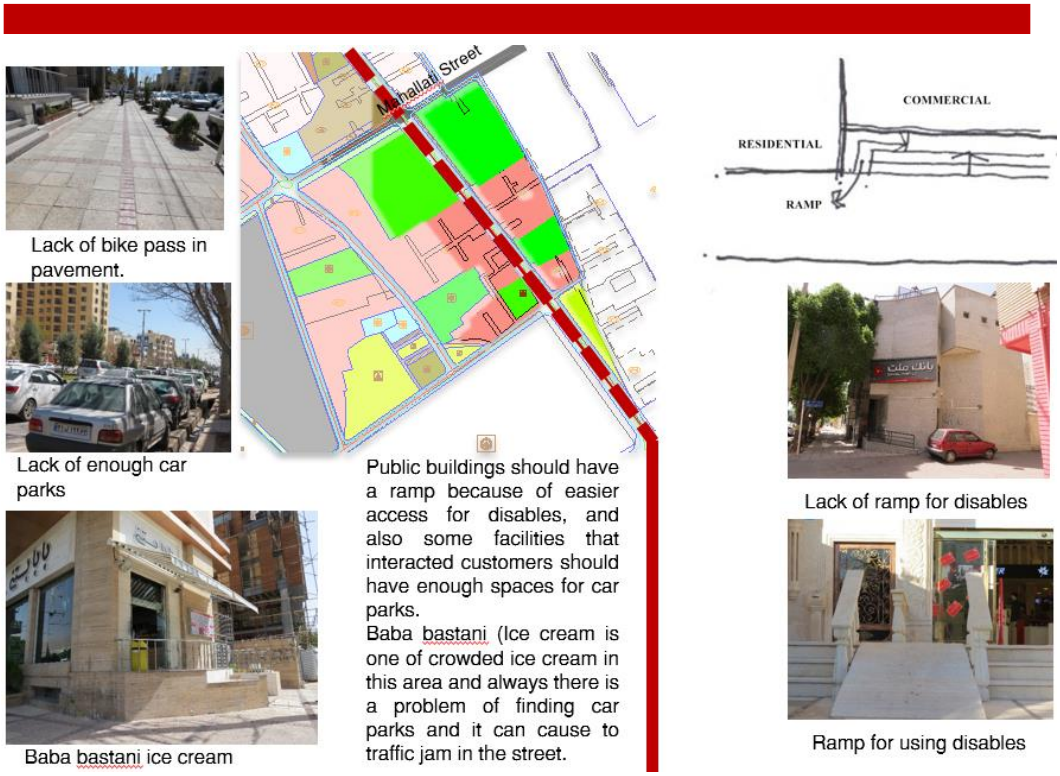


Figure 98. lack of primary facilities in the area (Source: photos/Author)

6.1.3. Environmental features

In this part of the city favorable climate, adequate water resources, vision and perspective that lead to the desired leisure spaces for the region and whole city itself exists. On the other hand, should be considered that the city air flow (winds from West to East) passes through this area and also city's flood start point is from this region. Moreover, city's calcareous drinking water source is stored in southern domains of this area. Thus, by understanding these features and according to 6th municipality review, it would not be wrong if said that by controlling natural hazards, air pollution, water pollution, destruction of vegetation in this area will directly help the impact of these effects on entire city. (http://www.eshiraz.ir/zone1)

6.1.4. Transportation and Traffic

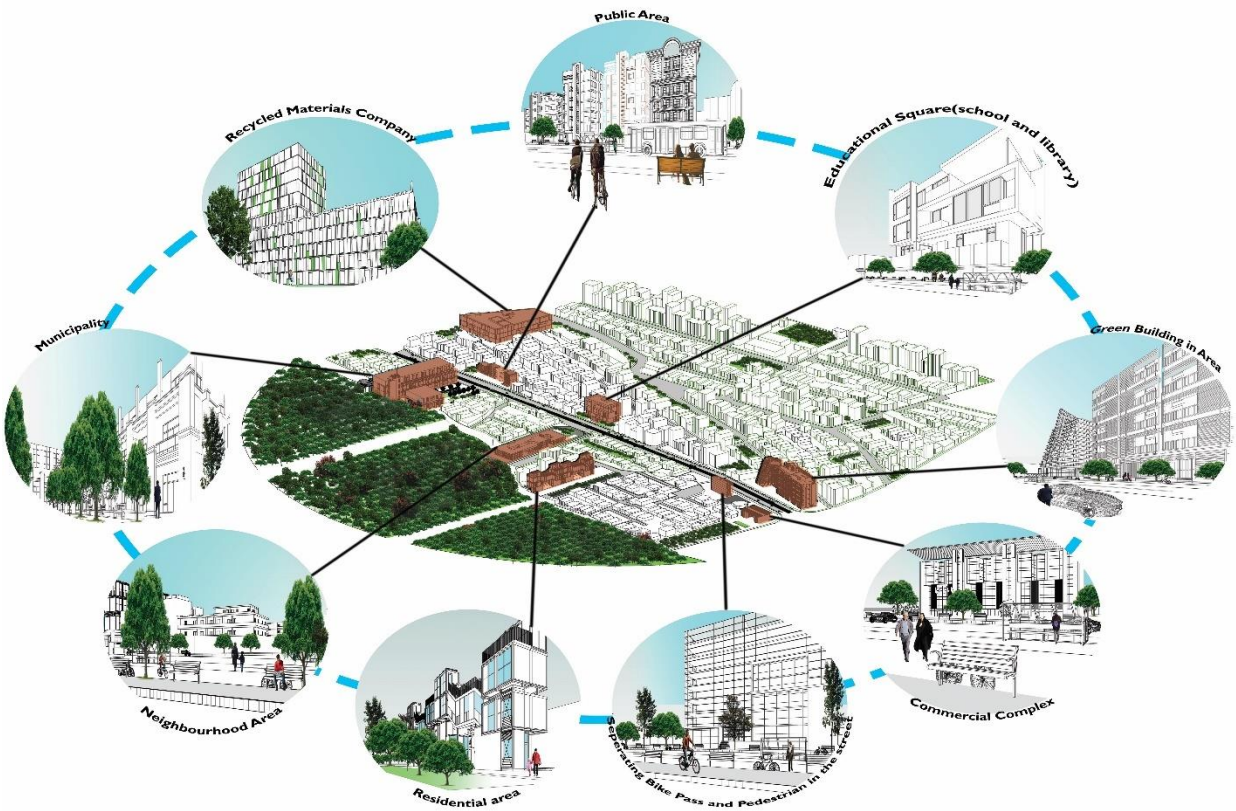
- Distress fixes in several sidewalks and ways
- Improved network access and mobilize them to traffic signs
- Construction of pedestrian overhead bridges in the connectivity with the avenue
- Equipped Ghodoosi street to traffic signs and safety issues for cars and pedestrian
- Taxi and bus transit station off the streets. (http://www.eshiraz.ir/zone1)

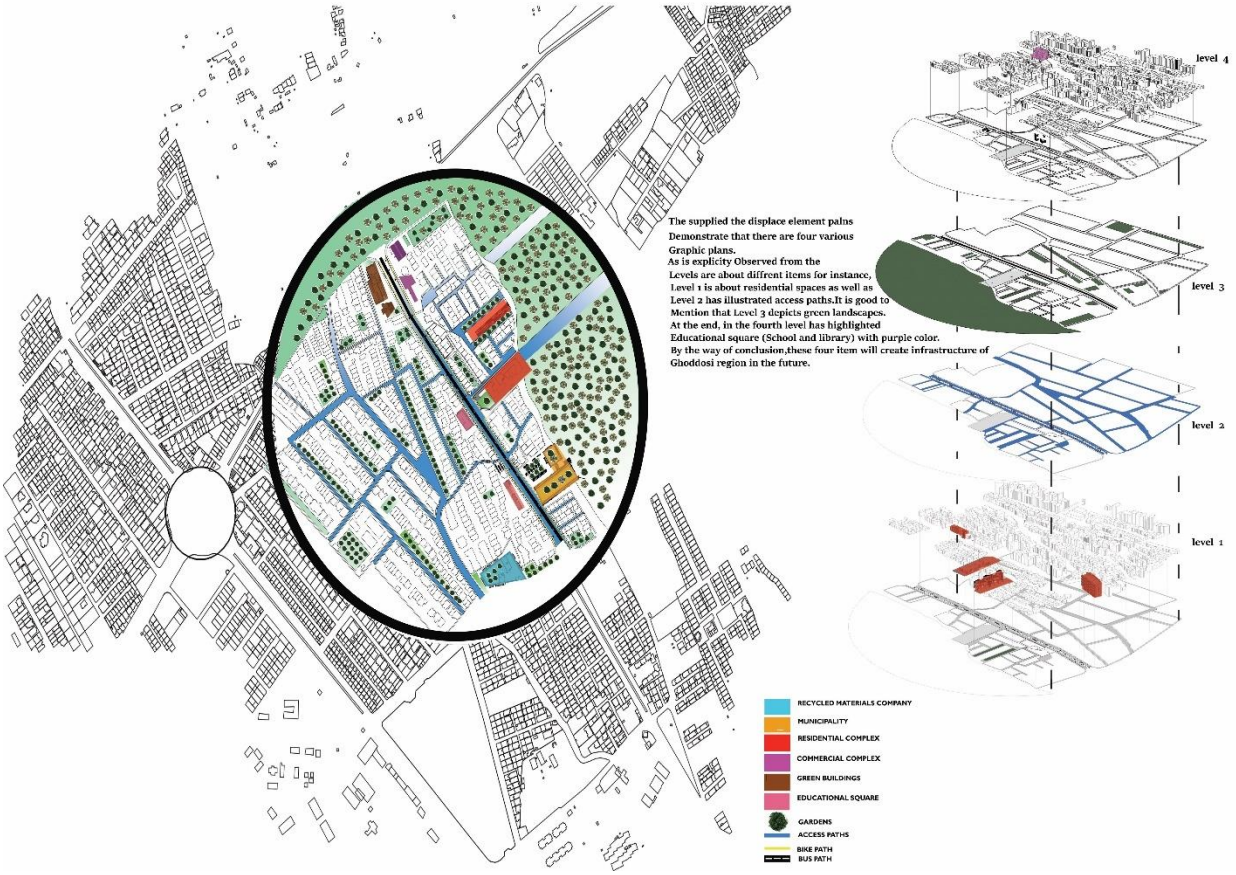
6.1.5. Swot analysis

	S	W	O	T
Functionality	-Rich building types -Local Park -Baba bastani ice cream shop -Services -Existing markets and bazaars	-Lack of recreational functions in park	-Designing local park -Designing hyper markets	-Visiting other areas because of recreational functions and park
Access	-Transportation access -Central area -Public transportation -Quality of asphalt ways -Wide pavement	-High traffic density -Lack of car parks	-Designing car parks due to abundance of commercial functions	-Creating parking: There is a possibility of decreasing relaxation of areas because of high number of residential textures
Physical	-The ratio of outdoor spaces to indoor spaces (Residential areas have more open spaces)	-Being of old textures -density	-Destroying old textures and constructing other functions	-Increasing population and destroying building with yards and can cause to increase the density
Environmental	-Near to the Qasrodasht gardens can bring good ventilation	-Lack of green areas (small local areas)	-Designing local park	-Destroying private gardens and constructing residential buildings
Social	-High cultural level of households are -There is a high possibility of coming people in this area of every ages and trends	-	-Commercial and cultural functions are more attractive due to high income of households	-
Economical	-High value of commercial real estate -High income of households	-	-Increasing of enterprising in residential area due to high income of households	-

Table 17. Swot analysis, (Source: Author)

6.2. Future development


Public Area
Recycled Materials Company
Educational Square(school and library)
Municipality
Green Building in Area
Neighbourhood Area
Residential area
Separating Bike Pass and Pedestrian in the street
Commercial Complex


The supplied the displace element palns
Demonstrate that there are four various
Graphic plans.
As is explicity Observed from the
Levels are about diffrent items for instance,
Level 1 is about residential spaces as well as
Level 2 has illustrated access paths.It is good to
Mention that Level 3 depicts green landscapes.
At the end, in the fourth level has highlighted
Educational square (School and library) with purple color.
By the way of conclusion,these four item will create infrastructure of
Ghoddosi region in the future.
level 4
level 3
level 2
level 1
RECYCLED MATERIALS COMPANY
MUNICIPALITY
RESIDENTIAL COMPLEX
COMMERCIAL COMPLEX
GREEN BUILDINGS
EDUCATIONAL SQUARE
GARDENS
ACCESS PATHS
BIKE PATH
BUS PATH

Chapter 7.
Conclusion

This thesis shows a new approach of how to implement sustainable smart discipline in a newly developed and comprehensive environment. This idea addresses future challenges in terms of urbanization and sustainable cities, and it can also provide a better understanding of the whole energy flow within a city about the true properties of all buildings, total energy distribution, production, economics, aspects. I presented a method of the sustainable new town, regarding techniques that are required to make a sustainable smart area like using the high potential of natural resources – improving the long-term social and ecological health of cities – built environment and natural components – new method and technologies based on smart cities – smart infrastructure.

This research tries to encourage a focus on urban sprawl, which is rapidly spreading in Shiraz city. This approach is important from two perspectives:

1. The new sustainable city provides a balance between ecological benefits to nature and recreational activities, technological advancements, a resilient city approach would act as a prototype for the city of shiraz for people. This approach creates an experience which would allow residents to develop a knowledge base about what may happen in the future regard to sustainability
2. The sustainable methods start from climate, site, massing, and program. With these useful data, we could change them into passive strategies: shading, lighting, ventilation, etc. After using passive strategies to develop the city, I also take advantage of renewable energy which will power the building in the city and be helpful for residents to learn sustainability.

For this thesis, I just provide a new concept for people who live in Ghodoosi urban areas a better living condition. An equal, comfort, happier life. It is not just designed an architectural form, but the most important thing is to design a social network Here, urbanization has a new meaning, not to provide people with a new city, new look, but to learn to respect everyone lives there, learn how to protect vulnerable groups, learn fair. I think this is the sociological significance of urbanization, a more fundamental significance.

Technological advancements like creating an integrated mechanism for waste management and energy efficiency in the site acts as a focus of the project. It is important to link leisure activities which creates a

vibrant place with educational, cultural, artistic, and technical benefits which can lead to sustainability with appropriate management.

This research finds it out that the city planning strategy prepared by the municipality could successfully pave the way by considering the relevant mentioned factors, stimulate professionals, urban decision-makers, and executive officials to articulate and strengthen the dynamics of management, qualification, and renovation to achieve sustainable smart city goals.

Based on the history and heritage, combined with the current situations and survey, using the sustainable design methods that start from climate, site, massing, and program to passive strategies, building systems, and the using of renewable energy could be used and developed in the sustainable design of Ghodoosi area in the future.

During this research, 6 steps were done carefully. In the first step, I investigate the sustainable smart city and how I can implement it in the city that has a high potential of becoming a sustainable smart city. In second step I realized a part of shiraz that is in a best zone of a city to become sustainable smart city because of vicinity to private gardens, abundance of green areas, possibility to implement new technologies based on sustainability which in this step I also had interview with some of the residents which more than 70 percent of residents were aware of sustainable smart city, which they mentioned some good idea to achieve sustainability and they believed that in city of shiraz and especially in Ghodoosi area (case study area) most of the fundamental criteria to achieve sustainable smart city have already done. In the third step, I investigate sustainable city and try to understand sustainable city requirements as functions, facilities, and infrastructures that are required for a city to become sustainable city. in forth step I investigate smart city and I searched some case studies in the world to find the best solution for the city to achieve smart city. I also realized some good measures that help us to have a smart city in the future. In the next step, I focus on the city of shiraz and I start to find problems toward sustainability. Poor management of traffic, earthquake, flooding, air pollution, and natural resources efficiency are the significant challenges for the unsustainable urban development that we will face with them in the process of having a sustainable smart city. Furthermore, in this step I try to find some solutions and strategies for each problem then I apply my idea of future development in the proposal area (Ghodoosi). In the last step I have designed my schematic proposal for the area of Ghodoosi in the 1st district of shiraz and I add all necessary methods that I studied and I investigated in this research to reach a sustainable smart area in a part of shiraz.

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